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The Application of Green Highway Concept in Highway Route Selection

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Abstract: *Highway construction is the foundation of national strategic development and bears important responsibilities for social and economic development. With the rapid development of China's highway industry, the impact of the entire life cycle of highway construction, operation, and maintenance on resources and environment is increasingly deepening. The 14th Five Year Plan mentions green economic and social development, and the selection of highway routes lays the foundation for the environmental impact of the entire life cycle of highways, which is closely related to achieving sustainable development of highway construction. This article carries out the evaluation of the green degree of highway route selection in Jiangsu Province, and verifies the practical significance of the model through the design and route selection of the Nantong Ring Expressway, in order to guide the sustainable development of green highway construction in Jiangsu Province from the basic stage of route selection.*

Keywords: *Highway route selection, Vague set, Green degree*

1. Introduction

1.1. Background and significance of this article

1.1.1. Research background

Highway construction is the foundation for promoting national economic development, an important driving force for improving national infrastructure construction, and plays an important role in promoting long-term social development. In order to achieve sustained economic growth, further improve infrastructure construction, and provide people with more convenient and comfortable travel experiences, road construction will still be a key focus for a long time in the future.

Jiangsu has extremely abundant wetland resources. The upper and middle reaches of the Yangtze River, Huai River, and Yishusi River have nearly 2 million square kilometers of incoming water, and the incoming water volume is relatively abundant. Highway route selection should be planned for soil erosion prevention.

1.1.2. Research meaning

At present, there is a lack of research on route selection from a green perspective, and a green evaluation system for highway route selection in Jiangsu Province is relatively lacking due to the special natural environmental conditions. This article evaluates the greenness of Nantong Ring Expressway route selection, which can be further promoted and applied to provide more scientific guidance for green route selection of highways in Jiangsu Province. To this end, research and carry out the evaluation of the green degree of highway route selection in Jiangsu Province, reflecting the characteristics of green highways while obtaining a more targeted and suitable green highway rating system, selecting more suitable route schemes, and guiding the early realization of carbon peak in the transportation sector.

1.2. Current research status at home and abroad

In 1986, Massachusetts utilized various methods to consider the environment as an important influencing factor in route selection decisions, selecting different alternative solutions for verification [1].

In 1998, Sadek combined GIS to examine multiple factors and conducted a comparison of route design schemes [2].

The 1999 US Road and Environment Handbook elaborated on the relationship between highway

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routes and the surrounding environment, and also refined environmental impact assessments [3].

In 2001, ManojKJha evaluated the comprehensive benefits of alternative solutions obtained by considering the actual cost of the project and the ecological benefits completed [4].

In 2013, XiuyingLiu focused on environmental impact and optimized the path treatment plan for complex mountainous road sections using multi-objective decision-making method to determine the optimal solution [5].

In 2016, Wang Li established a green highway route selection evaluation system and validated the model based on actual road cases. In the same year, Pushak explored different route selection schemes with different spatial distributions to find approximate optimal solutions among five algorithms, and obtained the optimal algorithm [6].

In 2018, Zhou Feifei used the PSR model to establish a relatively simple green highway evaluation system and conducted preliminary exploration on the sustainable development of highway construction. In the same year, Yu Xingliang considered a green highway evaluation system consisting of five elements and used the improved TOPSIS grey correlation analysis method to determine the optimal route selection plan [7].

In 2019, Xinyu Liang proposed D-FTOPSIS based on FTOPASIS and improved FTOPSIS. D-FTOPSIS can achieve optimal results in route scheme optimization under conditions of high responsiveness to expert decision-making [8].

1.3. Research content and methods

1.3.1. The research content of this article

(1) Based on the Guiding Opinions of the Ministry of Transport on the Implementation of Green Highway Construction, combined with the unique natural environment of Jiangsu, a green degree evaluation index system for route selection is constructed with five indicators: resource conservation, energy conservation and environmental protection, ecological friendliness, service improvement, and soil erosion.

