Scholar Publishing Group
Nature Environmental Protection
https://doi.org/10.38007/NEP.2023.040207
ISSN 2790-2684 Vol. 4, Issue 2: 58-67

Sensitivity of Natural Environment of Tourist Attractions Based on Fuzzy Comprehensive Evaluation

Agrawal Amogh*

Univ Quebec, Montreal, Canada

**corresponding author*

Keywords: Tourist Attractions, Environmental Sensitivity, Fuzzy Comprehensive Evaluation, Analytic Hierarchy Process Algorithm

Abstract: The study on environmental sensitivity of tourist attractions is an important part of the study on sustainable development of tourism, which is of great significance to the planning, construction, management and sustainable development of tourist attractions. Applying the fuzzy comprehensive evaluation (FCE) method to the evaluation of natural environmental sensitivity of tourist attractions is an attempt to apply the fuzzy mathematics method to the study of environmental sensitivity of tourist attractions. Therefore, this paper proposed to apply the FCE method to evaluate the natural environment sensitivity of scenic spots with rich ecological resources and located in the tourist area. The result showed that among the weight factors of the first-level scenic spots suitable for development, the highest was tourism resources, with a weight value of 0.394. Moreover, no matter what level of scenic spots, when dividing suitable development areas, tourism resources were always the most important factor. Therefore, it is urgent to protect the resources of natural scenic spots.

1. Introduction

Natural environmental sensitivity is an important factor in the management of scenic spots. The identification and evaluation of environmental sensitivity factors in scenic spots is of great significance for the management and sustainable development of scenic spots' ecosystems. From the perspective of sustainable development of tourism, environmental sensitivity is mainly reflected in ecosystem, species diversity, landscape diversity and bioclimate distribution. Different natural environment sensitivities have different sensitivity factors, and the natural environment sensitivities have spatial differences. Therefore, the environmental sensitivity evaluation results of tourist attractions must be comprehensively analyzed in combination with the environmental status quo and environmental carrying capacity of tourist attractions, so as to determine the specific evaluation indicators of environmental sensitivity.

Scholars have studied the sensitivity of natural environment of tourist attractions from many aspects. At present, there are few studies on the impact of natural factors on tourist attractions. Sedgwick Adam C discussed the latest progress in the design and application of fluorescent probes based on excited intramolecular proton transfer. The development of fluorescent probes based on excited intramolecular proton transfer is particularly attractive because of its unique properties, including large Stokes shift, environmental sensitivity and ratio sensing potential [1]. Stevenson Matt P used the existing evidence to clarify the description of the cognitive process sensitive to the natural environment, and discussed the aspects of the plan that have an impact on the intensity of the repair effect [2]. Radhouane Ikram aimed to investigate whether the voluntary external guarantee of voluntary environmental information provided by enterprises operating in environmentally sensitive industries is related to market value. He also studied how the various characteristics of the guarantee statement affect the value relevance of environmental disclosure of companies in environmentally sensitive industries [3]. It can be seen from the comprehensive analysis that at present, scholars mainly study from the ecological environment and socio-economic aspects, and lack of comprehensive research on the combination of natural factors and socio-economic factors, but comprehensive research is necessary. It is suggested to adopt the FCE method and establish the evaluation index system of natural environment sensitivity of tourist attractions.

AHP (Analytic hierarchy process) is a decision-making method that decomposes the elements that are always related to decision-making into objectives, standards, schemes and other levels, and carries out qualitative and quantitative analysis on this basis. FCE method is a comprehensive evaluation method based on fuzzy mathematics. According to the membership theory of fuzzy mathematics, qualitative evaluation is transformed into quantitative evaluation. Zhu Lingyan used Yaahp software to calculate the weight and consistency of AHP, and conducted sensitivity analysis. The FCE method was used to determine the evaluation index set and fuzzy evaluation set, and the evaluation model was established through FCE. On this basis, an empirical analysis was carried out [4]. Water resources are important basic energy. The determination of weight is one of the important indicators of water resources evaluation system, and the reasonable distribution of weight is the key to quantitative evaluation. In order to establish a scientific water resources exploitation disturbance impact evaluation index system, and make the evaluation results more reliable and effective, so as to realize the protection of water resources system, Liu Xiaomin proposed a water resources comprehensive evaluation system based on FCE model [5]. However, they did not assess the sensitivity of the natural environment of the tourist attractions.

