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LETTER TO THE EDITOR

Environmental Vulnerability Analysis Method of Interior Design Ecology Based on Grid Scale

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Aiming at the problem that the existing methods have low fitting degree between the evaluation results and the actual situation, a grid-scale-based environmental vulnerability analysis method for interior design ecology is proposed. The electronic map image is preprocessed by image mosaic and enhancement processing, and the standard image of the research area is obtained by cutting the vector map. The indoor environment image is processed to a grid scale of 10cm×10cm, and the grid of each layer corresponds one by one. Referring to the domestic indoor environment vulnerability evaluation index system, combined with the unique factors of the ecological environment of interior design, the environmental vulnerability evaluation index system was determined. Fuzzy Analytic Hierarchy Process (FAHP) was used to assign weights to each hierarchical factor, and an assessment model of ecological environmental vulnerability of interior design was constructed. By using the function of map algebra in spatial analysis, the single-factor spatial grid data are superimposed to obtain the ecological vulnerability index on each grid unit, and the grid-scale-based ecological environmental vulnerability analysis of interior design is completed. The experimental results show that the evaluation results obtained by the proposed method and the actual fitting degree are high, which verifies the comprehensive practicability of the proposed method.
Grid Scale; Interior Design; Ecology; Environmental Vulnerability

1 INTRODUCTION

Human living environment is an artificial environment with architecture as the main body. With the deepening of environmental awareness, people gradually realize the importance of natural landscape in the environment. Whether inside or outside the building, greening space will have a significant impact on people. Therefore, after meeting the basic functional needs of the environment, people are still spare no effort to introduce the elements of plants, water, rocks and other elements of nature into the environment, to recreate the living space by their own regression, to introduce the ecological concept into the interior design, and to carry out the interior ecological design. All kinds of environmental and social problems arising from interior design, construction and use, if not solved and guided in time, will probably develop into diseases that destroy ecology and environment, and increase the difficulty of environmental governance (Azwar et al. 2018).

From the current overall situation in China, the environmental vulnerability caused by the ecology of interior design can be summarized as follows: Firstly, the pursuit of ultimate effect is widespread, and relatively non-renewable resources such as steel, wood and rock are overused in some interior design. It is not only widely used in interior decoration of large public buildings, but also in some so-called luxury houses. It is extremely unfavorable for the sustainable development of the construction industry to consume a large number of non-renewable precious decoration materials. Secondly, synthetic chemical materials are widely used in modern interior decoration, and a considerable part of them contain substances harmful to human sports, which will be emitted for a long time in use. It not only has irritating odor, but also pollutes indoor air, and it will certainly affect people's health. Thirdly, due to the timeliness of interior decoration, interior decoration is in the process of continuous renewal of demolished building decoration materials, which cannot be recycled and discarded as building waste, and become a source of environmental pollution (Emeh and Igwe 2018). Fourthly, the interior design is only regarded as the use of decorative materials, as the form of decorative parts in the interior space, such as the use of natural light in interior design, the combination of design and natural ventilation, the creation of green landscape in interior design, the use of ecological building materials in interior design and so on. The above reasons lead to the vulnerability of the indoor ecological environment in varying degrees. The assessment of the ecological vulnerability can identify the key factors of the ecosystem vulnerability and their changing rules, and provide the basis for ecological protection and restoration.

Xue-Song Xu, Sheng-Jie Yang published an article in the Journal of Ekoloji 2018 Issue 106 entitled "The Vulnerability Assessment Model and Empirical Analysis of Chinese Urban Mineral Industry", which first divided the urban mineral system for the "marketization, supply, recycling, recycling" subsystem, and use the complex system theory to analyze its industrial relations (Xu and Yang 2018). Secondly, a mutation process model was established to describe the key factors and indicators of qualitative change. Thirdly, the introduction of branch fuzzy sets as membership functions expands the space of value selection and makes it more comprehensive. An empirical analysis was carried out on the statistical data of the mineral demonstration base in Miluo City, Hunan Province from 2009 to 2015. However, this evaluation method has low applicability and is difficult to apply to other fields.