(2) Using appropriate analytical methods to assign weights to the indicator system, selecting appropriate evaluation models, and ultimately confirming the use of group decision-making analytic hierarchy process to form an evaluation model based on the Vague set.

(3) Conduct an actual evaluation of the green degree of the established model combined with the Nantong Ring Expressway, and examine the practical applicability of the model.

1.3.2. The research method of this article

(1) Literature analysis method: By consulting relevant domestic and foreign materials, summarize the applicable methods for evaluating the green degree of highway route selection in Jiangsu Province.

(2) Comprehensive evaluation method: The green degree evaluation of highway route selection in Jiangsu Province comprehensively considers three aspects: highway function, regional environment, and green attributes.

(3) Empirical research method: Conduct on-site research on the Nantong Ring Expressway, obtain relevant information, analyze the route selection plan, and obtain the green degree and level.

2. Construction of Green Evaluation Index System for Highway Route Selection in Jiangsu Province

2.1. Green degree of highway route selection in Jiangsu Province

2.1.1. The Concept of Green Degree in Highway Route Selection in Jiangsu Province

The green degree of highway route selection in Jiangsu Province starts from the perspective of the entire lifespan of highways, with sustainable development of highways as the ultimate goal. On the premise of meeting the quality and safety of highways, reduce carbon emissions throughout the entire lifespan, and improve the operation of universities to achieve friendly coexistence among people, roads, and the environment.

2.1.2. Factors influencing the greenness of highway route selection in Jiangsu Province

(1) Resource conservation

The resource consumption of highways exhibits a special linear characteristic, involving a large area. The occupation of land by highways will cause the loss of original performance of cultivated land, damage forest land, and cause damage to fish ponds, etc; The destruction of water resources is reflected in the destruction of the quantity and quality of water bodies. Construction will consume a large amount of water resources, and the pollutants generated will seriously damage the water environment; Construction will generate a large amount of solid waste, occupy land, and some hazardous solid waste will seriously damage the environment; The noise generated by highway construction and operation will have an impact on the surrounding sound sensitive environment; Construction will also generate light pollution.

(2) Energy conservation and environmental protection

It is necessary to plan and construct with a development perspective, control from the design stage, pay attention to energy-saving and environmental protection design modes when selecting routes, fully utilize the terrain, construct service areas and maintenance areas, adopt a layout method of negative yin and positive yang, and fully utilize natural ventilation and natural lighting to control the source. High green route design schemes are selected.

(3) Environmentally friendly

Green highways comprehensively consider various environmental factors in engineering construction during the design phase, carry out environmentally friendly design, integrate various technologies and advanced material applications during construction, and combine environmental detection visualization platforms to carry out green construction with low environmental impact. During the maintenance and operation phase, low-carbon and environmentally friendly maintenance equipment and materials are implemented to monitor the road's appearance and environment. In response to emergency environmental hazards, pre management measures are established.

(4) Service improvement

Highway construction serves society, and the satisfaction of the public is a new requirement for highway quality. The green development of highways should be "people-oriented".

(5) Prevention of soil erosion

Jiangsu Province is located in the eastern coastal area of China, adjacent to Zhejiang and Shanghai to the south, and bordered by the Yellow Sea and East China Sea to the east. It has multiple rivers and abundant rainfall. During the process of construction excavation and roadbed slope construction, there may be soil erosion. Therefore, route selection is a selective detour of water filled sections, which directly reduces soil erosion during highway construction.

2.2. Green evaluation index system for highway route selection in Jiangsu Province

2.2.1. Selection of Green Evaluation Indicators for Highway Route Selection in Jiangsu Province

On the basis of studying relevant policies, this study analyzes the characteristics of highways in Jiangsu Province and selects relevant evaluation indicators, as follows:

(1) Resource conservation: Existing channel utilization, Land saving measures, Excavation and filling allocation, Bridge and tunnel ratio

(2) Environmentally friendly: Noise prevention and control, Ecological sensitive areas, Adverse geological sections

(3) Energy conservation and environmental protection: Energy consumption during construction period, Technical indicators, Route length, Compatibility with existing plans