In this paper, when analyzing the sensitivity of the natural environment of a tourist destination, the first thing to do is to select the sensitive factors. Whether the selection is appropriate or not would affect whether the overall natural environment of the tourist destination can be reflected in the comprehensive evaluation. From previous studies, most scholars have selected appropriate sensitive factors for different research purposes and conducted different studies at different levels. This paper took the protection and development of mountain tourism scenic spots that are not yet mature as an angle. The research purpose is to analyze the sensitivity of each factor in the scenic area, and then divide the suitable development and restricted protection areas of the scenic area, so as to achieve the sustainable use and sustainable development of the scenic area resources.

2. FCE Algorithm for Scenic Spots

2.1. Fuzzy Comprehensive Index Method

The fuzzy comprehensive index method is a method to obtain the comprehensive value of the index by weighted average of each single index on the basis of determining a reasonable single

index system.

The model of composite index method is as follows:

$$G^* = \sum_{i=1}^{n} G_i S_i \quad (1)$$

Among them, G^* is the comprehensive index of the evaluation object, and G_i is the evaluation score of each index in each element; S_i is the weight of each indicator, and n is the number of each element.

The fuzzy comprehensive index method is based on a group of single indicators, adding the weights of each indicator to achieve the synthesis of multiple indicators, which is convenient for the comprehensive analysis of the research object. In order to obtain good results, the comparability between various indicators and a reasonable weight are necessary. Generally, fuzzy mathematics can be used to establish a single indicator, and AHP can be used to determine the weight of each indicator.

2.2. AHP

Based on the nature of the problem and the overall goal to be achieved, the AHP divides the problem into different constituent factors, and according to the relevant influence and subordinate relationship between the factors, the factors are aggregated and combined at different levels, forming a multi-level analytical structure model. Finally, the problem is summed up as how to determine the relative important weights of the lowest level relative to the highest level, or how to arrange the relative advantages and disadvantages.

According to different objectives and functions, the system can be divided into multiple levels, and the hierarchical structure of general problems can be divided into three levels: target level, specification level and scheme level. The hierarchical structure of the level and the subordinate relationship between the factors can be described through Figure 1.

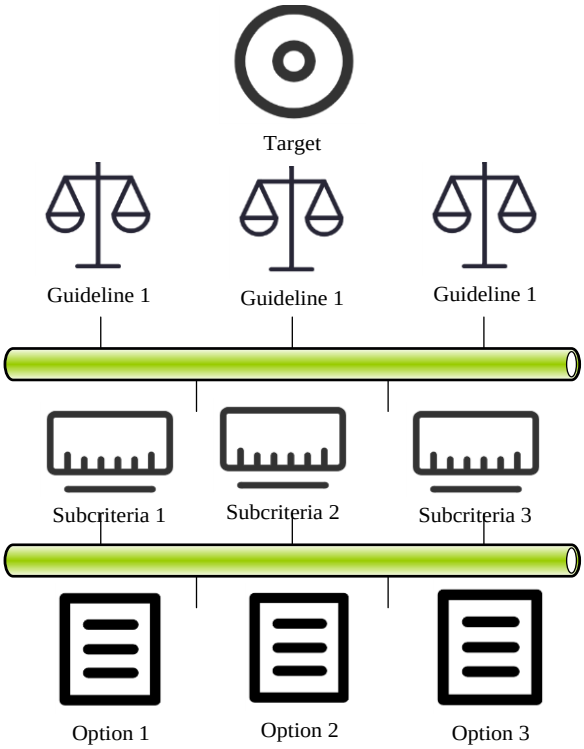

Figure 1. Hierarchy chart

It is assumed that the ranking weight vector of m_{r-1} elements on layer $r-1$ to the total target is:

$$S^{(r-1)} = (s_1^{(r-1)}, s_2^{(r-1)}, \ldots, s_{m_{r-1}}^{(r-1)})^D \quad (2)$$

The weight vector of each element m_r on layer r to the i-th element on the previous layer is:

$$Q_i^{(r-1)} = (q_{1i}^{(r)}, q_{2i}^{(r)}, \ldots, q_{m_r i}^{(r)})^D, i = 1,2,\ldots, m_{r-1} \quad (3)$$

2.3. FCE Method

This method can make a comprehensive evaluation of things with fuzzy factors, and has been widely used in economic society. In real life, many problems usually involve many factors. In this case, it is possible to divide the factors into several levels, that is, to judge each factor of a single level individually and then to judge all the factors of each level together. At present, there is no systematic method to determine the membership function in the FCE method, and the comprehensive algorithm needs to be further studied. Generally, the appropriate membership function and algorithm should be selected according to the objectives, requirements and characteristics of the specific comprehensive evaluation problem, so as to make a more objective, scientific and meaningful evaluation.

