International Journal for Housing Science and Its Applications
Publish August 10, 2025. Volume 46, Issue 4 Pages 261-270

https://doi.org/10.70517/ijhsa46421

Optimization of plant community structure and ecological impacts in landscape gardens based on quantitative computational analysis models

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Abstract The reasonable configuration of plant community structure in landscape garden is the core factor to maintain ecological balance and landscape sustainable development. Starting from the spatial structure of plant communities, this paper proposes an evaluation index system for the spatial structure of plant communities consisting of four different dimensions, namely, horizontal structure, vertical structure, tree species composition structure and seasonal structure. The AHP-PCA entropy weight combination model was introduced as a method to assign weights to the indicator system and a test method for the indicator structure. A total of 120 landscape garden sample plots in three districts and counties of K city were selected as the research objects, and the questionnaire on the structure of landscape garden plant communities was designed by combining the natural conditions of K city with the evaluation index system of the spatial structure of plant communities. Based on the questionnaire data and AHP-PCA entropy weight combination modeling method, the evaluation index system of landscape garden plant community structure was determined. Using this index system to evaluate the plant community structure of 120 landscape garden sample plots, the highest evaluation values are between evaluation levels 1-3, indicating that the overall configuration of plant community structure in landscape gardens in K city is more reasonable.

Index Terms plant community structure, landscape garden, AHP-PCA entropy weighting method, ecological balance

I. Introduction

As the place where human beings transform nature most thoroughly, under the process of urbanization, its development is facing ecological and environmental crises such as environmental pollution, climate change, soil erosion, etc., which have become extremely serious urban problems in the process of urban construction and development at present [1]-[3].

As an important component of urban ecosystems, landscaping plays a key role in exerting ecological service functions, maintaining urban ecological balance, and improving urban ecological environment quality [4], [5]. For coping with sensitive urban environmental problems such as climate change, PM 2.5, rain flooding, etc., the garden plant community improves the biodiversity in the area, maintains ecological balance, and almost becomes a panacea for urban diseases, and also has the function of landscape and cultural display in landscape garden design, which makes gardens present uniqueness [6]-[8].

With the comprehensive improvement of urban economy, society, environment and other comprehensive level, urban garden construction has been developed rapidly. However, in the deteriorating urban environment, plant habitats have been seriously damaged, and the growth and development of plant communities are really worrying [9]. Some garden construction is too one-sided pursuit of quantitative growth, large size, high density and other irrational planting methods on the stability and sustainability of the garden plant community structure pose a hidden danger [10]. Some urban garden construction projects are subject to “short, flat, fast” influence, especially in the “one-time molding” construction mode under the pursuit of high-quality landscape effect in a short period of time, which also brings a certain degree of difficulty to the plant landscape creation [11]. In this case, specification and scale become the means to realize the so-called “high quality” plant landscape effect in a short period of time. These behaviors only take into account the short-term benefits, and do not give much consideration to the dynamic development process of plant communities, which destroys the landscape connectivity and poses a hidden danger to the stability of the plant community structure and the sustainability of the landscape benefits [12], [13]. On the basis of maintaining the continuous growth of the number of urban gardens, how to improve the quality of gardens and promote their sustainable development still requires in-depth consideration. Healthy and stable plant community structure is a prerequisite for measuring the quality of gardens, which can not only provide a good growing environment for plants, but also help to improve the adaptive ability to cope with environmental changes and other problems [14], [15]. Without a stable plant community, it is difficult to realize the benefits and functions of gardens.

In this paper, the structure of the index system for evaluating the spatial structure of plant communities is initially determined, and the calculation method of each index is described. Secondly, it describes the calculation methods of AHP weights, principal component weights and minimum information entropy combination weights, and constructs the AHP-PCA entropy weight combination model. Again, 120 landscape garden sample plots in 3 districts and counties of K city were taken as the research objects, and 9 natural index data were collected as the data basis for evaluating the structure of landscape garden plant communities. Hierarchical analysis was used to process the 9 natural index data to obtain the factors with higher correlation with plant growth. Meanwhile, combining the evaluation index system of spatial structure of plant communities with the natural conditions of K city, the evaluation index system of plant community structure in landscape gardens was established based on the results of the questionnaire survey, and then the AHP model of plant community structure in landscape gardens was constructed. Finally, the constructed AHP model was used to statistically analyze the plant community structure of landscape gardens in three counties and districts in K city.

