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IMPLEMENTATION OF DECISION SUPPORT SYSTEM FOR ECOLOGICAL ENVIRONMENT PLANNING OF URBAN GREEN SPACE

Abstract: As a highly concentrated residential area, urban development and population concentration have caused serious environmental pollution problems that threaten the safety of the water and atmospheric resources that humans rely on for survival. To address this issue, the importance of urban green space (UGS) has become increasingly prominent. This paper collected data related to UGS (green space coverage, vegetation type, environmental quality, population distribution, etc.) for processing, used the entropy algorithm to build an ecological environment assessment model, and then used the particle swarm optimisation algorithm to optimise the model accordingly. Finally, a decision support system was proposed for UGS ecological environment planning, which comprehensively considered future environmental changes. Through comparison before and after the application of decision support system, this paper tested and verified several indicators such as green space coverage, biological diversity index, and climate adaptability. Among them, after the application of the decision support system, the green space coverage rate has increased year by year, and many indicators in the biological diversity index have improved significantly. The average climate adaptability of traditional UGS planning was 70 %, while the average climate adaptability of decision support system green space planning was 90 %, which has been significantly improved. The outcome shows that the system has a notable effect in improving the climate adaptation and ecological quality of the city.

Keywords: urban green space, ecological environment, planning decision, decision support system, sustainable development

Introduction

As urbanisation continues to accelerate, cities face increasingly severe climate change and environmental issues. The Urban Green Space Ecosystem Planning Decision Support System (UGS) aims to provide comprehensive information support to urban planners and decision makers through data collection, analysis and simulation functions. The system can incorporate multiple data sources, including land use, climate, water resources, etc., to help understand the condition of urban green spaces. the UGS is an indispensable part of the urban ecosystem. Urban green space can absorb and purify pollutants in the air, reduce air pollution, and provide fresh air for residents to breathe. Second, the vegetation of urban green space can absorb and retain precipitation to mitigate the risk of urban flood.

The planning of the ecological environment of UGS has always been a hot issue and has received a great deal of attention. Sun et al. [1] quantified and mapped the aboveground carbon storage of UGS in Beijing, the capital of China, and found that if UGS was planned

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and designed according to the high carbon density trajectory, UGS had great potential to mitigate future climate change. However, when urban development reached a certain carbon density threshold, this potential was very limited. Wang et al. [2] investigated 513 sports activities of UGS residents, built an ordered probit regression model based on the collected cross-sectional population data, and analysed the impact of UGS on sports activities of residents from the perspective of social ecology. Li and Fan [3] integrated the indicators of ecology and urban development evaluation into the UGS landscape planning scheme and simply understood and predicted human behaviour, to make a more comprehensive evaluation and prediction of the UGS landscape planning scheme. Li et al. [4] divided the impact of UGS into direct parts, including the scale, coverage, and accessibility of UGS, and indirect parts, including the environmental and economic performance of UGS, which was measured by the bootstrap DEA model (Data envelope analysis). However, traditional planning of UGS is often lacking in scientific and systematic knowledge, which cannot effectively cope with climate change and environmental pressure. Therefore, the growth and application of the UGS ecological environment planning decision support system has become an urgent demand. It can provide a scientific basis and decision support for urban planning and decision-making, and improve the climate adaptability and quality of the ecological environment of cities.

In the research of UGS ecological environment planning, some achievements have been made in the decision support system. For example, Guo et al. [5] evaluated the impact of various natural and socioeconomic factors on green space changes. He determined the weights of various resistance factors in the ecological process based on the results of the factor detector, and used the minimum cumulative resistance method to build the ecological network of green spaces in Jinan, providing decision-making support for urban planning and management. Oscilowicz et al. [6] used a planning decision support system to demonstrate that a green environment is directly related to the material and sociocultural displacement of socially or ethnically disadvantaged residents, as well as unsafe housing conditions, and has a significant impact on health. Ouzir et al. [7] believed that public green space is the main island with high altitude and natural surface in the urban structure, which can accommodate a relatively large number of plant species. He established a decision support system for efficient planning of UGS in Algeria. However, most research is limited to a single field or specific environmental conditions. The limitations of this research have led to insufficient comprehensive consideration of future environmental changes.

A large number of data related to UGS was collected in this paper, including green space coverage, vegetation type, environmental quality, and population distribution. By processing these data, an ecological environment assessment model was constructed using the entropy algorithm. The model can quantitatively evaluate the ecological environment of UGS, and thus provide decision support for urban planning and environmental management. In order to further optimise the evaluation model in this article, a particle swarm optimisation algorithm was also–introduced to adjust the weight and parameters of the model, so as to make the evaluation findings of the model more accurate and reliable. Through rational planning and management of UGS, the effect of urban heat island can be effectively alleviated; air quality can be improved, and biodiversity can be better protected [8, 9].

