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Research Article

A Further Study and Assessment on Geographic Information System: From Highway Ecological Landscape Environment Angle of View

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With the development of the national economy, our country's highway construction is developing in a more advanced and humane direction. On the basis of meeting traffic needs, people have begun to pay more attention to the construction of highway landscapes. Based on the understanding and integration of domestic and foreign landscape evaluation system research, this paper constructs a new type of highway landscape evaluation model and selects Zhangjiakou, one of the co-host cities of the Winter Olympics, to analyze and verify the model. We use the designed evaluation model to analyze and evaluate the three highways in the Zhangjiakou area. First, based on the analytic hierarchy process, the combination of qualitative and quantitative evaluation indicators is selected, and then, the GIS geographic information system is used to obtain the basic data of the quantitative indicators and the questionnaire method is used. The grade evaluation of three highways is realized, and the optimization measures and construction strategies for the landscape quality along the highway are proposed. The results show that the research results of this evaluation system are of great significance to the landscape construction along the line, the protection of landscape resources, and the development of tourist roads.

1. Introduction

Economic development, social progress, more and more travel methods for the public to choose, the types of highways are constantly enriched, and the grades are also improved with the development of the city. Under the current situation of continuous improvement in people's living standards, the single driving function of the highway has long been unable to meet the needs of the user population for a more comprehensive function. While considering the driving and transportation functions, it is necessary to meet the needs of the user in terms of comfort and aesthetics. Therefore, on the basis of basic engineering and economic and technical requirements, highway construction should also be combined with landscape construction to build a new form of scenic integration [1].

In 2015, Beijing won the right to host the 2022 Winter Olympic Games, and the state plans to build a more concentrated competition venue in f21 in Beijing's urban area, Yanqing District and Zhangjiakou Chongli District. In addition to ensuring the basic fast passage during the Winter Olympic Games, while taking into account the daily traffic and tourism viewing needs of the Chongli area of Zhangjiakou City, based on its special geographical location, but also taking into account that the area through which the highway passes should have a deep cultural heritage and rich tourism landscape resources, the selected highway should be able to meet the visual needs of the tourist population for the landscape and the spiritual pursuit of history and culture. On this basis, different levels can be selected, but there should be consistent scenery. Roads with rich landscape layers are the main research objects of this paper [2]. The construction of the Jingli Expressway successfully solved the important problem of allowing athletes and spectators to switch between three venue groups in different regions at the fastest speed [3]. The Chongli-Chicheng section of National Highway 6335 has a rich landscape type along the way, which belongs to the intermediate road on the highway, and the driving speed is maintained at an average of 60 km/h. At the same time, 80 km/h can also enjoy the natural scenery along the highway without excessive human intervention [4]. County Road X410 is beautifully built on a mountain and winding road, which can give different visual impacts to the drivers and passengers [5]. Therefore, it is necessary to evaluate the landscape along the three different grades of highway, understand the current situation, history and culture, ecological efficiency, and service value of the landscape along the highway, and evaluate and predict these factors that may affect the visual landscape and the perception of the user population.

2. State-of-the-Art

The concept of landscape evaluation was introduced to China late, and the initial landscape evaluation is more like a by-product of landscape construction. On the basis of learning from foreign experience, we conduct landscape evaluation in combination with current domestic policies and specific projects. Domestic landscape evaluation is mainly aimed at the coastal landscape, forest landscape, wetland landscape, tortoise and various types of landscape park landscapes, etc. In recent years, with the rise of scenic landscape evaluation, the study of highway landscape evaluation has also made some progress. However, the evaluation of China's highway landscape is basically from the perspective of green space [6]. Domestic landscape evaluation mostly uses AHP (analytic hierarchy method), comprehensive evaluation method, SD (semantic difference method), fuzzy hierarchical analysis method, GST (gray statistics method), BE (beauty evaluation method), and other methods. Chen Kai et al. first determined the most suitable indicator from the selected initial indicators by the GST method. Then, the AHP method is used to determine the index weights and construct a forest park rehabilitation landscape assessment system. Zhao Aonan used the analytic hierarchy method and the comprehensive evaluation method to construct a conservation-oriented park evaluation index system including 6 criterion layers and 23 index factors, and at the same time, he used the landscape assessment system to conduct landscape assessments of 5 conservation parks such as Tianjin Nancuiping in the north. Li Huimin takes aesthetics, ecology, and function as the criterion layer uses the analytic hierarchy method and the fuzzy comprehensive evaluation method to construct a landscape evaluation grading model and evaluates the three comprehensive parks in Changchun. Based on the AHP method, Yang Xiujuan et al. constructed a leisure agricultural landscape evaluation index system with natural landscape, cultural landscape, and production landscape as the project layers, 10-factor layers such as diversity, geomorphological landscape, and regional culture, and 32 index layers [7].