II. Evaluation of the spatial structure of plant communities

II. A. System of evaluation indicators

II. A. 1) Structure of the indicator system

In this paper, from four perspectives: horizontal structure, vertical structure, species composition structure and seasonal structure, we propose a spatial structure evaluation index system of plant communities containing nine secondary indicators: density, spacing, coverage, tree-shrub-grass ratio, forest layer ratio, species diversity, naturalness, seasonal phase, and evergreen-deciduous ratio, which is shown in Fig. 1.

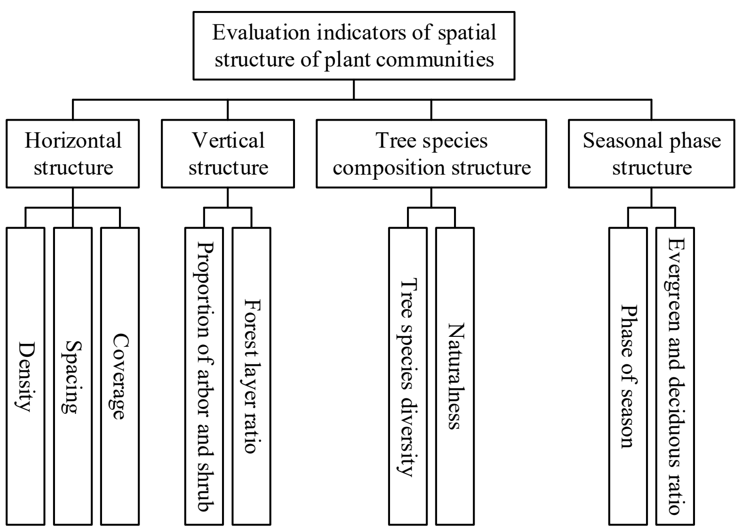

Figure 1: Index System Structure Diagram

II. A. 2) Calculation of indicators

Density: $D = N$ (number of individuals of a plant per unit area)/ S (per unit area), i.e., the ratio of the number of tree and shrub plants to the sample area.

Spacing: The aggregation index R is the ratio of the mean of the distances of the nearest neighboring individual plants to the mean distance expected under a random distribution.

The formula for the aggregation index R is equation (1):

$$R = \frac{\frac{1}{n}\sum_{i=1}^{n} r_i}{\frac{1}{2}\sqrt{\frac{10000}{N}}} \tag{1}$$

where ri is the distance from the i th single plant to its nearest neighboring single plant. N is the number of plants per hectare. n is the number of plants in the sample plot. If $R=1$, the stand is randomly distributed. If $R>1$, the trees are uniformly distributed. If $R<1$, then the trees are clustered, and R tends to 0, indicating that the distance between trees is getting denser and denser.

Cover: $C=Sl$ (area covered by tree species)/ S (sample area)

Proportion of trees, shrubs and grasses: the proportion of the number of tree plants, the number of shrubs, the lawn area and the sample area in the sample. The specific evaluation method is the expert scoring method, which can be roughly graded according to the following criteria:

Grade I: scores in 0.81~1.00 points, good combination of trees, shrubs and grasses, reasonable proportion of trees, shrubs and grasses, three-dimensional compound layer structure is obvious.

Grade II: the score is 0.61~0.80, the degree of combination of tree, shrub and grass is good, the proportion of tree, shrub and grass species is reasonable, and there is a certain three-dimensional compound layer structure.

Grade III: with scores of 0.41~0.60, the degree of combination of tree-irrigation-grass is average, the proportion of tree-irrigation-grass species is incomplete, and there is a lack of mesquite connection, i.e., a lack of shrub layer.

Grade IV: Scores in the range of 0.21~0.40, poor degree of tree-irrigation-grass combination, incomplete configuration of tree-irrigation-grass species proportions, and lack of community upper wood, i.e., tree layer.

Grade V: scores in the range of 0.00~0.20, the degree of integration of tree-irrigation-grass is very poor, the proportion of tree-irrigation-grass species configuration is very incomplete, there is almost no upper and middle trees, and there is only a lawn ground cover structure.