Implementation of the UGS planning support system

UGS planning is an essential issue in the development of modern cities. However, compared to the increasingly spreading urbanisation process, there are still certain challenges in effective planning and management of UGS. Under limited land resources, how to reasonably allocate green spaces to meet the needs of residents and improve the livability and sustainability of cities is a complex issue that requires full consideration of various factors. Different residents and stakeholders have different needs for green spaces. Some people hope to have more sports venues; some people pay more attention to the ecological environment and natural landscape, and some people prefer places for social and cultural activities. How to achieve optimal green space allocation while meeting diverse needs is a challenge. To assist urban planners to make scientific decisions during the process, the decision support system for UGS planning are:

This system utilises advanced technology and data analysis to help planners focus on planning strategies and innovative solutions. Above all, the system has gathered and organised a large amount of urban data, and then established a corresponding ecological environment evaluation model for simulation.

This intelligent decision support can aide planners in making long-term green space planning decisions and improve the efficiency and feasibility of urban planning.

In summary, the design and implementation of the UGS planning decision support system can provide a powerful tool [10, 11].

Spatial data collection and processing

Spatial data collection and processing is an important part in the UGS planning decision support system [12, 13], and the following is a specific process:

(1) Data collection: data related to UGS can be collected, including land use type, land ownership, green space coverage, vegetation type, environmental quality, and population distribution.
(2) Spatial analysis: GIS (Geographic Information System) and other tools are used to conduct spatial analysis on the collected data. Based on vegetation type and environmental quality data, the assessment of green space suitability and the analysis of the ecological environment can be carried out.
(3) Data processing and integration: The original data collected is processed and integrated to meet the needs of green space planning, including data cleansing, format conversion, data standardisation, data interpolation, etc. At the same time, different data levels can be integrated to establish a comprehensive urban green map for subsequent analysis and visualisation. The green map of the simulated city based on the collected data is shown in Figure 1.

Through the above process, spatial data related to UGS can be collected, analysed, and processed, and some relevant data can be supported to enhance the reliability and accuracy of data. These processed data can provide a scientific basis for subsequent green space planning decisions and support the design and implementation of the UGS planning decision support system [14, 15].



Fig. 1. Map of the urban green space

Construction of ecological environment assessment model

The construction of an ecological environment assessment model is to assess the contribution of UGS to the ecological environment and sustainable development. By building an evaluation model, it is possible to quantify and compare indicators such as biodiversity and climate adaptability in different green areas, helping decision makers to make scientific decisions about the planning and management of green spaces. Based on the results of the evaluation index, the model presents the contribution level and sustainable development of each green area, providing scientific data support and a decision-making basis for decision-makers, helping them understand the advantages and disadvantages of different regions, and thus selecting the most suitable green space planning plan. Complex data can be transformed into assessment results that are easy to understand and compare, and can also provide a decision-making basis for the ecological protection and healthy development of UGS [16, 17].

The entropy method quantifies the differences and relative importance between indicators by calculating the entropy value of each indicator, and determines the weight of each indicator based on the entropy value [18, 19]. The method can more accurately reflect the impact of different indicators on the ecological environment. The following is the specific formula of the entropy algorithm:

$$H_x = -\sum_{y=1}^{n} p_{xy} \ln(p_{xy}) \tag{1}$$

where, H_x is the information entropy of the x-th indicator, representing the uncertainty measure of the indicator in the entire evaluation system, and p_{xy} - the normalised value of the x-th indicator.

After that, it is necessary to use the Analytic Hierarchy Process (AHP) for weight calculation, which is a qualitative and quantitative multicriteria decision-making method that can help determine indicator weights, build evaluation models and make decisions [20, 21]. AHP can decompose complex evaluation problems into a series of hierarchical sub-problems and establish a hierarchical structure model. By comparing nodes at different levels in pairs, a judgment matrix is obtained, and then the eigenvalue method is used to

solve the judgment matrix to obtain the weight of each node, so as to establish a complete ecological environment assessment model for evaluation and decision making. The relative weight is calculated as follows:

$$Q_{ij} = \frac{1}{\mu}\sum_{t=1}^{n} \frac{p_t}{R_{it}} \cdot \frac{1}{\sum_{t=1}^{n} \frac{p_t}{R_{it}}} \tag{2}$$

where, p_t is the importance of the t-th factor to the i-th factor, and R_{it} is the cost or resource required by factor i to control factor j.