Due to the particularity of the linear corridor landscape of highways, there are relatively few studies on highway landscape evaluation in China. The wide scope of highway landscape evaluation, complex landscape elements, and many uncertainty factors have led to the selection of highway landscape evaluation factors that are also different from general landscape evaluation. Starting from the impact of the road landscape on driver safety, Yuan Lingwei constructed an evaluation index system and introduced the cloud model and cloud center of gravity evaluation method into the evaluation. Wu Mengni used the integrated technology of GIS and ENVI to build a landscape assessment system for mountain expressways and included the yuan-based extendability method in the scope of the evaluation.

Highway environmental information assessment and analysis benefit from the increasingly mature GIS technology, which will also improve the efficiency and quality of road environmental assessment and management. This enables the environmental information of highways to shift from textual form to visual analysis data so that people can intuitively feel the data. On this basis, many domestic scholars use GIS technology for landscape assessment, combined with landscape evaluation methods, and use the spatial processing analysis function of GIS to clearly and intuitively arrange the evaluation indicators. Li Yan and others used the combination of *R* and GIS technology to obtain data and, at the same time, produce thematic maps to evaluate and analyze the landscape of Jiufeng Urban Nature Reserve. Li Fengfang and others used the combination of big data and GIS technology to evaluate the landscape of the Beijing Olympic Forest Park and put forward optimization suggestions. Liao Qipeng et al. used GIS and the fuzzy comprehensive evaluation method to construct a landscape evaluation system for abandoned mining areas at the same time, combined with the hierarchical analysis method, and put forward rectification opinions for abandoned mining areas. Based on ecology, vision, and behavior, Yao Yang of Chongqing University established the theoretical system of the CEV system, including C (Naihua), E (ecology), and V (visual characteristics), by analyzing the development of highways at home and abroad, the current status of the landscape, and the elements constituting the landscape. At the same time, combined with a number of expressways such as the Yunnan Sixiao Expressway, a highway landscape evaluation system was constructed.

Combined with the above research, this paper proposes an evaluation model based on the highway ecological landscape environment geographic information system. First, based on the analytic hierarchy process, the qualitative and quantitative evaluation indicators are selected, and then the GIS geographic information system is used to obtain the basic data of the quantitative indicators. Finally, the evaluation of highway grade is realized by means of a questionnaire, and the overall scheme of the evaluation model is shown in the figure as shown in Figure 1 [8].