Forest layer ratio (Si), defined as the proportion of trees in the n nearest neighboring trees of the reference tree i that do not belong to the same layer as the reference tree. It can be expressed in equation (2):

$$Si=\frac{1}{n}\sum_{j=1}^{n}S_{ij} \tag{2}$$

where n is the number of neighboring wood plants. The value of S_{ij} is defined as equation (3):

$$Sij=\begin{cases}1, & \text{If the reference tree } i \text{ and the adjacent tree } j \text{ do not belong to the same layer}\\ 0, & \text{If the reference tree } i \text{ happens to be adjacent tree } j \text{ on the same level}\end{cases} \tag{3}$$

Among them:

(1) $0\le Si\le 1$.

(2) Si has $n+1$ values and is discrete. When $n=4$, its 5 possible values are:

$Si=1$, all 4 nearest neighboring trees around the reference tree are not in the same stand as the reference tree.

$Si=0.75$, 3 of the 4 nearest neighbor trees around the reference tree are not in the same stand as the reference tree.

reference tree.

For $Si=0.25$, 1 of the 4 nearest neighbor trees around the reference tree is not in the same stand as the reference tree.

$Si=0$, all 4 nearest neighbor trees around the reference tree are in the same stratum as the reference tree.

(1) The mean value of the stand ratio is calculated as equation (4):

$$\overline{S}=\frac{1}{N}\sum_{i=1}^{N}S_i \tag{4}$$

where N is the total number of reference trees. Si is the stand ratio of the i th reference tree.

(2) For single-storey forests, $\overline{S}=0$ and its different structural units have $Si=0$.

Tree species diversity (H): Shannon-Wiener index is adopted, mainly used to reflect the degree of richness of greening tree species types, which is a comprehensive reflection of the richness of tree species and the uniformity of each tree species, as in equation (5).

$$H=-\sum_{i=1}^{R}P_i\log P_i \tag{5}$$

where $Pi=mi/N$. R,N has the same meaning as above, and m is the number of individuals of the i th tree species. The larger the value of H, the higher the diversity of tree species.

Naturalness: The Grabherr classification system for evaluating the naturalness (naturalness) of urban forests was adopted, and its classification system was improved appropriately according to the characteristics of urban green spaces by changing the 9-level classification system to 6 levels.

Evergreen-deciduous ratio: the ratio of the number of evergreen trees to the number of deciduous trees in the sample plot.

Seasonal phase: the community plants show different appearance in different seasons through different climatic phases such as germination, leaf spreading, flowering, fruiting and dormancy, so that the whole community shows different appearance in each season. The seasonal phase of a plant community can be deduced from the composition of plant species in the community.

II. B.AHP-PCA entropy weight combination model

As the mainstream methods to obtain the weights of evaluation indicators, hierarchical analysis (AHP) and principal component analysis (PCA) have been widely used. The AHP method mainly uses the consistency test of judgment matrix to judge whether the calculation of index weights is reasonable, there is no uniform standard for the quantity and quality of experts, and the evaluation results are mixed with strong subjectivity. The PCA method extracts indicators with significant sample gaps through the cumulative contribution rate, which reduces the dimensionality of the indicators while maximizing the retention of the original indicator information, and can largely exclude the influence of subjective factors, but it will lead to a certain loss of information. Based on the above reasons, this study adopts the combined entropy weight model of AHP-PCA to determine the optimal weight value of each evaluation indicator, and combines with ArcGIS10.2 to complete the evaluation of the current status of ecological environment vulnerability in the study area in each time period.

II. B. 1) AHP weights

AHP constructs the judgment matrix by determining the target layer, criterion layer, element layer and indicator layer, and labeling the importance of each indicator using Satty's 19 scale method. The weight value of each indicator is obtained through eigenvector normalization, and the consistency test is carried out by using the consistency ratio (CR), which is given in equation (6):

$$CR = \frac{CI}{RI} = \frac{\lambda_{\max} - n}{RI \times (n-1)} \tag{6}$$

where, CI is the consistency index, RI is the corresponding average random consistency index, n is the number of elements, and $\lambda_{\max}$ is the maximum eigenvalue of the judgment matrix. When CR<0.1, the judgment matrix is considered to have satisfactory consistency and the weights of the model evaluation indicators are calculated reasonably. The test result CR=0.05<0.1 in this study is calculated reasonably.