Finally, the gray correlation analysis method is utilised, which can reflect the degree of interrelationship between different factors or samples by calculating the correlation index [22]. By measuring the degree of correlation, it is possible to reveal the internal connections and the degree of influence between variables, helping to understand the complexity of ecological environmental systems. This method can also establish mathematical models through historical data correlation analysis to infer future trends and changes in environmental quality:

$$x_i = \frac{min\ {}^{p_i}/_{p_j}}{\sum_{j=1}^{n}(min\ {}^{p_i}/_{p_j})} \tag{3}$$

where $min\ p_i/p_j$ represents the smallest ratio between p_i and p_j; x_i - the correlation between the i-th factor and the reference sequence.

Planning scheme generation and optimisation

Using computer algorithms and optimisation models, multiple candidate schemes can be quickly generated and the best scheme can be found through evaluation and comparison. This method can help urban planners better consider the protection of the ecological environment, rational use of resources [23, 24].

The genetic algorithm optimisation method is adopted to generate multiple planning schemes [25, 26]. Multi-objective optimisation algorithms are utilised to generate multiple candidate solutions and find the optimal balance point by weighing the weights of different indicators, so that the planning scheme can achieve good economic, environmental, and social benefits [27]. This plan fully considers the requirements for the protection of the ecological environment, the rational use of resources and the sustainable social development. Through the generation and optimisation of the planning scheme, the target is to achieve the healthy development and sustainable development goals of UGS, and establish a liveable, business and tourism friendly urban environment.

After obtaining the generated scheme, this article uses a particle swarm optimisation algorithm for corresponding optimisation. First, the parameters need to be initialised: the number of particles n, the maximum number of iterations T_{max}, and the inertia weight w. Next, the position and velocity of the particles are calculated. The formulas for updating particle velocity and position are as follows:

$$v_i(t+1) = w \cdot v_i(t) + c_1 \cdot r_1 \cdot (p_i(t) - x_i(t)) + c_2 \cdot r_2 \cdot (g_i(t) - x_i(t)) \tag{4}$$

$$x_i(t+1) = x_i(t) + v_i(t+1) \tag{5}$$

where $v_i(t)$ is the velocity of particle i at the current time t. w - the inertia weight used to balance the historical velocity of particles themselves. c_1 and c_2 are acceleration constants that, respectively, control the influence of individual cognition and social cognition. r_1 and

r_2 are random weights used to introduce randomness. $p_i(t)$ is the individual optimal position of particle i at the current time t.

Finally, it is necessary to calculate the fitness of the particles, which is generally used to evaluate the performance of the current particle.

$$Fitness(r_i) = f(r_i) \tag{6}$$

where, r_i represents the i-th particle, and $Fitness(r_i)$ - its fitness. $f(r_i)$ is a function customised on the basis of the specific requirements of the problem.

The UGS ecological environment structure diagram is a visualisation tool, which is used to display different types of green space in the city and its ecological environment functions. This schematic diagram graphically presents the distribution, connection and relationship of UGS. The structure of the ecological environment of UGS in this system is shown in Figure 2.