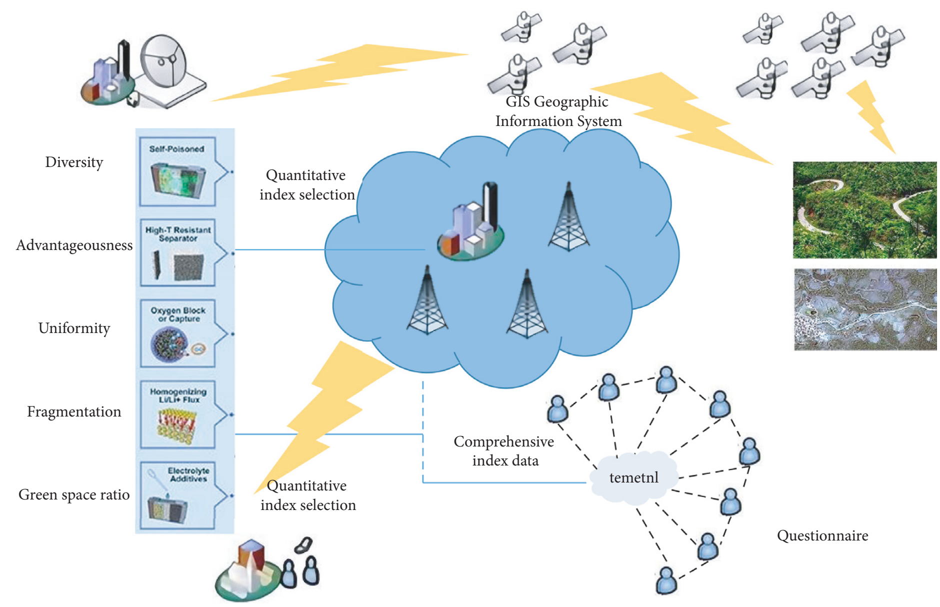

Figure 1: Evaluation process based on highway ecological landscape environment geographic information system.

3. Methodology

3.1. Quantitative Indicator Calculation Method. Quantitative evaluation indicators include the determination of overall landscape heterogeneity and the calculation of green space rate. The overall heterogeneity of the landscape can be determined by indices such as landscape diversity, landscape dominance, landscape uniformity, and landscape fragmentation.

3.1.1. Landscape Diversity Index. The index size of landscape diversity determines the richness, overall quantity, and distribution area of various types of landscapes in the scenic environment measured by it, and its values are clearly reflected. If the composition type of a landscape is relatively single, it means that it does not have diversity, which means that the diversity index value of the landscape is , but it can also mean that it is uniform. When there are two or more types of composition of a landscape and the proportion of each landscape composition type is equal, then the landscape has the greatest diversity, and the value of the landscape diversity index is also the largest. With the increasing proportion of different landscape composition types to the total landscape, the landscape diversity index will decrease, and the diversity of the landscape will also decline. Its expression is

$$H = -\sum_{i=1}^{m} (P_i)\log(P_i), \tag{1}$$

where H is the landscape diversity index; the corpse is the probability of the appearance of plaque type l in the landscape, usually expressed as the proportion of the area of plaque type i to the total area of the landscape; and m is the total number of patch types in the landscape [9].

3.1.2. Landscape Advantage Index. The core connotation of the index lies in the influence rate and domination ratio of the internal single or multiple landscape elements in the overall landscape system, and the main role of the analysis from some angles is to play a more or less changing factor and influencing factor for the biodiversity of a certain landscape environment and play a certain correction role in the landscape diversity index. For different landscape composition types with the same number of components, the degree of landscape advantage decreases with the increase of the landscape diversity index. Its expression is

$$D = H_{\max} + \sum_{i=1}^{m} (P_i)\log(P_i), \tag{2}$$

where D is the landscape advantage index; $H_{\max}$ represents the maximum diversity index, $H_{\max} = \log(m)s$; and the meaning of m and Pi are the same as in the landscape diversity expression. In general, larger D values correspond to landscapes where 1 or a few patch types dominate.

3.1.3. Landscape Uniformity Index. This index is a quantitative index of the degree of distribution of different landscape types within the same landscape system. Its expression is

$$E = \left(\frac{H}{H_{\max}}\right). \tag{3}$$

Here, E is the landscape uniformity index and H is a modified Simpson index, where $H = -\log[\sum (P_i)^2]$

3.1.4. Landscape Fragmentation Index. The landscape fragmentation index is mainly represented by the number of patches in the landscape type and the proportion of the total

Table 1: Comparison matrix.

Comparison of the factors of judgment between two and two	A B C D ...
A	
B	
C	
D	
...	

area occupied by the landscape, over time, the degree of human interference with the landscape gradually expands, which will also lead to the development of the landscape in a more fragmented direction, and the number of plaques will gradually increase [10]. As the plaque density index increases, the landscape fragmentation index increases randomly. The description of its expression is

$$\mathrm{PD} = \sum_{i=1}^{m} \frac{n_i}{A}. \tag{4}$$

Here, PD is the total density of the plaque, indicating the degree of fragmentation of the landscape as a whole; n_i is the number of class i plaques; and A is the total area of the landscape.