II. B. 2) Principal component weights

Use ArcGIS10.2 software control analysis function to import all the indicators, set the number of principal components to 13, ensure that each principal component contains all the indicators, derive the contribution rate and cumulative contribution rate of each principal component, and retain the principal component with a cumulative contribution rate of more than 85% as the main component of ecological environment vulnerability. Determine the weights of each indicator using the mathematical model, the formula is as equation (7)-(8):

$$H_j = \sum_{j=1}^{m} \lambda_{jk}^2 (j = 1, 2, \cdots, 13; k = 1, 2, \cdots, 5) \tag{7}$$

$$w_{2j} = H_j / \sum_{j=1}^{9} H_j (j = 1, 2, \cdots, 9) \tag{8}$$

where, H_j is the common factor variance of each indicator, w_{2j} is the principal component weight of each indicator, j is the number of indicators, k is the number of principal components, and λ is the loading coefficient of indicator j on the k th principal component.

Meanwhile, in order to verify whether the selected indicators are suitable for principal component analysis, i.e., to verify whether the values of the indicators are independent of each other, the indicators are tested with the help of factor analysis (Bartlett's spherical test) of SPSS25. The results show that the Bartlett's chi-square values of 2000, 2005, 2010, 2015 and 2020 are all greater than 32530, so the correlation coefficient matrix is considered to be significantly different from the unit matrix, and the KMO is greater than 0.75, which indicates that the original variables are suitable for factor analysis according to the KMO metric. In summary, the vulnerability indicators selected in this study are suitable for principal component analysis.

II. B. 3) Minimum information entropy combination weights

The subjective weight (w_{1j}) and objective weight (w_{2j}) of each factor can be obtained by AHP and PCA methods, and in order to compensate for the inaccuracy of the two methods in the subjective and objective assignments, according to the principle of minimum information entropy, the combination of weights (w_j), w_{1j} and w_{2j} are closer and more accurate, and their mathematical models are shown in Eqs. (9)-(10):

$$\min F = \sum_{j=1}^{m}[w_j \times (\ln w_j - \ln w_{1j})] + \sum_{j=1}^{m}[w_j \times (\ln w_j - \ln w_{2j})] \tag{9}$$

$$s.t. \sum_{j=1}^{m} w_j = 1 (w_j > 0, j = 1, 2 \cdots, m) \tag{10}$$

where, $\min F$ is the minimum information entropy. w_j is the combination weight of factor j. m is the number of factors, which is 13 in this paper.

Meanwhile, the combination weight of each factor can be found according to the Lagrange median theorem, and the formula is as in equation (11):

$$w_j = \frac{(w_{1j} \times w_{2j})^{0.5}}{\sum_{j=1}^{m}(w_{1j} \times w_{2j})^{0.5}} (j = 1, 2, \cdots, m) \tag{11}$$

III. Evaluation of landscape garden plant community structure

In this study, a total of 120 landscape architecture plots in three districts and counties (P1, P2 and P3) of the city were randomly collected and scored, including (Y1) slope, (Y2) road, (Y3) slope aspect, (Y4) land use, (Y5) annual rainfall, (Y6) average annual temperature, (Y7) river, (Y8) vegetation index and (Y9) population density, and the overall natural conditions of the three districts and counties were sorted out. Based on the natural data framework, the evaluation indexes of landscape architecture plant communities were further screened to verify the rationality of the index system. The performance evaluation of plant community structure in 120 landscape architecture plots was carried out.

III. A. Physical and geographic profile

K City is located at longitude 125°50′ 25′ ′ -130°10′ 05′ ′ , latitude 30°10′ 45′ ′ -33°35′ 40′ ′ , in the southeast of the province, between two first-tier cities. The total area is 942.51 km², of which about more than 25% is water. K City is located in the subtropical monsoon climate zone, with a mild and humid climate and four distinct seasons. The average annual temperature is 17.2℃ and the average annual precipitation is 1105.1mm.

III. B. Representation of natural conditions based on the hierarchical analysis method

The data of natural indicators using principal component analysis to describe the three districts and counties are shown in Table 1, in which the mean values of (Y5) annual rainfall and (Y6) annual mean temperature are: 4.87 and 4.75, respectively, indicating that the annual rainfall and annual mean temperature conditions in K City are better and suitable for the growth of a wide range of plants.

Table 1: Descriptive statistics

Variable	N	Maximum	Mininmun	Mean	Standard deviation
Y1	120	2.5	5.5	2.44	1.18
Y2	120	2.5	6.5	2.6	1.359
Y3	120	2.5	6.5	2.8	1.329
Y4	120	3	6	3.17	1.324
Y5	120	2.5	6.5	4.87	1.026
Y6	120	2.5	6.5	4.75	1.092
Y7	120	2.5	6.5	1.59	1.033
Y8	120	2.5	6.5	3.82	1.322
Y9	120	2.5	1.5	2.65	1.255

The correlation matrix of the nine natural indicators obtained from the sample point data is shown in Figure 2.