3. Natural Environment Sensitivity of Tourist Attractions

Zone A is rich in tourism resources. According to the tourism resource evaluation indicators formulated by the state, this paper determined the tourism resource evaluation indicators of the scenic spot tourism resource units through field investigation. Based on the research needs, 27 tourism resource units were selected, including four tourism resources, three tourism resources, two tourism resources, one tourism resource and the number of undeveloped grades, as shown in Table 1.

Table 1. Summary of tourism resources

	Quantity	Proportion
Level Four	3	11.1%
Three-Level	5	18.5%
Two-Level	10	37.1%
One-Level	6	22.2%
Not Obtained	3	11.1%

3.1. Division of Comprehensive Sensitivity Assessment

The purpose of this paper is to analyze the sensitivity of various natural environmental factors and summarize the vulnerable areas so as to pay attention to their protection in the planning of tourist attractions. For areas with low sensitivity, that is, areas where natural factors are not easy to be destroyed and have strong anti-interference ability, they are the key construction areas of the scenic spot [6-7]. In order to emphasize the protection of areas with high sensitivity of various factors, this area was specially selected in this paper as a “restricted protection area” to show that these areas with low sensitivity can be used for the development and construction of tourist attractions, and they were divided into “suitable construction areas” in order.

The seven sensitive factors selected are: tourism resources (A1), elevation (A2), slope (A3),

slope direction (A4), land use type (A5), water body (A6), air anion concentration (A7) [8-9]. In different planning objectives, whether they should focus on development or strengthen protection has different importance. The protection is the factors that are easy to be destroyed, while the construction is the factors that can attract the attention of tourists [10-11]. For example, in the protection of scenic spots, slope is an important factor, while in the development of scenic spots, slope is a secondary factor.

3.2. Division of Restricted Protection Area

In the development and construction of scenic spots, the basic principles of strict protection, unified management, reasonable development and sustainable utilization should be implemented based on the nature and social needs of the scenic spots. It is necessary to fully consider the relationship between the three stages of history, contemporary and future, so as to truly realize the purpose of resource protection and comprehensive utilization of scenic spots. In the sensitivity analysis of single factor, the attention to the sensitive areas in the development of tourism, especially the extremely sensitive areas, was put forward [12-13]. Through the comprehensive analysis of each factor, the ecological sensitivity of each factor was determined, and the comprehensive evaluation of each factor was carried out. According to the "bucket effect", how much water a bucket can hold depends on how high the lowest board is. Therefore, based on the most vulnerable sensitive factors, combined with the sensitivity of other factors to the reserve, the weight of each factor is determined [14-15]. A The results of the division of restricted protection areas in scenic spots are shown in Figure 2.