3.1.5. Green Space Rate. The green area rate is the ratio of all the green space in the area to the total area occupied by the area. Whether a region has implemented measures to protect the ecological environment and whether it meets the environmental standards given by the government is expressed through the results of the green space rate [11]. According to the latest green space standard, "Urban Land Classification and Planning and Construction Land Standard" issued by the Ministry of Housing and Urban-Rural Development of the People's Republic of China (GB50137?2011), green space includes park green space, protective green space, square land, auxiliary green space, and regional green space. It is calculated as

$$\lambda_g = \left[\frac{\left(A_{g1} + A_{g2} + A_{g3} + A_{xg}\right)}{A_c}\right] \times 100\%, \tag{5}$$

where λ_g stands for the green space rate; A_{g1} is the green area of the park; A_{g2} stands for the protection of green area; A_{g3} is the green area in the square land: A_{xg} is the auxiliary green area; and A_c is the total area of regional land.

3.2. Analytic Hierarchy. The analytic hierarchy method refers to the decomposition of a complex multiobjective decision-making style into multiple levels, and both qualitative and quantitative analyses are carried out, which makes the evaluation results more systematic and hierarchical. This paper is used to calculate the weights of first-level indicators to indicate the relative importance of modules such as difference, sharing, economy, ecology, and spirit in the common prosperity indicator system. The calculation steps are as follows:

Table 2: The values of RI corresponds to N.

Order	1	2	3	4	5	6	7	8	9
RI value	0	0	0.52	1.12	1.26	1.36	1.41	1.46	0.49

Step 1: the importance of the same level of indicators is compared in two ways. Transform the importance of each indicator into a comparison of the degree of importance between two and two, thereby transforming virtual qualitative judgments into measurable quantitative judgments. The measurement scale of comparison is divided into five levels: more important, more important, equally important, less important, and less important, corresponding to the comparative scores of 4, 2, 1, 1/2, and 1/4, respectively, and the comparison matrix example is shown in Table 1.

Step 2: list the judgment matrix. According to the comparison of the importance of indicators at the same level, it can constitute a judgment matrix A. The elements in the matrix represent the score of the importance of the indicator compared to the indicator. $a_{ij} i j$

$$A = \begin{pmatrix} a_{11} & \cdots & a_{1j} \\ \vdots & \ddots & \vdots \\ a_{i1} & \cdots & a_{ij} \end{pmatrix}. \tag{6}$$

Step 3: calculate the weights. The geometric mean G_j of each scale in each row of the matrix is determined, and then the weight coefficient $W_j$is obtained by normalizing it, and the specific formula is as follows:

$$W_j = \frac{G_j}{\sum G_j}, \quad (j = 1, 2, \ldots, 6). \tag{7}$$

Step 4: do conformance check. In order to ensure the scientific rationality of the weight importance of subjective judgment, it is necessary to test the consistency of the weighting results according to the following formula:

$$\begin{aligned} \lambda_{\max} &= \frac{\sum_{j=1}^{m} w_j/G_j}{n}, \\ \mathrm{CI} &= \frac{\lambda_{\max} - n}{n - 1}, \\ \mathrm{CR} &= \frac{\mathrm{CI}}{\mathrm{RI}}. \end{aligned} \tag{8}$$

Table 3: The values of evaluation level.

Evaluation level	Excellent	Good	General	Difference
CEI (%)	100–80	79–50	49–20	<20
Highway landscape quality level	I	II	III	IV

Here, the maximum characteristic value of the matrix is represented; n represents the number of indicators; CR and CI are the consistency indicators; CR represents the test coefficient; and the RI, the corresponding n values, and $\lambda_{\max}$ are shown in Table $2\lambda_{\max}$.

If the calculation result of CR is less than 0.1, it means that the importance of the selected indicators is scientifically and reasonably ranked and it passes the consistency test.

3.3. The Comprehensive Evaluation Level of Highway Landscape Was Established. First of all, according to the weight of the index determined by the questionnaire and combined with the final survey data of the questionnaire, the comprehensive assessment index of the highway landscape is obtained. The calculation formula is as follows:

$$B = \sum_{i=1}^{n} X_i \times F_i. \tag{9}$$

Here, B is the comprehensive evaluation index of the highway landscape; X_i is the evaluation weight; and F_i is the index evaluation score.

$$\mathrm{CEI} = \frac{B}{B_0}, \tag{10}$$

where CEI refers to the comprehensive indicator, B is the comprehensive evaluation index of the ideal highway landscape, and the final evaluation score is obtained by multiplying the highest value of each indicator by multiplying the corresponding weights. The final value is the criterion for evaluating the grading, and the percentage of difference is rated as shown in Table 3.