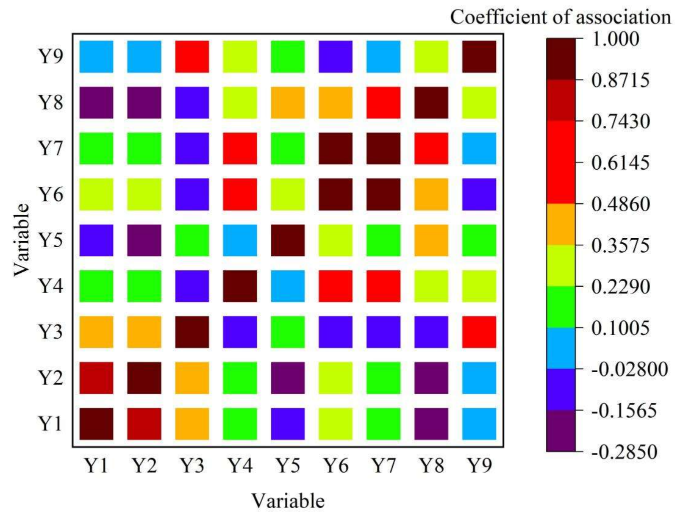

Figure 2: Correlation matrix

III. C. Construction of the AHP model

III. C. 1) Establishment of an evaluation indicator system

According to the actual situation of landscape garden plant landscape in K city, combined with the evaluation index system of plant community spatial structure proposed in chapter 2, a total of 50 landscape garden experts and 20 master's degree students in landscape gardening were invited to fill in the questionnaire of landscape garden landscape evaluation system. The questionnaire contains the following 20 indicators: ratio of color to green, accessibility, plant plant planting form, sense of spatial permeability, stayability, serviceability, seasonal richness, plant health, plant diversity, rationality of plant interspecies collocation, visual satisfaction, color richness, richness of plant ornamental features, green visibility, flower quantity, duration of summer flowering period, coordination with the surrounding environment, native Regional characteristics, environmental adaptability, diversity of life types, in order to use the number 1-20 for numbering, set the full score of each indicator to 10. 20 evaluation indicators importance rating is shown in Figure 3.

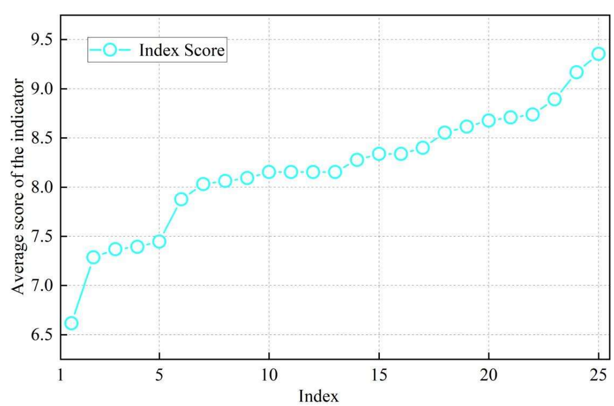

Figure 3: Evaluation index importance score

Indicators with importance scores of 7.5 and above are selected, and there are the following 15 indicators: seasonal richness, plant health, plant diversity, rationality of plant interspecies collocation, visual satisfaction, color richness, richness of plant ornamental features, green visibility, sense of spatial permeability, amount of flowers, storability, duration of the summer flowering period, the ratio of color to green and the form of plant planting.

Synthesizing the results of the questionnaire data collation and the existing research, the landscape garden evaluation index system and corresponding weights are proposed from the three levels of ecology, landscape and social service in Table 2.