(4) Service improvement: The smoothness of road linearity, Demolition impact, Greening degree and ornamental value

(5) Prevention of soil erosion: Length of soft soil subgrade, Water system runoff

2.2.2. Green evaluation index system for highway route selection in Jiangsu Province

Establish a green evaluation index system for highway route selection in Jiangsu Province, as shown

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in Table 1, and the formula is shown in Equation (1).

$$G=f\,(R, P, E, S, I) \tag{1}$$

In the formula: G, select the line chromaticity;

R - Resource conservation;

P - Energy conservation and environmental protection;

E - Environmentally friendly;

S - Service improvement;

I - Prevention of soil erosion.

3. Establishment of Green Degree Evaluation Model for Highway Route Selection in Jiangsu Province

3.1. Method for determining the weight of evaluation indicators

Establishing a quality evaluation system, the relative importance of each element in the evaluation system is the weight, and the calculation of the weight will directly affect the rationality and scientificity of the evaluation results.

Highway route selection only involves the primary stage of feasibility and is limited by human and material resources. Considering the difficulty of obtaining data for various indicators, it is extremely difficult to use objective weighting method. Therefore, subjective weighting is chosen, and the hierarchical characteristics of the comprehensive indicator system are compared for hierarchical classification. The scale method of numbers 1-5 and their reciprocal is used for representation (see *Table 1*). Compare the central indicators C1, C2... Cn for each layer, and compare the driving force of the previous layer pairwise. Quantify the relative importance of the indicators using specific ratios.

Table 1: Cij Assignment Reference Table

Scale aij	Meaning of assignment
1	C_i and C_j have the same importance compared to each other
2	C_i has a higher importance compared to C_j
3	C_i has higher importance compared to C_j
4	C_i has significant importance compared to C_j
5	Compared to C_j, C_i has a strong importance
1/2, 1/3...1/5	The importance of C_i compared to C_j is opposite to the above description

(1)The judgment matrix of the expert with the number k is multiplied by rows to obtain the value W_i^j. The obtained value is then subjected to an n-th power root operation to obtain the value, which is then normalized. Obtain the preliminary weights of the indicators provided by experts, as shown in Equation (2).

$$W_i^k = \frac{\overline{W_i^k}}{\sum_{i=1}^{n} \overline{W_i^k}} \quad (i=1,2,3,...,n) \tag{2}$$

(2) The maximum eigenvalue of the judgment matrix A_k of the expert with serial number k is denoted as λ_{max}^k (k=1,2,3,...m), and can be obtained by substituting it into equations (3):

$$\lambda_{max}^k = \frac{1}{n}\sum_{i=1}^{n} \frac{\sum_{j=1}^{n} b_{ij}^k W_j^k}{W_i^k} \tag{3}$$

(3) The satisfactory consistency ratio of Ak can be carried into equations (4). When C_R^k <0.1, the satisfactory consistency of the judgment matrix can be adopted, otherwise it is discarded.

$$C_R^k = \frac{\lambda_{\max}^k - n}{(n-1)\ RI} \tag{4}$$

In the formula, RI - Random consistency index.

(4)The comprehensive weight of experts includes both subjective and objective aspects. Calculate the subjective weights of experts from equations (5):

$$r_k = \frac{R_k}{\sum_{k=1}^{m} R_k} \quad k=1,2,...,m. \tag{5}$$

In the formula, RI is the subjective evaluation value of the expert's level.

(5) The objective weight of experts needs to be calculated through the consistency ratio of the judgment matrix. The higher the ratio, the higher the credibility, and the greater the weight of experts. Anyway, this also holds true. The objective relative weight of experts can be calculated using equations (6):

$$P_k = \frac{1}{1+\alpha C_R^K} \quad (a>0,\ k=1,2,3,...,m.) \tag{6}$$

Parameter a plays a regulatory role, and it is consistent with the number of participating experts in the evaluation.