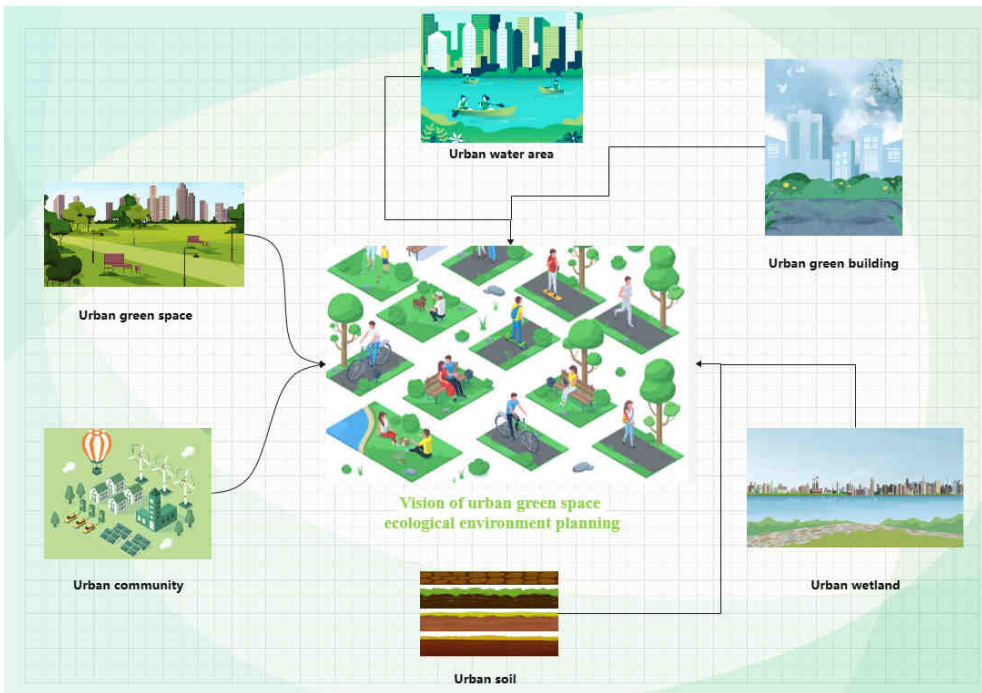


Fig. 2. Schematic diagram of the ecological environment structure of UGS

Development of decision support systems

Ecological principles and models are used to assess the ecological function of urban green spaces. By evaluating the ecological functions of green spaces. This visual interface diagram provides intuitive and effective decision support for UGS ecological environment planning and decision making. Through data analysis technology, urban green space data is collected and analysed. Depending on the results of these data analyses, the system can then offer suggestions for improvement, such as increasing the area of green space, emphasising the layout of green space, and so on, in order to improve the ecological function and

ecological service value of urban green space. The visual support system is shown in Figure 3.

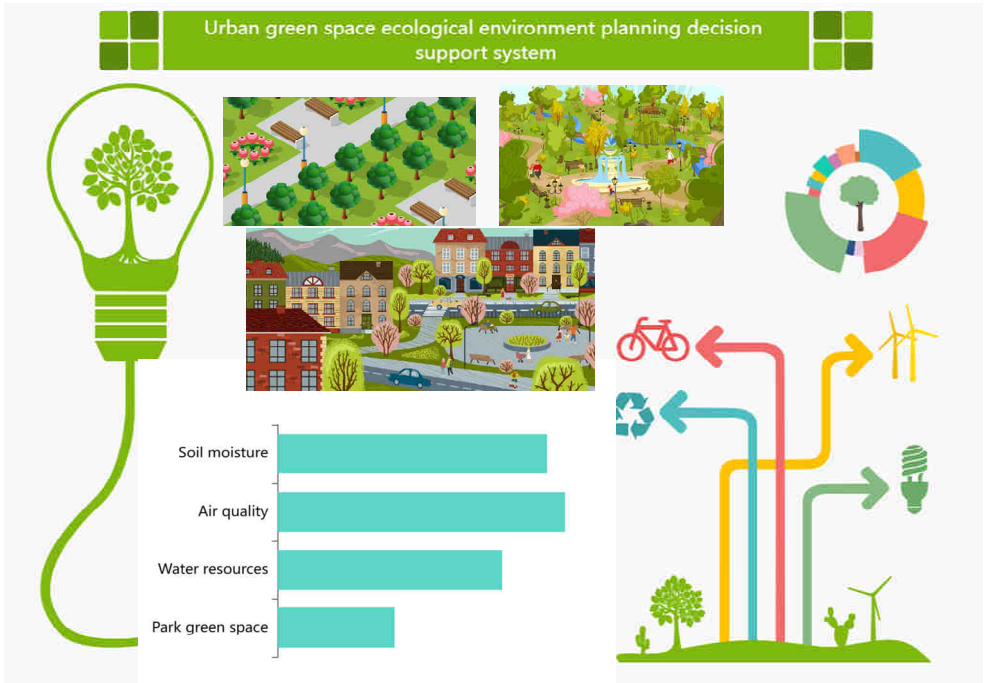


Fig. 3. Visual interface of the UGS ecological environment planning decision support system

Through this interface map, users can intuitively notice the distribution of UGS, different types of vegetation coverage, water distribution, biodiversity areas, and other important information. At the same time, the interface diagram also provides a visual display of various indicator data related to green space planning. In this visual interface diagram, the system can provide intelligent planning suggestions and optimisation schemes to support decision makers in making scientific and reasonable decisions in UGS planning. The interface diagram can provide the evaluation results of multiple optimisation schemes, including indicators of economic, environmental, and social benefits. Users can compare the advantages and disadvantages of different solutions through interface diagrams to make scientific and reasonable decisions.

Decision support systems play an important role in urban planning and decision-making processes. The following are some specific functions of the decision support system designed in this paper and the changes it may cause in the city:

(1) Integration and analysis of data: The decision support system integrates and analyses data related to green space in N city, such as vegetation coverage rate, soil quality, water environment status, etc. As we can see in the upper center of Figure 3, six types of public urban green space were considered in this article, which are a variety of parks, recreational forest belt; residential green space, traffic green space, attached green space, production protection green space, scenic green space located in the city

or suburbs which may be located in the scenic area, rest area and health resort, and also include urban water surface, road square. Through the analysis of these data, the ecological environment of urban green space can be fully understood, and existing problems and hidden dangers can be found in time.