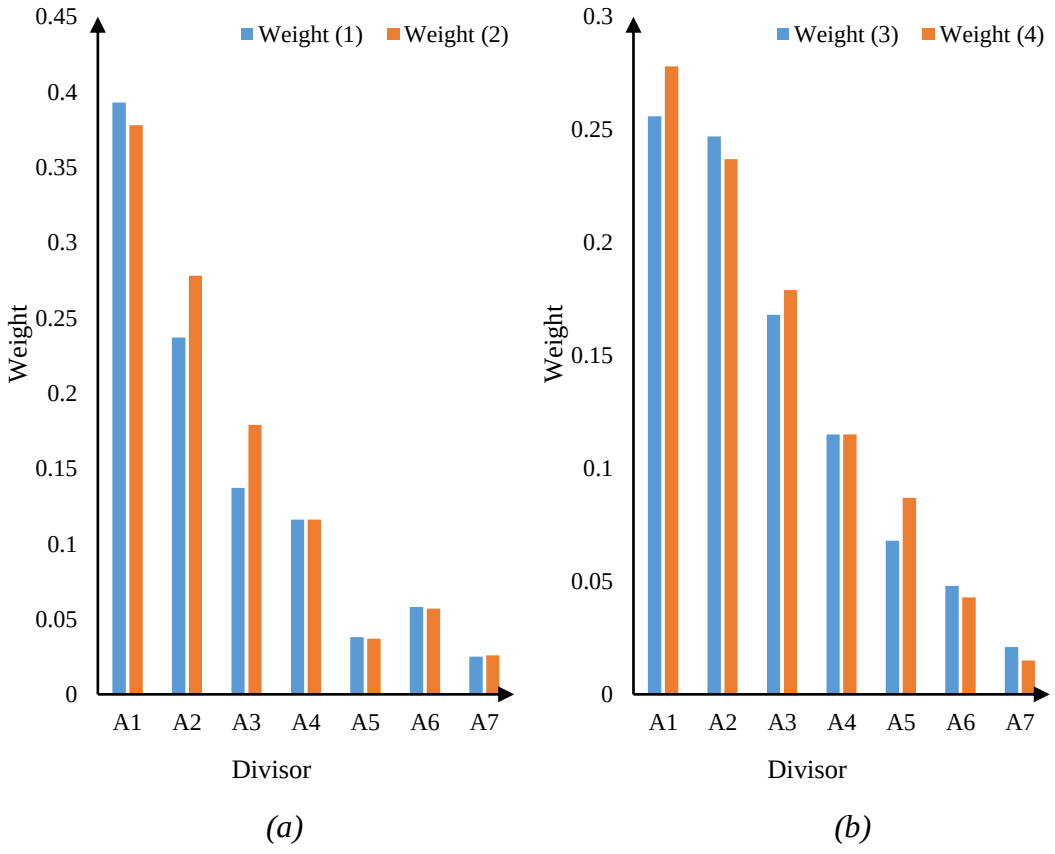

Figure 2. Weights of restricted protection factors of scenic spots at all levels

Figure 2 (a) shows the factor weights of the restricted protection areas of the first and second

level scenic spots, and Figure 2 (b) shows the factor weights of the restricted protection areas of the third and fourth level scenic spots. It can be seen from Figure 2 that no matter what level of scenic spots, the order of importance of the impact of environmental sensitivity factors on the delimitation of the reserve was tourism resources, altitude, slope, slope direction, land use type, water body, and air anion.

The layer stacking was completed according to the given weight value and weighted stacking method, and the new layer was divided into four levels from high to low according to the attributes of the new layer, which correspond to four levels of protection zones: primary protection zone, secondary protection zone, tertiary protection zone and development control zone, as shown in Figure 3.

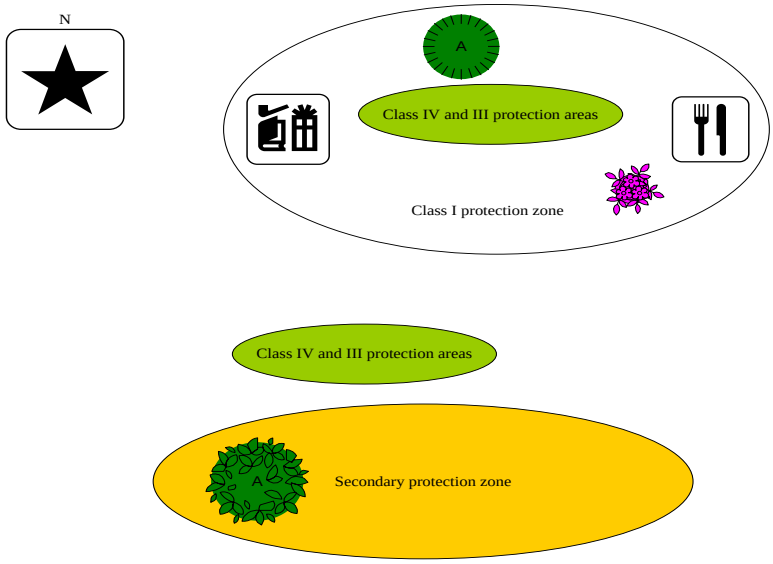

Figure 3. Restricted protection classification of scenic spots

(1) Class I protection zone

The results showed that the comprehensive sensitivity coefficient in this area is the largest. Areas within this level belong to areas with relatively high sensitivity of each single factor and should be protected. Among the first-level protection areas, there are some scenic spots of grade 4 and grade 3. The tourism resources in these areas are of high quality and are also the main development direction of the scenic spots, so they are also attractive to tourists. If it cannot be properly managed, the quality of tourism resources would be reduced, which would have a greater impact on tourism experience. Secondly, this area has a high altitude and a large slope. However, the scenery in this area is very good, and it is difficult to be developed, because too much would probably cause great damage to the plants here, and it is difficult to recover.