(6) Normalize the objective weights of experts, as shown in equations (7):

$$P_k^* = \frac{P_k}{\sum_{k=1}^{m} P_k} \tag{7}$$

Enter equations (8) to obtain the comprehensive weight of experts:

$$D_k = ar_k + (1-a)P_k^* \quad , a=0.5 \tag{8}$$

Using the comprehensive weights of experts and indicator weights, the relative weights of indicators for multiple experts are obtained, as shown in equations (9):

$$W_i = \sum_{k=1}^{m} W_j^k \times D_k \tag{9}$$

The evaluation system consists of two levels of indicators, the first level indicator is denoted as Wx, the second level indicator is denoted as Wxy, and the weight of the second level indicator is obtained from equations (10):

$$Wxy = Wx \times Wy \tag{10}$$

By using the above calculation formula, the weight coefficients of various evaluation indicators at all levels can be calculated.

3.2. Determination of evaluation index weights

3.2.1. Weight calculation of evaluation system indicators

After integrating the relevant information on the evaluation index system established in this study, it was handed over to 6 experts in the relevant field for judgment using the 5-scale method to obtain the judgment matrix. According to the calculation method mentioned above, the comprehensive expert weights of the first level indicators were calculated, as shown in *Table 2*:

Table 2: Expert Weights for Primary Indicators

Expert	Objective weight of experts	Normalization of expert objective weights	Normalization of expert subjective weights	Expert comprehensive weight
1#	0.8533	0.1022	0.1044	0.1013
2#	0.8712	0.1033	0.1017	0.0987
3#	0.8121	0.0936	0.1012	0.1012

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4#	0.8423	0.0997	0.0998	0.1049
5#	0.8865	0.1024	0.0956	0.0908
6#	0.8412	0.0988	0.0973	0.1031

The final first level indicator weight values G=(0.1533, 0.2934, 0.2545, 0.1044, 0.1944) are calculated by substituting values (9) and (10).

Similarly, the weight values of the secondary indicators in resource conservation can be calculated as R=(0.0534, 0.0417, 0.0233, 0.0217); The weight of each secondary indicator in energy conservation and environmental protection is P=(0.1127, 0.0533, 0.0719); The weight of each secondary indicator in environmental friendliness is E=(0.0211, 0.0728, 0.041); The weight of each secondary indicator in service improvement is S=(0.0413, 0.0311, 0.0617); The weight of the secondary indicators in soil erosion prevention is I=(0.0412, 0.0619).