(2) Analysis of the Geographic Information System: Urban geographic information including all kinds of plane and elevation control points, buildings, roads, water systems, terrain, vegetation, place names and some attribute information, etc. Geographic information system uses computer and network technology to input, store, query, retrieve, process, analyse, display, update, and provide applications of urban spatial and non-spatial data. The decision support system constructs an evaluation index system based on the above data analysis results, which is used to evaluate the status of the ecological environment of the green space in N city. These indicators can include green space landscape indicators, biodiversity indicators, water environment indicators, etc., which can comprehensively assess the ecological environmental quality of urban green space.

(3) Planning advice: Based on the index system and the results of the data analysis, the decision support system provides scientific and reasonable planning advice to decision makers. These suggestions include optimisation of the green space layout, improving the function of the green space, and protecting measures of green space which are helpful in improving the quality of the ecological environment and the level of sustainable development of urban green space, such as the use of clean energy, green commuting, economical construction, design and construction of green spaces on urban roads, scientific recycling and reuse of solid waste, etc.

(4) Decision process support: The decision support system provides a user-friendly interface and operation mode, so decision makers can easily and quickly use the system to make decisions. The system provides interactive support for decision process, helps decision makers compare alternatives, evaluate decision risk, and so on, so as to improve the scientific nature, stability, pertinence, and veracity of decision.

Comprehensive evaluation of the UGS planning support system

Comprehensive evaluation is one of the commitment steps of the UGS planning support system. With the complexity of UGS planning and the increase of data, planning decision-makers need a powerful and reliable system to assist decision-making. Comprehensive evaluation can promote a deeper understanding of the system's performance and functionality, as well as whether the system meets user needs.

In this paper, we take City N, located in southeast China, as the target city and collect a large amount of data from the local statistical yearbook from 2010 to 2019 and published literature, and some of the data are also from questionnaire survey. There are a wide variety of urban greening plants in City N, with nearly 2,000 species of higher plants belonging to more than 300 families and more than 1,000 genera. Among them, there are about 70 types of bryophytes, belonging to more than 40 families and more than 50 genera. There are about 60 kinds of ferns, belonging to more than 35 families and more than 45 genera. There are about 50 kinds of gymnosperm, belonging to more than 15 families and more than 30 genera. There are about 1800 species of angiosperms that belong to more than 200 families and 800 genera. The number of plant species in City N accounts for about 50 % of the plant resources in the region, and its rate of green space coverage reaches 45 %,

ranking in the forefront of similar cities in the region. The types of vegetation in City N are rich and diverse, including forest, grassland, wetland, flower bed, urban park and other types. Among them, the forest area represents 30 % of the total green space area, the grassland area represents approximately 15 %, and the wetland area represents approximately 5 %.

Based on the above various data of City N, a series of evaluation tests which aimed to verify were conducted as the following steps.

Environmental and social verification testing

This article conducted relevant experimental verification on the impact of applying decision support systems in the environment. The comparison table of environmental-related impacts is shown in Table 1.

Table 1

Comparison of environmental impacts

Comparison parameter	Before application	After application
Green area [km^2]	5,000	12,000
Per capita green area [m^2/person]	3	7
Air Quality Index (AQI)	73	95
Urban heat island effect index	0.5	0.2
Area of ecologically sensitive area [km^2]	70	40
Community residents satisfaction index	65	82

According to the analysis of the data in Table 1, the green coverage area: before the application, the green coverage area was 5,000 km^2 and after the application it increased to 12,000 km^2. This indicates that after application, the city has increased a large amount of green space coverage and expanded and renovated existing green spaces through new green space planning. Per capita green space area: Before application, the per capita green space area was 3 m^2 per person, but after application, it increased to 7 m^2 per person. This means that people can enjoy more green space after application, have better opportunities to access the natural environment, and have a positive impact on the ecological welfare and quality of life of urban residents. Air quality index: before the application, the air quality index was 73, but after the application it increased to 95. Urban heat island effect index: Before application, the urban heat island effect index was 0.5, and after application it decreased to 0.2. The above comparison data indicates that planning decisions have taken a series of measures to reduce the heat island effect of the city and enhance the thermal environment and comfort of the city after the application of the model. After the application of the decision support system, the city's air quality index has improved and the urban heat island effect index has decreased, indicating that the decision support system has had a positive impact on improving the city's environmental quality and thermal environment.

In conclusion, through the use of the decision support system, the increase of UGS, the improvement of per capita green space, the reduction of the heat island effect and the improvement of community residents' satisfaction have all made positive improvements. These comparative data reflect the positive role and effectiveness of the decision support system in the planning of the ecological environment of UGS.

