Landscape aging in ethnic minority regions based on entropy method-fuzzy comprehensive evaluation ——Take Yanji City, China as an example

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Abstract. Global aging is becoming more and more serious. How to improve the landscape environment to provide the elderly with a more comfortable, convenient and pleasant living environment, we need to create an suitable environment for the aging society based on the physical, psychological and social characteristics of the elderly. Taking China’s ethnic minority areas as an example, this paper selects 21 evaluation indicators for the landscape aging for ethnic minority areas from the perspective of security, accessibility, communicative, comfortable natureand richness. Through the use of entropy method, the fuzzy comprehensive evaluation of the application status of the elderly in the landscape of Yanji City is carried out, which aims to provide a reference for the improvement and development of the landscape aging in minority areas. The research results show that the index with the highest weight in the comprehensive evaluation of landscape aging of Yanji City in China's ethnic minority areas are the degree of spatial identification of 0.118 and the regional cultural embodiment of 0.086. The overall score of the evaluation system is 0.6017. All departments should set up special senior landscape work agencies or joint organizations to strengthen the attention to the landscape of ethnic minority elderly, increase their sense of belonging to the landscape, improve the greening environment and enhance the ageing of plant landscape design. Landscape architects should actively consider for the elderly, and strive to design a more comfortable landscape environment for the elderly.

1. Introduction
At present, global aging is becoming more and more serious. According to WHO statistics, with the increasing trend of population aging, in 2019, the global population over 60 years old were 650 million. The proportion of the global population over 60 years old will increase from 11% in 2019 to 22% in 2050. The National Civil Affairs Work Conference held in Beijing, pointed out that by the end of 2019, the number of people aged 60 and over in China reached 254 million. During the "14th Five-Year Plan" period, China will enter a moderately aging society. By 2025, the number of people aged 60 and over in China will exceed 300 million. In recent years, the State Council has vigorously advocated the continuous deepening of the reform of streamlining administration, delegating power, optimizing services and advancing the supply-side reform of elderly care services. We advocate actively responding to the aging of the population, encouraging the elderly to participate in society and building a livable and elderly care environment.

Yanbian Korean Autonomous Prefecture is the largest settlement of Koreans in China. This article
takes Yanji City, the capital of Yanbian Korean Autonomous Prefecture, as a typical research area. In this context, on the basis of clarifying the aging of the population, we will construct 5 standard layers covering security, accessibility, communicative, comfortable nature and richness. The landscape evaluation index system of 22 indicators adopts entropy method to make fuzzy comprehensive evaluation of the application status of landscape for the elderly in Yanji City, aiming to provide a reference for the improvement and development of landscape aging in minority areas.

2. Research methods

2.1. Sample collection and index determination

In 2020, a questionnaire survey was conducted among the elderly in Yanji City, Yanbian Korean Autonomous Prefecture, the largest settlement of Koreans in China. A total of 230 questionnaires were collected, and the average daily sampling frequency of the questionnaire was 3 times. Use EXCEL 2017 software to summarize data. Use SPSS 20.0 software for data statistical analysis.

2.2. Entropy Method

According to the definition of information entropy, for a certain index, the entropy value can be used to evaluate the degree of its dispersion. The smaller the information entropy value, the greater the degree of dispersion of the index, and the greater the influence of the index on the comprehensive evaluation\[1\]. Therefore, we can use information entropy tools to calculate the weight of each indicator and provide a basis for comprehensive evaluation. In this study, m samples and n analysis objects are referred to as (m, n) problems. The specific steps for determining the weight value through the entropy method are as follows:

1. The multi-index evaluation matrix is forwarded.
   \[ \gamma_{ij} = \frac{y_{ij} - \min_k \{y_{ik}'\}}{\max_k \{y_{ik}'\} - \min_k \{y_{ik}'\}} \]  

2. Calculate the proportion of the i-th index under the k-th criterion layer.
   \[ X_{ki} = x_{ki} / \sum_{j=1}^{n} x_{kj} \]  

Analysis of the basic situation of the survey sample: \( X_{ki} \) represents the value of the i-th index under the k-th criterion layer.

3. Calculate the index information entropy \( (H_i) \) and information redundancy \( (X_i) \).
   \[ H_i = -\frac{1}{\ln m} \sum_{k=1}^{m} x_{ki} \ln x_{ki} \]  

4. Calculate the index weight \( W \).
   \[ W_i'' = D_i / \sum_{i=1}^{n} D_i \]  

2.3. Fuzzy comprehensive evaluation method

Fuzzy comprehensive evaluation method is a method to solve the problem of fuzzy boundaries, which can quantify qualitative indicators, so that the evaluation indicators are more accurate. The specific evaluation process is as follows\[2\]:

1. Construct a fuzzy comprehensive evaluation index system, evaluation index thresholds, and calculate weight vectors \( (W) \).
(2) Calculate the membership degree of each index \((X_{jk})\), construct membership matrix \((R)\), the following formulas are used to calculate the membership degree of the forward index and the reverse index:

\[
R_{jk} = \frac{x_{jk} - x_{jmin}}{x_{jmax} - x_{jmin}}
\]

\[
R_{jk} = \frac{x_{jmax} - x_{jk}}{x_{jmax} - x_{jmin}}
\]

\[
R = (r_{jk})_{mn} = \begin{bmatrix}
  r_{11} & \cdots & r_{1n} \\
  \vdots & \ddots & \vdots \\
  r_{m1} & \cdots & r_{mn}
\end{bmatrix}
\]

(3) Calculate total membership degree.

\[
B = W \times R = (a_1, a_2, \ldots, a_n)
\]

2.4. Questionnaire design

After determining the evaluation index of Yanji City's landscape aging, the questionnaire was designed. The questionnaire design is mainly designed in the form of a Likert scale form, that is, 1 means "very bad", 2 means "bad", 3 means "general", "4 means "good" and 5 means "very good."