4. Result Analysis and Discussion

4.1. Plaque Type Established. The selected roads are located in Zhangjiakou City, Hebei Province. Due to the special geographical location of Zhangjiakou City, the territory is mostly mountainous and hilly and woodland is the most important type of plaque [12]. Based on the land use type map, using the spatial processing function of GIS, combined with remote sensing images to divide and count the area and quantity of plaques in the highway buffer zone, the main plaque types within the highway area of the Yanchong Expressway section of the Jingli Expressway are determined to include: forest land, agricultural land, water area, construction land, industrial and mining land, animal husbandry land, and barren grassland; The main types of plaques within the highway area of the 6335 Chongli-Chicheng section were determined to include: forest land, agricultural land, water area, construction land, and barren grassland. The main types of plaques within the X410 road area of the county-level highway were determined to include: forest land, agricultural land, water area, construction land, pastoral land, and barren grassland [13]. After processing the base map, the resulting data is quantified to obtain the area and number of different patches in the selected highway landscape buffer area, as shown in Tables 4–6.

4.2. Ecological Landscape Index Calculation and Analysis. Based on the calculation methods of ecological landscape indicators, combined with the data of plaque classification results, the biolimate index indexes of the three highways are calculated, and the calculation results are as shown in Table 7.

4.3. Qualitative Index Questionnaire Survey Data Reliability Analysis. First, the reliability analysis of the retraction questionnaire was carried out according to the Cronbach coefficient. Reliability and reliability are both professional bases for judging the authenticity of quantitative data research results and their relative standard values based on the professional correlation coefficient as the monitoring standard. In this paper, the relevant professional indicators in the questionnaire are analyzed by using the relatively popular Cronbach's α degree coefficient. First, analyze the α series; if this value is higher than 0.8, it indicates that the reliability is high; if this value is between 0.7 and 0.8, it means that the reliability is better; if the value of this number is usually between 0.6 and 0.7, then it means that it is a widely accepted reliability value; and if the value of this number is usually less than 0.6, it usually indicates that the reliability is not good and a new questionnaire needs to be reconducted. Second, if the CITC value is lower than 0.3, you can prioritize the direct deletion of the test item. The situation is different if the value of "adi number deleted by term" is significantly higher than the number not deleted. If the number is high, then we may consider recalculating the analysis after excluding the value at this time, as shown in Tables 8 and 9.

From the final result of a reliability coefficient of 0.987, it can be seen that the reliability quality of the questionnaire data is relatively high. In view of the "α series deleted by The Item," there are a small number of questionnaire scores that are uniformly low, and the questionnaire scores of the 6335 Chongli-Chicheng section are unreasonable. After deleting this part of the questionnaire, the reliability coefficient will be slightly improved, so a second screening of the I6C questionnaire data may be considered. For the "CITC value," the CITC value of the analysis term is greater than 0.4, indicating that there is a good correlation between the analysis terms and also indicating that the reliability level is good [14]. For the results of the reliability analysis obtained after the questionnaire was corrected, the invalid data here are for the score consistency items. In summary, the reliability of the highway qualitative index questionnaire survey data is high, and the next step of research and analysis can be carried out.

Table 4: Basic data of plaque types in the Yanchong section of 4–1 Jingli expressway.

Plaque type	Woodland	Agricultural land	Waters	Construction land	Industrial and mining land	Grazing land	Barren meadow
Area (ha)	8813	3825	127.5	391.5	321	890.5	3896
Quantity (pcs)	240	186	18	47	30	14	203

Table 5: Basic data of plaque types in the Chongli-Akagi section of G335.

Plaque type	Woodland	Agricultural land	Waters	Construction land	Grazing land	Barren meadow
Area (ha)	4073.2	2921	226.1	691.9	163.2	2128
Quantity (pcs)	91	58	4	45	2	68

Table 6: X410 plaque type base data.

Plaque type	Woodland	Agricultural land	Waters	Construction land	Barren meadow
Area (ha)	5596.3	1292	35.7	352.9	1297
Quantity (pcs)	45	30	5	45	28

Table 7: Calculation results of ecological landscape index.