The comparative table of social impact is shown in Table 2.

Table 2

Comparison of social impact

Contrast parameter	Before application	After application
Utilisation rate of green space [%]	47	68
Saving water consumption [10,000 m^2/year]	110	170
Land resource use efficiency [%]	71	84
Air purification rate [%]	75	90
Ecological landscape area [km^2]	30	50
Sustainable planning index	65	80
The number of jobs added	300	700

According to the data analysis in Table 2, the utilisation rate of green space: before application, the utilisation rate of green space was 47 % and after application it increased to 68 %. This shows that the rate of utilisation of green space in the city has increased through the application of a planning decision support system, and the utilisation efficiency of UGS may be improved through reasonable layout, transformation, and management of existing green space. Land resource utilisation efficiency: Before the application, the land resource utilisation efficiency was 71 %, but after the application it increased to 84 %.

Ecological landscape area: Before the application, the ecological landscape area was 30 km^2, and after the application, it increased to 50 km^2. This means that after application, the city has increased the area of its ecological landscape, which may be improved by measures such as adding ecological parks and wetland protection. This indicates that after application, decision support systems pay more attention to the principle of sustainable development in urban planning decisions, possibly considering various factors such as economy, society, and environment to formulate plans and improve the sustainability of cities. Number of added employment positions.

In summary, through the application of this decision support system, cities have achieved positive changes and benefits. These improvements reflect the positive impacts of decision support systems on sustainable development, resource utilisation efficiency, and environmental protection of cities.

Verification of UGS coverage

Verifying the precision of the UGS coverage rate is crucial to ensure the sustainable development of the urban ecological environment. Accurate green space coverage data can help decision makers better understand and evaluate the status of UGS resources and develop more effective green space protection and planning measures. Based on accurate green space coverage data, decision makers can determine priority protected green areas. Areas with low green space coverage or areas with rich biodiversity can be designated as key protection targets, and the corresponding protection policies and measures can be formulated to ensure effective protection of green space resources in these areas. The UGS coverage rate is also one of the important indicators for evaluating the degree of health of the urban ecological environment. The specific test comparison diagram is shown in Figure 4.

The data in each graph in Figure 4 represents the proportion of green space coverage per year in its overall structure. Figure 4a shows the coverage rate of UGS every year prior to the application of the decision support system. Although the UGS coverage rate every year also shows an increasing trend, the growth rate is too small to meet the needs of urban residents. However, Figure 4b shows a significant improvement in the green space

coverage area every year after the application of the decision support system compared to the previous data.

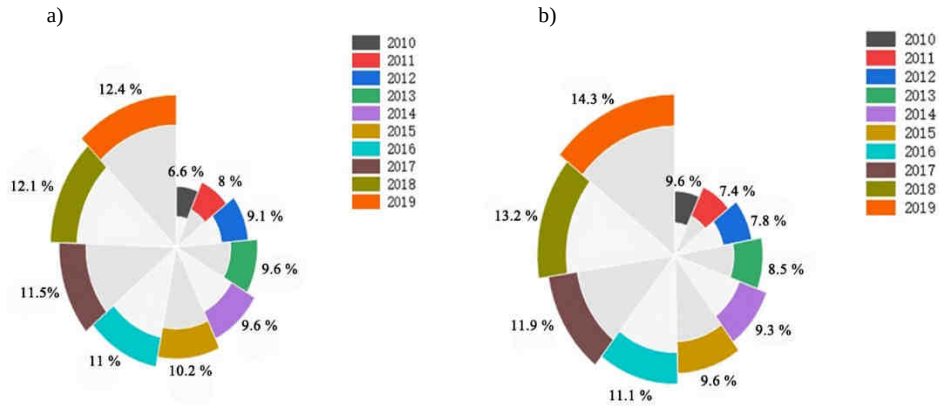


Fig. 4. Comparison of UGS coverage: a) green space coverage before application, b) green space coverage after application

In Table 3 is a comparison of various indicators for cities in 2015, 2020, and expected 2025.

Table 3

Comparison of changes in indicators of sustainable development

Comparison parameter	**2015 year**	**2020 year**	**2025 year (Planning outlook)**
PM2.5 concentration [μg/m³]	85	70	45
Wetland area [km^2]	20	35	50
Water quality index	62	71	85
Noise pollution level [dB]	87	63	40
Natural disaster risk level	High	Middle	Low
Soil erosion index	0.6	0.4	0.3

Table 3 integrates different environmental indicators and lists their values in 2015, 2020, and expected 2025 to show the changing trends of cities in environmental protection and sustainable development. Based on the data provided in Table 3, the following analysis and observations can be made.