3.2.2. Weight analysis of evaluation system indicators

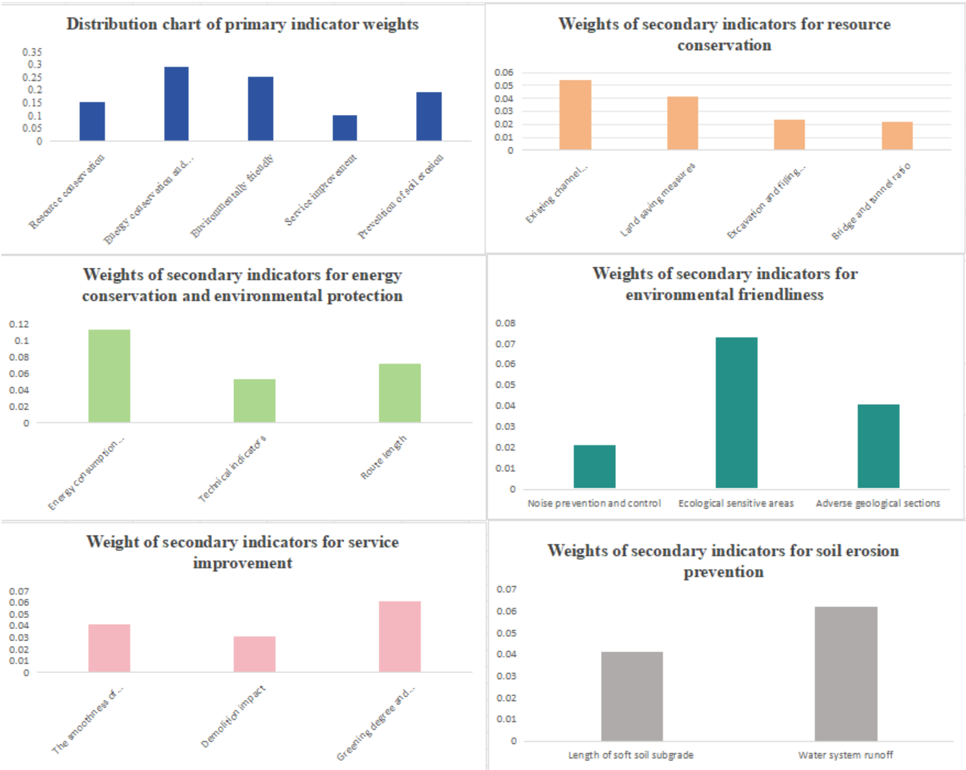

Figure 1 Distribution of Index Weights in the Evaluation System

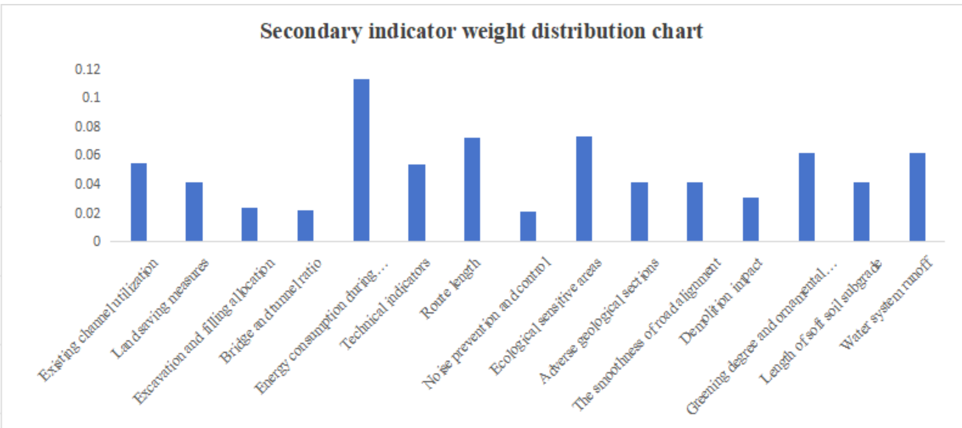

Figure 2: Distribution of Secondary Indicator Weights

Plot the obtained data, as shown in *Figure 1*, to more intuitively reflect the ranking of the weight proportions of primary indicators, arranged from high to low as follows: environmentally friendly, energy-saving and environmental protection, soil erosion prevention, resource conservation, and service

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improvement. The total proportion of environmentally friendly energy conservation and environmental protection exceeds 50%, indicating that experts believe that environmental friendliness and energy conservation and environmental protection have a high impact on the greenness of highway route selection in Jiangsu Province. Soil erosion prevention and resource conservation are also important factors, and the proportion of service improvement also exceeds one tenth. Combining with the "people-oriented" design concept, it is necessary to fully value driving experience in route selection.

Draw the secondary indicators of the evaluation system, as shown in *Figure 2*. The weight of energy consumption during the construction period exceeds 0.1, indicating that full attention should be paid to the energy consumption indicator during the construction period when selecting the route. In addition, the weight of the existing five indicators of channel utilization, technical indicators, route length, ecologically sensitive areas, and water system runoff exceeds 0.05, indicating that these five indicators have a significant impact on the green degree evaluation of the selected route, When determining the route selection, it is important to consider it carefully.

3.3. Green degree evaluation method for highway route selection in Jiangsu Province

3.3.1. Vague set evaluation method

The Vague set is an extended research method based on Gau and Buehrer for fuzzy sets, which extends the composite concept of membership, non membership, and uncertainty on traditional fuzzy sets. It has stronger display ability compared to the preferences of decision-makers and has been successfully applied in fields such as data detection and energy efficiency evaluation. The integration of uncertain information is more effective than traditional fuzzy sets.