Indicator name	Landscape diversity index	Landscape superiority index	Landscape evenness index	Landscape fragmentation index	Green space ratio
Yan Chong Section of Beijing-Li Expressway	1.9323	0.8751	0.5733	0.5733	4.0106
G335 Chongli-Chicheng section	1.9976	0.5874	0.6906	0.6906	2.6266
X410	1.4477	0.8742	0.4647	0.4647	1.7845

Table 8: Questionnaire survey reliability analysis results.

Number of items	Sample size	Cronbach coefficient
36	50	0.987

Table 9: Revised questionnaire reliability analysis results.

Number of items	Sample size	Cronbach coefficient
36	50	0.992

4.4. Evaluation Content. According to the study of the highway landscape evaluation index system in chapter 3, the landscape evaluation of selected highways is evaluated from three aspects: ecological landscape (B1), aesthetic landscape (B2), and cultural landscape (B3). The questionnaire survey is set up in the form of a picture comparison and is a reference item for each other. Based on the indicator data results of the questionnaire survey, the index weight was calculated by the AHP method, the final result was calculated by combining the weight value, and the highway was evaluated. According to the calculation method established by the comprehensive evaluation level of the highway landscape, the three highways are divided into landscape grades [15].

4.4.1. Criteria Layer Evaluation. As shown in the Table 9, on the whole, the average value of the cultural landscape in the criterion layer is the highest, but based on its relatively low proportion of importance and small expectations, the weighted calculation value is at the lowest level. The Yanchong section of the Jingli Expressway ranks first, with an average score of 7.9. The Jingli Expressway, which was born for the Olympic Games, is a new road under construction; the overall design is no longer the same, integrated with snow and Olympic two cultural elements, creating a beautiful atmosphere. The passed area has a landscape resource base, gives full play to environmental advantages, and has become an important reason for the high score of the cultural landscape. The aesthetic landscape of the G33s Chongli-Akagi section with the lowest average score is worth 5.2. After several field surveys, among the three highways, the highway landscape of G33s is relatively poor, does not have the unique design features of Jingli Expressway, and does not have the natural features of X410, resulting in its low score [16]. After weighted calculation, the highest score is the ecological landscape of the 6335 Chongli-Chicheng section, and the ecological landscape is worthy of the highest score of the three selection lines, with a high weight value and a large expectation value, and the comprehensive evaluation index is 3.9867. The comprehensive evaluation of its ecological environment is the most stable compared to the other two highways. as shown in Table 10.

4.5. Ecological Landscape Index Evaluation. The ecological landscape status of the three highway selection lines is analyzed by the index of comprehensive landscape

Table 10: Criterion layer weighted calculation results.

Guideline layer	Weight value (W)	Highway name	Mean score	Weighted calculation
Ecological landscape	0.5679	Yan Chong section of Beijing-Li Expressway	6.36	3.6118
		G335 Chongli-Chicheng section	7.02	3.9867
		X410	6.02	3.4188
Aesthetic landscape	0.3339	Yan Chong section of Beijing-Li Expressway	7.5	2.50425
		G335 Chongli-Chicheng section	5.2	1.73628
		X410	5.4	1.80306
Humanistic landscape	0.0982	Yan Chong section of Beijing-Li Expressway	7.9	0.77578
		G335 Chongli-Chicheng section	7.6	0.74632
		X410	7.6	0.74632

Table 11: Calculation result of the weighted ecological landscape index of Jingfeng high-speed extension Chong section.

Indicator layer (C)	Weight value (W)	Score	Weighted calculation
Landscape diversity	0.1690	9.4	1.5886
Landscape advantage degree	0.0897	5.2	0.4664
Landscape uniformity	0.0897	6	0.5382
Landscape fragmentation	0.0505	3	0.1515
Green space ratio	0.1690	8.2	1.3858

Table 12: G335 Chongli-Chicheng section ecological landscape index weighted calculation results.