The PM2.5 concentration was 85 μg/m^3 in 2015 and was expected to decrease to 70 μg/m^3 by 2020. It was expected to decrease to 45 μg/m^3 by 2025. This indicates that in the past few years, cities have taken effective measures to reduce particulate matter pollution and achieved significant improvements. Wetland area: in 2015, the wetland area was 20 km^2, increased to 35 km^2 by 2020, and increased to 50 km^2 by 2025. This shows that the city has taken a series of water quality improvement measures, including strengthening water pollution control, improving the efficiency of water treatment facilities, and strengthening source water protection.

In summary, according to the provided data analysis, it can be learned that cities have made positive progress in environmental aspects. From the perspectives of reducing air

pollution, increasing wetland area, improving water quality, reducing noise pollution, risk of natural disasters, and soil erosion, the efforts of cities to protect the environment and develop sustainable development are extremely obvious.

Verification of diversity index

Biodiversity is of great importance for UGS planning and environmental protection. To verify the level of biodiversity in UGS, a detailed verification investigation of the diversity index was implemented. The relevant comparison is shown in Figure 5.

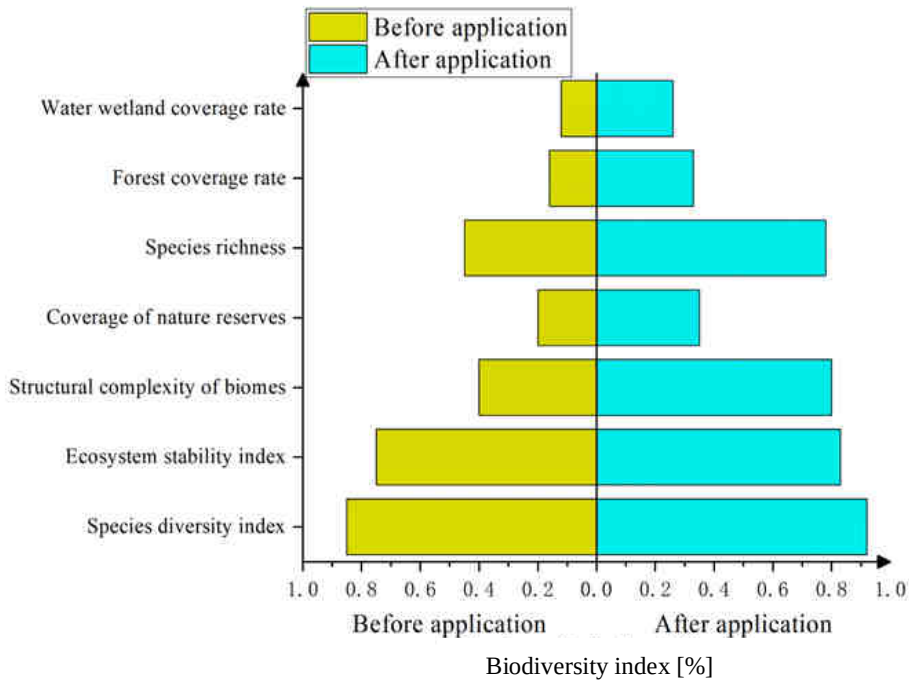


Fig. 5. Comparison of biodiversity

According to the analysis in Figure 5, the improved species diversity index: after the application of the decision support system, the species diversity index increased from 0.85 to 0.92, indicating that the biodiversity of biological species has increased, and the number and species of species in the ecosystem have become more abundant. Improved ecosystem stability index: after the application of decision support systems, the ecosystem stability index increased from 0.75 to 0.83, indicating that the stability of the ecosystem has been improved and ecological processes and interactions are more balanced and sustainable. Increased complexity of the biological community structure: after the application of the decision support system, the complexity of the biological community structure increased from 0.4 to 0.8, which means that the composition and structure of the biological community become more complex, and interspecific relationship and interactions become more abundant.

Increased coverage rate of natural reserves: after the application of decision support systems, the coverage rate of natural reserves increased from 0.2 to 0.35, which means that more areas have been protected and the damage to the natural ecological environment has been curbed to a certain extent. The increase in species richness: after the application of decision support systems, species richness increased from 0.45 to 0.78, indicating an increase in the number of biological species and an improvement in biodiversity in the ecosystem.

In summary, the application of decision support systems has significantly improved and enhanced biodiversity indicators. These results show that the decision support system plays a positive role in promoting the ecological environment planning and protection of UGS, and is conducive to promoting the protection and sustainable development of biodiversity.

As biodiversity becomes more complex, it also brings powerful economic benefits. The economic impacts of different planning schemes were quantified and compared, as shown in Table 4.