Liu (2016) proposed an evaluation method of ecological environment vulnerability in Yimeng Mountains based on SRP conceptual model. Based on SRP conceptual model, 13 evaluation indicators such as landscape diversity index, soil erosion and elevation were selected. Under the environment of GIS, combined with spatial principal component analysis and analytic hierarchy process, the ecological environment vulnerability in Yimeng Mountains was improved. According to the EVI value, the ecological environment vulnerability of the study area was classified. However, this method has the problem of low fitting degree between the evaluation results and the actual situation. Li et al. (2018) proposed an analysis method of coastal zone environmental vulnerability of the Yellow River Delta based on AHP-CVI technology. In this study, an evaluation index system of coastal environmental vulnerability in the Yellow River Delta was constructed, including natural inherent vulnerability factors and human special vulnerability factors. A quantitative method of vulnerability evaluation index was established, including national standards, expert evaluation, observation and calculation. The weight of evaluation index was determined by analytic hierarchy process, and the coastal vulnerability index method was used as evaluation model. Based on the GIS software platform, the environmental vulnerability assessment and spatial distribution pattern analysis of the coastal zone of the Yellow River Delta were carried out. However, this method has the problem of low evaluation efficiency. In view of the existing problems of the above methods, a grid-scale-based analysis method for ecological environmental vulnerability of interior design is proposed.

2 IDEA DESCRIPTION

2.1 Data processing of eco-environmental vulnerability in interior design based on grid scale

The structure of environmental vulnerability raster data is actually an array of pixels, each of which is located by a row or column. Because the grid structure is arranged according to certain rules, the position of the entity can be easily hidden in the storage structure of the network file, and the row and column coordinates can be easily converted to coordinates in other coordinate systems. Each code in the network file itself clearly represents the encoding of the entity's attributes. In raster data structure, point entity is represented as a pixel, line entity is represented as a set of adjacent pixels connected in a certain direction, and surface entity is represented by a combination of adjacent pixels gathered together. This data structure is very suitable for computer processing because row and column pixel arrays are very easy to store, maintain and display (Sahoo et al. 2016).

Based on the 1:50 topographic map of a local residential area, this paper carries out geometric correction (the average error is less than 0.5 pixels), preprocesses the electronic map image through image mosaic and enhancement processing, takes the registered map as the base map on the ArcGIS platform, and tracks the new feature tool in EDITOR on the newly built vector map layer. The boundary of the study area is studied, and the plane vector map of indoor environment is obtained. The standard image of the study area is obtained by cutting the vector map. According to the actual situation of indoor environment, the maximum likelihood classification method is used to classify the research area. Arc-GIS is used to establish the spatial topological relationship between the above interpreted data and to generate the ecological environment database of interior design. DEM data is the spatial resolution data covering the whole study area, and the data format is GRID. According to DEM, the indoor ecological environment information is extracted by surface analysis under ArcGIS module. The above data are rasterized uniformly, the resample module in ArcGIS is used to process the raster scale of 10 cm×10 cm, and ensure that each layer of raster corresponds to one another, which lays a foundation for the analysis of environmental vulnerability of interior design ecology.

2.2 Analysis of environmental vulnerability of interior design ecology

It is very difficult to establish a model containing all factors to evaluate the vulnerability of eco-environment in interior design. On the one hand, some parameters contained in these factors are difficult to obtain, and on the other hand, the relationship between them is complicated because of too many parameters (Di et al. 2016). Therefore, when analyzing the vulnerability of eco-environment in interior design, we should make a concrete analysis according to the specific problems, try to find out the main factors affecting the vulnerability of eco-environment in interior design, and eliminate the secondary factors.

2.2.1 Constructing evaluation index system

Referring to the domestic evaluation index system of indoor ecological environment vulnerability and combining with the unique factors of the ecological environment of interior design, the evaluation index system of environmental vulnerability is determined. The evaluation index system consists of natural vulnerability evaluation index and human vulnerability evaluation index. The evaluation index of inherent vulnerability of natural environment is composed of 4 major indicators and 11 sub-indicators, while the evaluation index of social environment vulnerability is composed of 3 major indicators and 11 sub-indicators.

2.2.2 Determination of the weight of evaluation indexes

Fuzzy Analytic Hierarchy Process (FAHP) is used to assign weights to each level factor. Steps are:

1) Firstly, through expert consultation, the relative importance of each element of indoor ecological environment is compared between two groups, and it is expressed by a positive triangular fuzzy contrast matrix.

2) By using the Lambda-Max method, the fuzzy weights of each factor of each expert are calculated.

3) Integrating the fuzzy weight values of each expert's factors with the average method.

4) Calculate the total ranking weight of each level factor, determine the importance of the factor layer to the index layer to the target layer in the index system, and obtain the weight value of each element of the indoor ecological

environment.