Indicator layer (C)	Weight value (W)	Score	Weighted calculation
Landscape diversity	0.1690	9.8	1.6562
Landscape advantage degree	0.0897	6.8	0.61
Landscape uniformity	0.0897	8.5	0.7625
Landscape fragmentation	0.0505	5	0.2525
Green space ratio	0.1690	5	0.845

heterogeneity, and the data are listed separately here due to the different types of plaques of the three highway selection lines [17], as shown in Tables 4–8, the landscape diversity index of the Yanchong section of the Jingli Expressway was 1.9323, and the proportion of 7 plaques obtained from the basic data was relatively medium, and the maximum difference value was 0.4795. The 6335 landscape diversity index was 1.9976 The proportion difference of 6 patches obtained from the basic data was relatively small, and the maximum difference value was 0.3992. The X410 landscape diversity index was 1.4477, and the proportion of 5 patches obtained from the basic data was relatively large, and the maximum difference value was 0.6527. The weighted calculation results are shown in the table.

It can be seen from the table that the landscape patches in the Yanchong section of the Jingli Expressway are rich in types, and the weight of landscape diversity is higher, so the index score is higher, and the weighted calculation value is the highest value of the ecological landscape. There are woodland patches accounting for a large area, but also due to the large number of patches resulting in the fragmentation of the entire landscape. Another reason that cannot be ignored is the limitation of the buffer zone, which is worth 3 points, and the comprehensive assessment of this criterion layer indicator is the lowest value, which cannot be ignored. The ratio of the total green area of the kilometer buffer zone to the total area of the buffer zone is higher than 70%, the evaluation standard according to the green space rate is at a good level, and the fragmentation of the landscape has become the main factor affecting the stability of the ecological environment, as shown in Table 11.

It can be seen from the table that the landscape patch type of the 6335 Chongli-Chicheng section is at a medium level, and the score of the landscape diversity index is the highest average score among the ecological landscape indicators of the three highway selection lines, which is quite important based on the landscape diversity index. The optimal value of the ecological landscape is comprehensively evaluated. There are relatively many construction lands on both sides of the highway, and the proportion difference between the types of landscape patches is small, so the landscape diversity index score is higher and the landscape is more uniform, but it also leads to a low landscape advantage score, with a score of 4 points. The ratio of the total green area of the 1 km buffer zone to the total area of the buffer zone was 0.6238, and the result was less than 70% compared with the other two roads, and the vegetation cover was small. However, the comprehensive evaluation of the ecological environment is relatively the most tranquil, and there is no extreme number of values affecting the landscape of Niujie, as shown in Table 12.

It can be seen from the table that the X410 county road landscape patch type is small. The landscape diversity index score is the lowest value of the three highways, only 6.8 points. The main reason is because there are more agricultural land and construction land on both sides of the

Table 13: X410 ecological landscape index weighted calculation result.

Indicator layer (C)	Weight value (W)	Score	Weighted calculation
Landscape diversity	0.1690	6.8	1.1492
Landscape advantage degree	0.0897	5.2	0.4664
Landscape uniformity	0.0897	2.8	0.2512
Landscape fragmentation	0.0505	6.5	0.3283
Green space ratio	0.1690	8.8	1.4872

Table 14: Three highway comprehensive evaluation results.

Highway name	Yan Chong section of Beijing-Li Expressway	G335 Chongli-Chicheng section	X410
Overall evaluation index	70.3%	64%	60.3%
Overall rating	II	II	II
Evaluation level	Good	Good	Good

highway, the area is not open enough, so there are fewer types of landscape patches, and the proportion of landscape patches is relatively large. The landscape is not uniform, and the landscape uniformity index is the lowest value of the comprehensive assessment at this level [18]. The ratio of the total green area to the total area of the buffer zone in the 1 km buffer zone is 0.7938, which is the highest value of the three highways, and the average worth score is also the highest score in the ecological landscape evaluation index, and the weighted calculation result is also the maximum value of this level. Due to the existence of extreme data values that affect the ecological environment, the comprehensive assessment of the ecological environment along the X410 is vulnerable and relatively unstable, as shown in Table 13.

4.6. Comprehensive Rating and Analysis of Results. According to the final results of the comprehensive landscape evaluation data (according to Tables 4–11), the landscape evaluation grades of the three highways selected around the competition city in the Hebei District of the 2022 Winter Olympics are “good,” the three highways selected around the competition city of the 2022 Winter Olympics are “good,” and the comprehensive evaluation scores are S3801 > G335 > X410. Among the three major criterion layers of the three highways, the human landscape scores are the highest, but due to the low weight value, Therefore, the comprehensive rating is poor, the aesthetic landscape rating is average, and the highest comprehensive rating is the ecological landscape, as shown in Table 14.