3.3.2. Evaluation Model Based on Vague Set

(1) Vague set

Definition1: For the domain U, Ax belongs to U, and the Vague set A on U can be characterized by $t_A(x)$ and $f_A(x)$. The interval between $t_A(x)$ and $f_A(x)$ domains U is [0,1], and $t_A(x)$ and $f_A(x)$ respectively represent the lower bound of membership degrees derived from the evidence supporting and opposing x belonging to A. In the mathematical relationship $t_A(x)+f_A(x) \leq 1$, it is stipulated that $h_A(x)=1- t_A(x) - f_A(x)$ is the degree of hesitation on A, and the larger the value of $h_A(x)$, the relative relationship between x and A is represented. The more uncertain information there is, and it is specified that $(t_A(x), 1-f_A(x))$ is the Vague set of A at point x [9], with two values taking intervals between [0,1].

(2) The Vague set of expert opinions

Convert the expert opinions calculated in the previous text into a vague set, as listed in *Table 3*:

Table 3: Seven level Terminology and Vague Set

Grade	Fraction	Corresponding meaning	Vague	Hesitancy
Very green	9	The sustainable development situation is very good, making a significant contribution to the greenness of highways	[0.85,0.9]	0.05
Greener	8	The sustainable development status is good, and it contributes significantly to the greenness of highways	[0.7,0.8]	0.1
Green	7	Good sustainable development status and significant contribution to the greenness of highways	[0.6,0.75]	0.15
commonly	6	The sustainable development status is average, and the contribution to the greenness of highways is average	0.5	0
Poor	5	Poor sustainable development status and low contribution to highway greenness	[0.4,0.55]	0.15
difference	4	Poor sustainable development status and low contribution to highway greenness	[0.3,0.4]	0.1
Very poor	3	The sustainable development situation is very poor, and the contribution to the greenness of highways is very low	[0.15,0.2]	0.05

(3) Determination of classification standards

The "Green Building Evaluation Standards" issued in 2019 classify green buildings into four levels: basic level, one star, two star, and three star. Yunnan Province divides green roads into four levels: gold, silver, bronze, and qualified.

Based on the existing level classification and the actual situation of green highways in Jiangsu Province, this study divides the evaluation levels of green highways in Jiangsu Province into "first level green", "second level green", "third level green", and "fourth level green". Scores below 0.5 are not included in the evaluation. Please refer to *Table 4* for specific details.

Table 4: Green Level Evaluation Table

Green degree	First level green	Secondary Green	Third level green	Fourth level green
Scoring situation	[0.5,0.6)	[0.6,0.7)	[0.7,0.85)	[0.85,1.0]
Specific description	The basic performance of line selection is comprehensively guaranteed, and the greenness is relatively low.	The basic performance of line selection is comprehensively guaranteed, and the greenness is average.	The basic performance of line selection is comprehensively guaranteed, with a high degree of greenness.	The basic performance of line selection is comprehensively guaranteed, and the greenness is very high.

4. Empirical analysis

4.1. Green evaluation of route selection for the Nantong Ring Expressway

4.1.1. Basic situation of Nantong Ring Expressway

The starting point of the Haimen to Tongzhou section of the Tongxi Expressway project (hereinafter referred to as the "Nantong Ring Expressway") is located in Haimen, connecting to the Tongzhi high-grade highway. The route faces north and crosses S336, Ningqi Railway, and Shanghai Shaanxi Expressway. After crossing the Tongyang Line and S335 on the east side of Erjia Town, the route looks northwest and crosses G228 and Yangtong Highways north of Tongzhou District. After crossing Fugang Road and the dredging channel of Tongzhou Bay Port Area on the south side of Shigang Town, it crosses S225 to the northwest and ends at the Xinlian Hub at the intersection of the Shenhai Expressway and the north connection of the Shanghai Tong Bridge. The total length of the route is 65.984km, with a total investment of 14.925 billion yuan, with a construction period of three years.The main information summary of the Nantong Ring Expressway route plan is shown in *Table 5*.