Table 2: Evaluation index system of Landscape architecture

Criterion layer	Weight	Index layer	Weight	Final ranking
(A1)Ecological	0.3562	(B1)plant diversity	0.07325	10
		(B2)Plant health status	0.05065	4
		(B3)Diverse lifestyle	0.0636	8
		(B4)The rationality of combination among plant species	0.04912	3
		(B5)environmental suitability	0.09881	15
(A2)Landscape	0.5081	(B6)Seasonal richness	0.04076	1
		(B7)Color richness	0.09565	14
		(B8)Diversity of ornamental characteristics of plants	0.08641	13
		(B9)Visual satisfaction	0.07299	9
		(B10)The harmony with the surrounding environment	0.0449	2
		(B11)Green looking ratio	0.05397	6
		(B12)The duration of the flowering period of summer flowers	0.08508	12
		(B13)Flowers	0.05164	5
(A3)Community service	0.1357	(B14)Accessibility	0.05703	7
		(B15)Local regional characteristics	0.07614	11

III. C. 2) Validation of the rationality of the structure of the evaluation system

On the basis of the final weights of the indicators, the output guideline layer indicator rotated component matrix is shown in Table 3, and the indicator layer rotated component matrix is shown in Table 4.The results show that the number of principal components extracted from the guideline layer is consistent with the number of indicators at each level of the constructed evaluation system, which further verifies the rationality of the structure of the constructed evaluation system.

Table 3: Criterion layer index rotation matrix

Criterion layer	Component		
	1	2	3
1	0.946	-0.12	0.057
2	0.95	-0.143	0.054
3	0.944	-0.117	0.059

Table 4: Indicator layer indicator rotation matrix

Index layer	Component		
	1	2	3
B1	0.696	0.056	-0.033
B2	0.014	-0.282	-0.033
B3	0.353	-0.18	0.232
B4	0.256	-0.012	0.093
B5	0.608	0.003	0.058
B6	0.022	0.3	-0.185
B7	0.24	0.705	-0.073
B8	-0.017	0.605	0.243
B9	0.028	0.783	-0.012
B10	0.212	0.213	-0.097
B11	-0.271	0.633	0.074
B12	-0.138	0.224	-0.278
B13	0.157	0.742	0.292
B14	0.172	-0.28	0.403
B15	0.133	-0.153	0.208

III. D. Comprehensive evaluation results of landscape garden plant community structure

A questionnaire was designed based on the landscape garden evaluation index system proposed above, with a score of 100 points. The evaluation grades are 1 (0-250 points), 2 (25-50 points), 3 (50-75 points), 4 (75-100 points) A total of 1,200 questionnaires were randomly distributed offline to the visitors of the 120 landscape garden sample sites, and 1,104 valid questionnaires were recovered, with an effective questionnaire rate of 92.00%. Using SA1-SA120 to number the 120 landscape garden sample sites, of which SA1-SA40 belongs to the P1 area, SA41-SA80 belongs to the P2 area, and SA81-SA120 belongs to the P3 area, and the results of the comprehensive evaluation of the 120 landscape gardens are shown in Table 5.

Table 5: Comprehensive evaluation results of 120 landscape architecture plots

Number	Evaluation score	Level	Number	Evaluation score	Level
SA1	27.74	2	SA61	98.7	4
SA2	96.14	4	SA62	75.15	4
SA3	67.51	3	SA63	65.22	3
SA4	96.35	4	SA64	32.78	2
SA5	13.42	1	SA65	36.29	2
SA6	44.94	2	SA66	96.25	4
SA7	67.57	3	SA67	47.67	2
SA8	21.42	1	SA68	99.47	4
SA9	74.63	3	SA69	41.65	2
SA10	59.92	3	SA70	66.42	3
SA11	26.61	2	SA71	52.88	3
SA12	77.16	4	SA72	14.83	1
SA13	52.97	3	SA73	25.33	2
SA14	87.89	4	SA74	32.19	2
SA15	64.51	3	SA75	60.22	3
SA16	47.19	2	SA76	25.9	2
SA17	39.67	2	SA77	19.49	1
SA18	97.9	4	SA78	64.32	3
SA19	65.14	3	SA79	68.61	3
SA20	77.45	4	SA80	54.88	3
SA21	65.36	3	SA81	80.44	4
SA22	22.57	1	SA82	45.47	2
SA23	33.85	2	SA83	45.7	2
SA24	59.04	3	SA84	16.57	1
SA25	68.74	3	SA85	66.33	3
SA26	9.74	1	SA86	56.77	3
SA27	40.4	2	SA87	26.65	2
SA28	68.14	3	SA88	38.79	2
SA29	17.34	1	SA89	81.36	4
SA30	49.41	3	SA90	81.61	4
SA31	26.97	3	SA91	9.4	1
SA32	75.62	4	SA92	5.39	1
SA33	60.49	3	SA93	21.22	1
SA34	62.12	3	SA94	68.62	3
SA35	69.99	3	SA95	76.76	4
SA36	32.83	2	SA96	8.53	1
SA37	85.95	4	SA97	74.88	3
SA38	73.34	3	SA98	43.05	2
SA39	75.26	4	SA99	77.94	4
SA40	68.73	3	SA100	32.64	2
SA41	73.55	3	SA101	3.42	1
SA42	20.75	1	SA102	8.6	1
SA43	90.42	4	SA103	79.04	4
SA44	26.9	2	SA104	98.38	4
SA45	50.58	3	SA105	24.25	1
SA46	7.67	1	SA106	80.53	4
SA47	44.23	2	SA107	22.7	1
SA48	61.92	3	SA108	9.38	1
SA49	49.12	2	SA109	44.91	2
SA50	91.91	4	SA110	16.87	1
SA51	67.79	3	SA111	14.49	1
SA52	33.73	2	SA112	3.82	1
SA53	85.77	4	SA113	53.64	3
SA54	14.3	1	SA114	53.68	3
SA55	79.96	4	SA115	16.93	1
SA56	31.98	2	SA116	65.9	3
SA57	22.59	1	SA117	7.31	1
SA58	9.67	1	SA118	34.06	2
SA59	64.58	3	SA119	95.45	4
SA60	48.46	2	SA120	85.65	4