Protection measures: when the tourism resources in the area are properly developed, attention should be paid to the protection of the scenic area environment; it is necessary to strictly control the number of tourists in the area, which can be controlled by time and stage to match the environmental carrying capacity of the scenic spot; to protect the safety of tourists, necessary protective fence measures can also be set up.

(2) Secondary protection zone

The score of comprehensive sensitivity factors in this area is high. Compared with the primary protection zone, the sensitivity of the environmental impact factors in the secondary protection zone is relatively low. In this area, the sensitivity of each factor is not high, and it has strong anti-interference ability, so it can carry out the construction of facilities closely related to the scenic spot. As can be seen from Figure 1, it is characterized by three-level tourism resources, high forest

resources, located near the water source, high altitude and above the high slope. The landscape quality of this area is good and can be moderately developed.

Protection measures: it is necessary to develop tourism projects for tourists to watch in combination with the characteristics of the tertiary tourism resources; in the district, it is important to focus on restoring and nurturing the forest resources of the scenic area; in this area, the number of tourists should be controlled and the bad behavior of tourists and residents should be reduced; the number of tourists is determined by the altitude and slope of the area, and attention should be paid to the safety of tourists when visiting.

(3) Grade III protection zone

The comprehensive sensitivity factor score in this area is low. The main body of tourism activities characterized by small disturbance intensity has been formed. Most of them are concentrated in relatively flat areas, where tourism resources are intensive and the quality is not high; most of them are at the radiation edge of high-level tourism resources; most of them are based on Class I and II tourism resources. Single tourism resources are relatively scattered, but corresponding tourism service facilities and infrastructure can be established.

Protection measures: within the protection of this area, it is an area for large-scale development of tourism resources, but it is necessary to adhere to moderate development, otherwise it will lead to the inability to recover the scenic resources. It is necessary to pay attention to the protection of forest land resources, restore and cultivate new vegetation, so as to improve the vegetation diversity of the scenic area and maintain the stability of the scenic area ecosystem. It is necessary to strengthen the protection of the environment and strictly prohibit the unreasonable behavior of tourists and residents.

(4) Development control area

The corresponding area has the lowest comprehensive sensitivity score. In the development control zone, tourism resources are of low ornamental value, unreasonable land use type and low sensitivity to various factors, so they are the focus of tourism development. In Figure 1, the development control area is mainly concentrated at the edge of the planning area and close to the urban traffic trunk. Land use types include three types of residential land and abandoned land.

Development countermeasures: with environmental protection in mind, it is possible to build higher density tourist attractions and establish large service facilities such as vacation villas, hotels, guest houses, and infrastructure. At the same time, due to its proximity to major traffic arteries, special attention should be paid to its protection during construction. Among them, the development control area corresponds to the relatively favorable development area, so the specific measures for its development are detailed in the next section.

3.3. Division of Suitable Development Areas

The goal of scenic spot planning is to rationally develop the scenic spot resources and make them available to people, so as to provide people with places to watch, entertain and carry out scientific activities, which will maximize the social, economic and environmental benefits of the resources. As long as the scenic spot has economic benefits, it can maintain the normal operation of the scenic spot, and it can also have funds to manage and repair the scenic spot facilities to ensure the sustainable development of the scenic spot. Therefore, the region should be reasonably developed, planned and constructed to achieve the purpose of reasonable protection and development.

The weight value of the evaluation factor is obtained by comparing and scoring the impact of various natural environmental factors on the construction suitability.