2.2.3 Establishment of evaluation model

Ecological vulnerability is very vulnerable to external interference and instability, which is described by ecological sensitivity. At the same time, the self-repairing ability of the ecological environment after interference can be expressed by ecological elasticity. In addition, the level of ecological vulnerability is also related to its environment, so it is expressed by pressure (Chouhan et al. 2017). Based on the concept of IPCC vulnerability, considering the characteristics of the study area, and referring to the relevant research results, this paper chooses the factors affecting the ecological vulnerability of indoor environment to establish an evaluation model, and determines the evaluation factors based on the "sensitivity-elasticity-pressure" model. The model is as follows:

$$EEVI = \sum_{i=1}^{n} w_i x_i \tag{1}$$

Among them, EEVI value is the index of ecological environmental vulnerability of interior design; n is the number of evaluation indicators, w_i is the weight coefficient of the first evaluation index; x_i is the standardized value of the evaluation index i. Generally, the greater the EEVI value, the higher the degree of ecological vulnerability; conversely, the lower the degree of ecological vulnerability.

2.2.4 Calculation of ecological vulnerability index

Through the established calculation model and the determined weights, the ecological environment vulnerability index is calculated to evaluate the indoor ecological environment vulnerability. In the ArcGIS software, the 10cm×10cm digital grid is used as the basic evaluation unit. According to the ecological vulnerability calculation formula, the single-factor spatial raster data is superimposed by the map algebra function in spatial analysis to obtain the ecology vulnerability index on each grid unit and completes the vulnerability analysis of the ecological environment of interior design based on grid scale.

3 RESULTS

In order to verify the comprehensive effectiveness of the proposed grid-scale-based environmental vulnerability analysis method for interior design, a test is needed. The operating system is Windows XP, and the testing software is MATLAB. The environmental data of a local residential area is selected as the experimental data. Literature method are applied to the analysis of indoor environmental vulnerability, and the method is evaluated with this paper (Liu 2016). The price results are compared with the actual fitting degree, and the experimental results are shown in Figure 1.

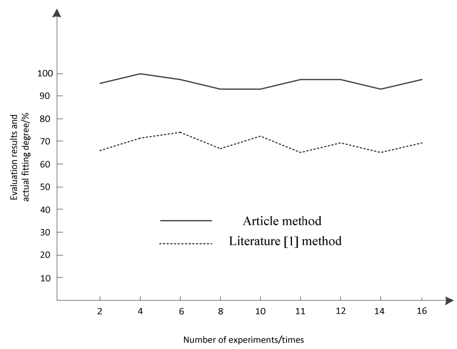

Figure 1 Comparison of evaluation results with actual fitting degree

The analysis of the above figure shows that the evaluation results obtained by Literature method have a lower degree of fitting with the actual results, and the evaluation results obtained by the method proposed in this study have a higher degree of fitting with the actual results (Liu 2016). The main reason for the more accurate evaluation of this method is that the fuzzy analytic hierarchy process is used to assign weights to each level factor, and a vulnerability evaluation model of ecological environment for interior design is constructed. By using the algebraic function of map in spatial analysis, the single factor spatial grid data are superimposed to obtain the ecological vulnerability index on each grid unit. The method in this paper can effectively improve the accuracy of indoor ecological environment vulnerability assessment by using the above steps.

4 CONCLUSIONS

The existing assessment methods of indoor ecological environment vulnerability generally adopt weighted scoring method and fuzzy mathematics method. The weighted scoring method is more artificial in determining the weights of evaluation factors, and it cannot reflect the impact of the continuous changes of the index values of each evaluation factor on the vulnerability of groundwater environment. The fuzzy mathematics method has some shortcomings in determining the weights of evaluation factors and constructing the membership function. Fuzzy Analytic Hierarchy Process (FAHP) can be used to solve their shortcomings.

In this paper, the electronic map image is preprocessed by image mosaic and enhancement processing. The indoor environment image is processed to a grid scale of 10 cm×10 cm, and the grid of each layer corresponds to one another. Fuzzy Analytic Hierarchy Process (FAHP) is used to assign weights to each level factor, an assessment model of ecological environmental vulnerability of interior design is constructed, and the vulnerability of each environmental factor is calculated. The experimental results show that the evaluation results of this method and the actual fitting degree are high. This method has laid a solid foundation for the progress in the field of environmental vulnerability analysis, and provided a new idea for the formulation and implementation of indoor ecological environment protection strategies.

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