As can be seen from Table 5, the distribution of the 120 landscape garden sample sites is relatively concentrated in Level 3, with a total of 37 sites, accounting for 30.83%. The distribution on level 1 and level 4 is consistent with each other, with 27 respectively, accounting for 22.5%. The number of distributions on level 2 is 28, accounting for 24.17%. Of the 40 sample plots in Zone P1, the highest percentage of sample plots on Rank 3 was 45.00%. 40 sample plots in Zone P3 had the highest number of sample plots distributed on Rank 1, accounting for 37.5% of the sample plots. The percentage of sample plots in the three districts is shown in Figure 4.

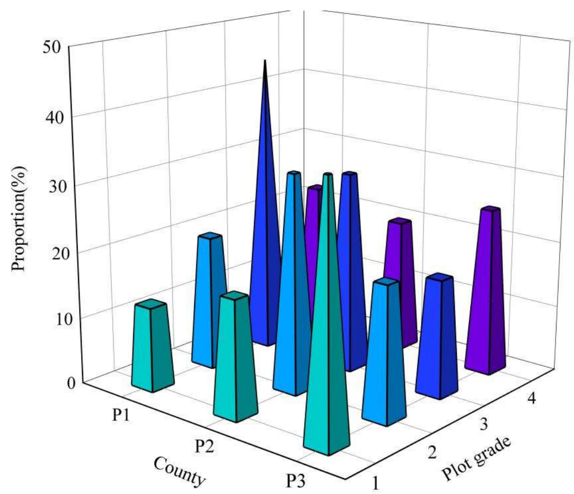

Figure 4: The proportion of the grade distribution of the sample plots

Comprehensive Table 5 and Figure 4, the three counties and districts as a whole are relatively consistent in their performance of landscape and garden landscaping, and the highest evaluation values of each district and county are between evaluation levels 1-3, indicating that on the whole the structure of landscape and garden plant communities in K City is more reasonable. Among them, P1 district has the best performance in landscape gardening landscape, and P2 district is the second best.

IV. Conclusion

In this paper, on the basis of the index system for evaluating the spatial structure of plant communities, the AHP-PCA entropy weight combination model is used as the establishment and verification method of the index system. Based on the natural condition situation of K city, the index system for evaluating the structure of landscape garden plant communities is built. In the component analysis, the number of principal components at the criterion level extracted from the system is consistent with the number of indicators at each level, and the indicator system is reasonably structured.Among the comprehensive evaluation results of plant community structure of 120 landscape garden sample sites, 37 sample sites belong to grade 3, accounting for 30.83%. The highest evaluation values of the three counties and districts are all between evaluation levels 1-3, reflecting the rationality of the configuration of plant community structure in landscape gardens in K city.

With the assistance of quantitative calculation and analysis methods, the designed evaluation index system of landscape garden plant community structure can provide effective data reference for the optimization of plant community structure and ecological sustainable development in landscape gardens while objectively and scientifically evaluating the landscape garden plant community structure.

Funding

This work was supported by the Construction of Virtual Reality Practice Bases in Universities in the Context of Industry-Academia Integration.

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