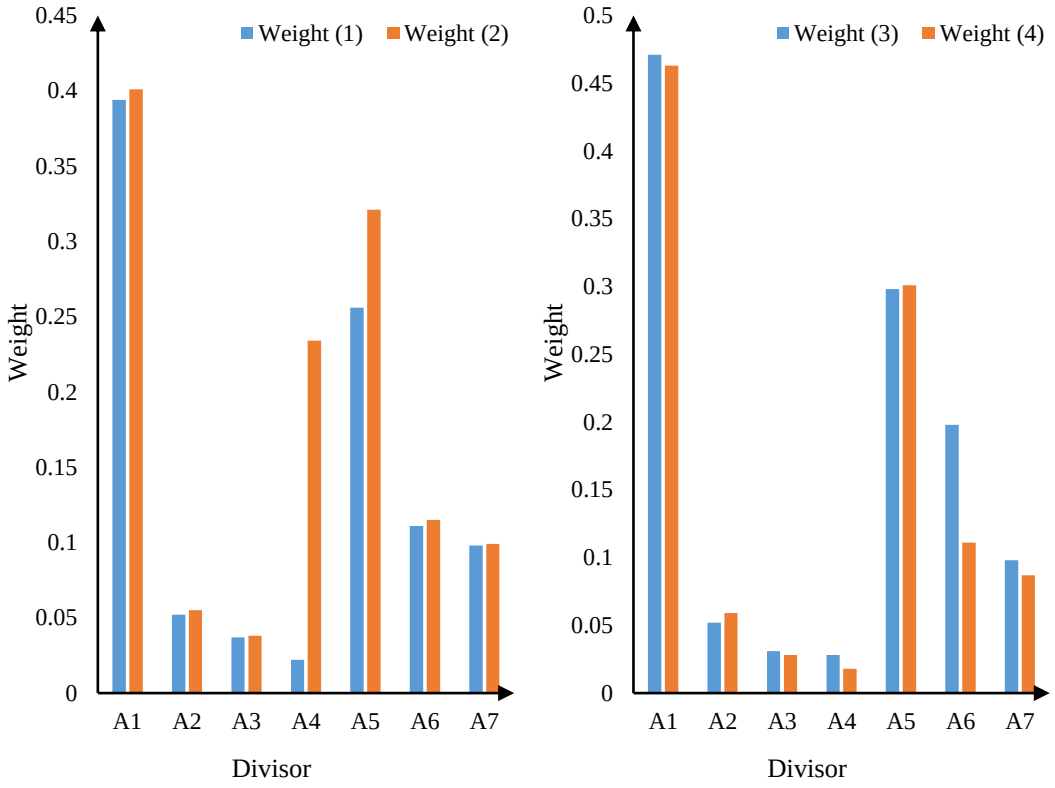

Figure 4. Weight distribution of various factors for the division of suitable development areas

Figure 4 (a) shows the weights of suitable development area factors for the first and second level scenic spots, and Figure 4 (b) shows the weights of suitable development area factors for the third and fourth level scenic spots. It can be seen from Figure 4 that tourism resources had the highest weight factor among the first-level scenic spots, with a weight value of 0.394. No matter what level of scenic spots, the relative importance of each factor was tourism resources, land use type, water body, air anion concentration, elevation, slope, and slope direction from high to low when dividing suitable development areas. When considering the suitable construction area, tourism resources are the most important, because it is the key to produce the economic benefits of the scenic area, followed by the land use type. Therefore, it is also very important to determine the importance of the land and water body suitable for development and construction in the development. It is an important factor to attract tourists. Among them, the concentration of air negative ions will have a relatively small contribution to the construction of the oxygen bar in the scenic area, including the elevation, slope and aspect of the oxygen bar in the tourist rest center. Therefore, the goal of sensitivity analysis of the adaptive development system for tourist attractions is to carry out reasonable construction and development of the planned area with the least damage to resources.

4. Conclusion

At present, some successful experiences have been achieved in the planning and development of tourist attractions, and a series of systems have been formed. However, starting from the sensitivity of the natural environment, the research on its analysis and development is still in its infancy. Based on the preliminary work, the project planed to introduce the concept of sensitivity, and select Landscape Zone A as an example. Seven natural landscape elements were selected, namely tourism

resources, altitude, slope, slope direction, hydrology, land use status, negative ions, etc. AHP method was adopted. Through quantifying the sensitivity of each natural landscape element and the comprehensive sensitivity of each natural environment element in the landscape belt, the impact of different natural landscape elements on the tourism development of the landscape belt was quantitatively evaluated from the perspective of tourism planning and development of the landscape belt, and its evaluation was also carried out. Finally, the limitation and suitability of tourism resources were determined, and then they were reasonably developed and protected.

Funding

This article is not supported by any foundation.

Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Conflict of Interest

The author states that this article has no conflict of interest.