Table 5: Green Level Evaluation Table

Number	project	unit	quantity
1	Route length	km	65.984
2	Quantity of earthwork and stonework	10000m^3	1089.9
5	Bridge	/m/seat	18749.7m/54
8	Permanent occupation of land	acre	7466.8
9	Engineering cost	Ten thousand	1492500

4.1.2. Establishment of Green Degree Evaluation Index System for Nantong Ring Road Selection

Based on the establishment method of the green degree evaluation index system for the selection of green highways in Jiangsu Province in Chapter 3, and taking into account the actual situation of Nantong Ring Expressway, an evaluation index system is established, as shown in *Table 6*.

Table 6: Evaluation Index System for Nantong Ring Road

Goal	First level indicators	Secondary indicators
Green evaluation index system for highway route selection in Jiangsu Province	Resource conservation	Existing channel utilization R_1
		Land saving measures R_2
		Excavation and filling allocation R_3
		Bridge and tunnel ratio R_4
	Energy conservation and environmental protection	Energy consumption during construction period P_1
		Technical indicators P_2
		Route length P_3
	Environmentally friendly	Noise prevention and control E_1
		Ecological sensitive areas E_2
		Adverse geological sections E_3
	Service improvement	The smoothness of road alignment S_1
		Demolition impact S_2
		Greening degree and ornamental value S_3
	Prevention of soil erosion	Length of soft soil subgrade I_1
		Water system runoff I_2

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4.1.3. Determination of the Weight of Green Degree Evaluation Indicators for Nantong Ring Road

According to the engineering situation of Nantong Ring Expressway, the weight calculation is carried out according to Chapter 3, as shown in *Table 7*.

Table 7: Weights of Green Degree Evaluation Index System for Nantong Ring Expressway

Goal	First level indicators	Secondary indicators	weight
Green evaluation index system for highway route selection in Jiangsu Province	Resource conservation R	Existing channel utilization R_1	0.0673
		Land saving measures R_2	0.0517
		Excavation and filling allocation R_3	0.0277
		Bridge and tunnel ratio R_4	0.0203
	Energy conservation and environmental protection P	Energy consumption during construction period P_1	0.0798
		Technical indicators P_2	0.1123
		Route length P_3	0.0434
	Environmentally friendly E	Noise prevention and control E_1	0.0876
		Ecological sensitive areas E_2	0.1231
		Adverse geological sections E_3	0.0533
	Service improvement S	The smoothness of road alignment S_1	0.0473
		Demolition impact S_2	0.0311
		Greening degree and ornamental value S_3	0.0742
	Prevention of soil erosion I	Length of soft soil subgrade I_1	0.0573
		Water system runoff I_2	0.1142

4.1.4. Green Degree Evaluation of Nantong Ring City Based on Vague Set

Based on the indicator system established in Chapter 3, in order to obtain more accurate evaluation results, the evaluation form is submitted to the university's environmental institute for evaluation. The language obtained from the evaluation form is converted into a vague set. The list is shown in Table 8:

Table 8: Vague Collection of Nantong Ring Expressway Route Selection

Indicator Items	Institution 1	Institution 2	Institution 3	Institution 4
R_1	[0.5,1.05]	[0.7,1.02]	[0.85,1.01]	[0.7,1.02]
R_2	[0.85,1.01]	[0.6,1.05]	[0.6,1.05]	[0.6,1.05]
R_3	[0.7,1.02]	[0.5,1.05]	[0.7,1.02]	[0.85,1.01]
R_4	[0.7,1.02]	[0.5,1.05]	[0.5,1.05]	[0.6,1.05]
P_1	[0.6,1.05]	[0.7,1.02]	[0.7,1.02]	[0.6,1.05]
P_2	[0.7,1.02]	[0.7,1.02]	[0.5,1.05]	[0.85,1.01]
P_3	[0.6,1.05]	[0.5,1.05]	[0.7,1.02]	[0.6,1.05]
E_1	[0.6,1.05]	[0.5,1.05]	[0.85,1.01]	[0.6,1.05]
E_2	[0.5,1.05]	[0.6,1.05]	[0.7,1.02]	[0.6,1.05]
E_3	[0.6,1.05]	[0.7,1.02]	[0.7,1.02]	[0.6,1.05]
S_1	[0.7,1.02]	[0.5,1.05]	[0.85,1.01]	[0.7,1.02]
S_2	[0.7,1.02]	[0.85,1.01]	[0.7,1.02]	[0.6,1.05]
S_3	[0.6,1.05]	[0.85,1.01]	[0.7,1.02]	[0.85,1.01]
I_1	[0.6,1.05]	[0.7,1.02]	[0.85,1.01]	[0.7,1.02]
I_2	[0.85,1.01]	[0.6,1.05]	[0.7,1.02]	[0.5,1.05]