5. Conclusion

Based on the analytic hierarchy (AHP), based on the expert questionnaire survey method, this paper makes an in-depth study and analysis of highway landscape evaluation by combing and summarizing the theoretical research related to highway landscape evaluation, taking the Yanchong section of the Jingli Expressway, the G335 Chongli-Chicheng section, and the X410 Highway as examples [19]. The following research results were obtained:

There are certain rules to follow in the selection of highway landscape evaluation indicators. Based on the research results of predecessors, combined with field investigations, through the analysis of highway landscape characteristics and highway constituent elements, the principles of the highway landscape evaluation and the three main criteria of highway landscape evaluation system are proposed, namely ecological landscape, aesthetic landscape, and humanistic landscape.

In the construction of the highway landscape evaluation index system, the first step is to use the concentrated trend and discrete degree analysis method to exclude volatility degrees greater than 0 from 22 indicators [20]. 15 indicators, respectively, of landscape stability in ecological landscapes; the highway separation zone in the aesthetic landscape; and the myths and legends in the cultural landscape are three indicators. The remaining 19 are left as the final evaluation indicators for the third layer of the evaluation model. The second step is to calculate the weights of each level index by the analytic hierarchy method (AHP) to construct a highway landscape evaluation model. The criterion layer and the index layer both passed the consistency test, among which the highest weight value of the criterion layer was the ecological landscape, and the weight value was 0.5679, and the highest weight value of the factor ranking weight of the decision-making target in the indicator layer was the green space rate and landscape diversity, and the weight value was 0.169.

In the practice of highway landscape evaluation, different situations may occur. Through the expert scoring pairs selected for the Jingli Expressway Yanchong section, G335 Chongli-Akagi section, and X410 three landscape scores are conducted on different grades of highways, and the comprehensive evaluation grades are all “good”. The three highways with the highest scores are all ecological landscapes, indicating that ecological landscapes are still the basis of landscape evaluation. Among them, the green space rate is distributed at about 75%, and this conclusion can also be drawn from the distribution of the area of the patch type. The proportion of woodland is about 1/2 of the total area of the buffer zone. The Yanchong section of the Jingli Expressway can better meet the needs of drivers and passengers. At the level of aesthetic landscape, the safety protection facilities scored the highest, indicating that the safety protection facilities are more complete. The highest weighted score is the landscape of the service area, indicating that the attention of the user population is relatively high and the service area design of the Jingli Expressway has regional characteristics. The service facilities are complete, the plant levels are rich, and there are certain color changes, which can be used as a reference for the construction of the highway landscape. As a national highway, the 335 Akagi-Chongli section, and the county-level highway 410 have the highest overall scores. As a component of the landscape of the highway itself, the highway linear shape is given a greater expectation value by the driver and passengers, and the weighted value of 0.682.

This article mainly includes four aspects. The first aspect is mainly to specifically describe the background of research development, purpose, and significance of the research and to analyze, summarize, and sort out the research results of previous generations of scholars. The second aspect is mainly based on the theoretical basis and the research content of this paper, and it puts forward the basic principles of evaluation and the principles used for selecting evaluation indicators. The evaluation index is constructed by drawing on the indicators of the existing highway landscape evaluation system, and the highway landscape evaluation system is constructed by using the analytic hierarchy method. The third part is the empirical part, that is, the evaluation of the three highways of the Jingli Expressway in Yanchong, the G335 Chongli-Chicheng section, and the X410 Highway, the analysis of the evaluation results, and the interpretation of those results. We summarize the problems existing in the three highway landscapes. The last part is mainly based on the problems in the road landscape in Part IV and explores the potential of X410 as a tourist road, while at the same time proposing a perfect strategy. Based on the analysis of highway landscapes at different levels, this paper constructs a highway landscape evaluation index model, and some research results are obtained, hoping to provide useful information for the practical work of highway landscape planning, evaluation, and tourism highway construction.

Data Availability

The labeled data set used to support the findings of this study is available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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