References

[1] Sedgwick Adam C., Luling Wu, Haihao Han, Steven D. Bull, Xiaopeng He, Tony D. James, et al. Excited-state intramolecular proton-transfer (ESIPT) based fluorescence sensors and imaging agents. Chemical Society Reviews. (2018) 47(23): 8842-8880. https://doi.org/10.1039/C8CS00185E

[2] Stevenson Matt P., Theresa Schilhab, Peter Bentsen. Attention Restoration Theory II: A systematic review to clarify attention processes affected by exposure to natural environments. Journal of Toxicology and Environmental Health, Part B. (2018) 21(4): 227-268. https://doi.org/10.1080/10937404.2018.1505571

[3] Radhouane Ikram, Mehdi Nekhili, Haithem Nagati, Gilles Pache. Is voluntary external assurance relevant for the valuation of environmental reporting by firms in environmentally sensitive industries? Sustainability Accounting, Management and Policy Journal. (2020) 11(1): 65-98. https://doi.org/10.1108/SAMPJ-06-2018-0158

[4] Lingyan Zhu. Research and application of AHP-fuzzy comprehensive evaluation model. Evolutionary Intelligence. (2022) 15(4): 2403-2409. https://doi.org/10.1007/s12065-020-00415-7

[5] Xiaomin Liu, Haiyan Liu, Wan Zheng, Lifei Wang, Qiong Chen. Study on evaluation index system of sustainable development of mine water resources based on PSO-AHP model and fuzzy comprehensive evaluation. Journal of Intelligent & Fuzzy Systems. (2021) 41(3): 4253-4264. https://doi.org/10.3233/JIFS-189686

[6] Burns Emily E., Alistair BA Boxall. Microplastics in the aquatic environment: Evidence for or against adverse impacts and major knowledge gaps. Environmental toxicology and chemistry. (2018) 37(11): 2776-2796. https://doi.org/10.1002/etc.4268

[7] Dean Joshua F., Jack J. Middelburg, Rien Aerts, Luke G. Blauw, Matthias Egger, Mike S. M. Jetten, et al. Methane feedbacks to the global climate system in a warmer world. Reviews of Geophysics. (2018) 56(1): 207-250. https://doi.org/10.1002/2017RG000559

[8] Sarkis Joseph, Qingyun Zhu. Environmental sustainability and production: taking the road less travelled. International Journal of Production Research. (2018) 56(1-2): 743-759. https://doi.org/10.1080/00207543.2017.1365182

[9] Rudyanto Astrid, Kashan Pirzada. The role of sustainability reporting in shareholder perception of tax avoidance. Social Responsibility Journal. (2021) 17(5): 669-685. https://doi.org/10.1108/SRJ-01-2020-0022

[10] de Graaf Inge EM, Tom Gleeson, L. P. H. (Rens) van Beek, Edwin H. Sutanudjaja, Marc F. P. Bierkens. Environmental flow limits to global groundwater pumping. Nature. (2019) 574(7776): 90-94. https://doi.org/10.1038/s41586-019-1594-4

[11] Chamas Ali, Hyunjin Moon, Jiajia Zheng, Yang Qiu, Tarnuma Tabassum, Jun Hee Jang, et al. Degradation rates of plastics in the environment. ACS Sustainable Chemistry & Engineering. (2020) 8(9): 3494-3511. https://doi.org/10.1021/acssuschemeng.9b06635

[12] Ying Guo, Mengjuan Zhong, Zhiwei Fang, Pengbo Wan, Guihua Yu. A wearable transient pressure sensor made with MXene nanosheets for sensitive broad-range human-machine interfacing. Nano letters. (2019) 19(2): 1143-1150. https://doi.org/10.1021/acs.nanolett.8b04514

[13] Sturman Oliver, Pierre-Luc Germain, Johannes Bohacek. Exploratory rearing: a context-and stress-sensitive behavior recorded in the open-field test. Stress. (2018) 21(5): 443-452. https://doi.org/10.1080/10253890.2018.1438405

[14] Huang Liang, Xueping Zhang, Qingqing Wang, Yujie Han, Youxing Fang, Shaojun Dong. Shape-control of Pt-Ru nanocrystals: tuning surface structure for enhanced electrocatalytic methanol oxidation. Journal of the American Chemical Society. (2018) 140(3): 1142-1147. https://doi.org/10.1021/jacs.7b12353

[15] Sale Alessandro. A systematic look at environmental modulation and its impact in brain development. Trends in neurosciences. (2018) 41(4): 4-17. https://doi.org/10.1016/j.tins.2017.10.004