Table 4

Comparison of economic benefits

Comparison parameter	Before application	After application
Tourism Revenue Growth [10,000 Yuan/year]	900	1,500
Incremental investment in green building construction [10,000 Yuan]	6,000	8,000
Energy savings [10,000 Yuan/year]	1,100	2,300
Reduction in health expenditure [10,000 Yuan/year]	1,400	3,400
CO_2 emission reduction [t/year]*	1,900	3,100

* [t] = tonne = 10^3 kg = 10^6 g

Before the use of the decision support system, the increase in tourism revenue was 9 million yuan per year, and after the application, it increased to 15 million yuan per year. This indicates that cities can bring better tourism revenue growth through the application of planning decision support systems and may attract more tourists through efforts to improve ecological environment quality, green space construction, and other aspects.

As a result of the application of this decision support system, the city has achieved positive economic benefits. These improvements demonstrate the positive implications of the decision support system for the city's sustainable development, economic efficiency and environmental protection.

Climate adaptability testing

While facing climate change, climate resilience refers to the ability of a city to mitigate disaster risks, protect the environment and improve the quality of life of its inhabitants. To compare the impacts of different green space planning strategies on climate resilience, the following comparison chart shows the results of traditional unattended ground sensor planning and green space planning in terms of climate resilience from a decision support system. The details are shown in Figure 6.

Figure 6 shows the comparative data of the two in terms of climate adaptability. The horizontal axis represents a total of nine experiments, and the vertical axis represents climate adaptability in units of %. According to the above analysis, the average climate adaptability of traditional UGS planning was 70 %, with the highest 76 % and the lowest

62 %. The average climate adaptability of green space planning in the decision support system was 90 %, with a maximum of 94 % and a minimum of 86 %. Through the comparison, it can be learned that the planning of green spaces of the decision support system performed better in terms of climate adaptation and the average climate adaptability was higher. The highest and lowest values also exceeded the highest and lowest values of traditional UGS planning.

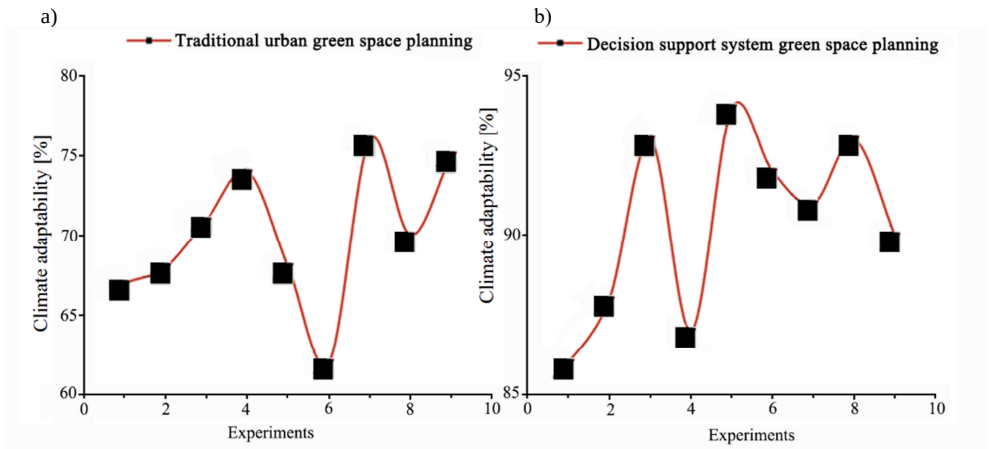


Fig. 6. Comparison of climate adaptability: a) climate adaptability of traditional urban green space planning, b) climate adaptability of green space planning in decision support system

Conclusion

As an important part of the urban ecosystem, UGS is of great significance in improving the urban living environment and improving the quality of life. To scientifically plan UGS and effectively manage the ecological environment, it is urgent to establish a system to support decision making. The purpose of this study was to explore the research and implementation of the UGS ecological environment planning decision support system, and to provide scientific planning methods and decision support means for urban sustainable development. This paper was tested and verified from multiple dimensions and concluded that the decision support system has greatly improved the ecological environment of UGS. There are still some uncertainties and precision limitations in the current model established. In this paper, by comparing the coverage of green spaces and the corresponding biodiversity index before and after the application of the decision support system, the superiority of the design decision support system for the planning of ecological environments of urban green spaces was verified. By continuously optimising the parameter settings of the model, the selection of algorithms and the structure of the model, the accuracy and predictive ability of the model can be improved. At the same time, model validation and testing are conducted to compare and validate the output results of the model with the actual situation, to evaluate the performance of the model and make improvements. However, through continuous efforts and innovation, it is still necessary to have confidence in improving and optimising the UGS planning decision support system to reach a new height, providing a better guarantee of the sustainable development of the city.

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