According to equation (10), the comprehensive evaluation Vague values of institution Hk for route selection are obtained by multiplying the Vague values of the secondary indicators of the four institutions with the final comprehensive secondary indicator weights, as shown in *Table 9*.

Table 9: Comprehensive Evaluation Vague Values for Route Selection of Ring Expressway

V_j^k	H_1	H_2	H_3	H_4
Vague	[0.842,0.923]	[0.816,0.895]	[0.813,0.916]	[0.850,0.925]

The weight of all four university institutions is 0.1677. Multiply the weights with the comprehensive evaluation values in *Table 9* to obtain the group comprehensive evaluation value:

E=[0.8131,1.0789]

The score function corresponds to Score=0.8769.

According to the calculation results of Score, corresponding to Table 5 the evaluation level of the green degree scheme for the Nantong Ring Expressway is "Level 4 Green".

4.1.5. Analysis of the Green Degree Evaluation Results of Nantong Ring Road

Through the green degree evaluation of resource conservation, energy conservation and environmental protection, environmental friendliness, service improvement, and soil erosion prevention included in the selection of the Nantong Ring Expressway, the green degree of the plan is 0.8769, which is rated as "fourth level green".

The evaluation results indicate that the overall performance of the Nantong Ring Expressway in terms of environmental friendliness, safe passage, energy conservation and environmental protection, and soil erosion is very good, and the greenness of the route plan is relatively high.

5. Conclusion

In recent years, the concept of "green transportation" and "green highways" has gradually become more perfect, and the process of greening highway construction has been further accelerated. The green route selection of highways in the design stage has also defined the development direction of green highways from the root.

This study comprehensively analyzes the research results of numerous scholars, and based on the actual route selection of the Nantong Ring Expressway, the following conclusions are drawn:

(1) Determine the green degree evaluation index system for selecting green highway routes. This article analyzes and studies the regional characteristics, highway project characteristics, principles of highway route selection, and connotation of green highways in Jiangsu Province, and summarizes the concept and related influencing factors of green degree in highway route selection in Jiangsu Province. Select a green degree evaluation system that includes five primary indicators: resource conservation, energy conservation and environmental protection, ecological friendliness, service improvement, and soil erosion. In addition, under the primary indicators, set up 20 secondary indicators related to intensive channel utilization, bridge and tunnel selection, horizontal and vertical linear combination, and ecological route selection.

(2) Establish a green degree evaluation model for highway route selection in Jiangsu Province. By using the improved group decision-making analytic hierarchy process to assign weights, five primary indicators were obtained for resource conservation, energy conservation and environmental protection, ecological friendliness, service improvement, and soil erosion, with weights of 0.1533, 0.2934, 0.2545, 0.1044, and 0.1944, respectively. Afterwards, a green degree evaluation model for highway route selection in Jiangsu Province was established using the Vague set. The evaluation levels of highway route selection in Jiangsu Province were divided into four levels, corresponding to "first level, second level, third level, and fourth level", representing the green degree of highway route schemes with different green levels.

(3) This study evaluated the green degree evaluation model established for the application of the Nantong Ring Expressway, and obtained a green degree of 0.8769, with an evaluation level of "level four".

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