3. Evaluation of landscape aging in minority areas

3.1. Construction of evaluation index system

Based on the understanding of the concept and connotation of landscape aging, and following the principle of selection of evaluation indicators, construct a landscape aging evaluation index system\(^{[3]}\). Based on the criteria of security, accessibility, communicative, comfortable nature and richness, this paper screened out 22 evaluation indexes of landscape aging for minority areas. The evaluation index system is shown in Figure 1.

Figure 1. Map of Yanji City’s landscape aging evaluation system.
3.2. Reliability test
The statistical software SPSS20.0 can be used to obtain the reliability test results. It can be seen from Table 1: The reliability coefficient value is 0.962, which is greater than 0.9, which indicates that the research data has a high reliability quality. Regarding the "deleted alpha coefficient", if the space facilities item is deleted, the reliability coefficient will be greatly improved, so this item will be revoked. In terms of "CITC value", the CITC value of each item is greater than 0.4, which indicates that there is a good correlation between the items and the reliability is good. To summarize, the reliability coefficient of the research data is higher than 0.9, which means that a large amount of evidence shows that the reliability of the data is of high quality and can be used for subsequent analysis.

| Factor layer                        | Total correlation (CITC) | The deleted alpha coefficient | Cronbach alpha coefficient |
|-------------------------------------|--------------------------|-------------------------------|-----------------------------|
| Space facilities                    | 0.527                    | 0.962                         |                             |
| Site height difference protection   | 0.599                    | 0.962                         |                             |
| Paving material                     | 0.700                    | 0.961                         |                             |
| Medical and health facilities       | 0.693                    | 0.961                         |                             |
| Barrier-free facilities             | 0.749                    | 0.960                         |                             |
| Traffic organization rationality    | 0.778                    | 0.960                         |                             |
| The degree of spatial identification| 0.725                    | 0.961                         |                             |
| Space microclimate                  | 0.804                    | 0.960                         |                             |
| Distribution of rest facilities     | 0.802                    | 0.960                         |                             |
| Comfort of facilities and materials | 0.818                    | 0.960                         |                             |
| Environmental health                | 0.733                    | 0.961                         |                             |
| Spatial acoustic environment        | 0.735                    | 0.961                         |                             |
| Toilet distribution                 | 0.776                    | 0.960                         |                             |
| Spatial scale                       | 0.731                    | 0.961                         |                             |
| Space circumference and degree      | 0.709                    | 0.961                         |                             |
| Diversity of plant landscape        | 0.673                    | 0.961                         |                             |
| Spatial type diversity              | 0.718                    | 0.961                         |                             |
| Color richness                      | 0.748                    | 0.960                         |                             |
| Waterscape richness                 | 0.778                    | 0.960                         |                             |
| Parent-child space                  | 0.774                    | 0.960                         |                             |
| Signpost                            | 0.586                    | 0.962                         |                             |
| Regional cultural embodiment        | 0.672                    | 0.961                         |                             |

Standardized Cronbach alpha coefficient: 0.962

3.3. Validity test
Validity depends on the extent to which the questionnaire surveyor correctly measures the variable that the researcher wants to measure. In the process of empirical research, checking whether the design of each variable is reliable is an important link. This study uses Bartlett's test of Sphericity and KMO(Kaiser-Meyer-Olkin) values to test the validity of the questionnaire design. Table 2 shows that the common degree value of all research items is higher than 0.4, indicating that this research item can be effectively extracted. The KMO value is 0.938, which is greater than 0.8, which indicates that the data is highly valid. In addition, among the 5 factors, the variance interpretation rate values are
17.302%, 16.855%, 16.597%, 16.126%, 8.937%, and the cumulative variance interpretation rate after rotation was 75.816%>50%. This means that information about research items can be extracted effectively. Finally, confirm the factor loading coefficient to see whether the relationship between the factor and the research item is expected to be consistent. If the absolute value of the factor loading coefficient is greater than 0.4, then it indicates that there is a corresponding relationship between the options and the factors. The KMO and Bartlett test were used to verify the validity. As the above table shows, the KMO value is 0.938, which is greater than 0.8, which indicates that the research data is highly valid.

| Factor layer                                      | Factor 1 | Factor 2 | Factor 3 | Factor 4 | Factor 5 |
|--------------------------------------------------|----------|----------|----------|----------|----------|
| Site height difference protection treatment       | 0.122    | 0.025    | 0.711    | 0.307    | 0.250    | 0.678    |
| Paving material                                   | 0.111    | 0.335    | 0.596    | 0.381    | 0.186    | 0.660    |
| Medical and health facilities                     | 0.152    | 0.211    | 0.273    | 0.755    | 0.215    | 0.758    |
| Barrier-free facilities                           | 0.180    | 0.318    | 0.654    | 0.318    | 0.265    | 0.733    |
| Traffic organization rationality                  | 0.226    | 0.397    | 0.453    | 0.324    | 0.440    | 0.712    |
| The degree of spatial identification               | 0.342    | 0.242    | 0.372    | 0.182    | 0.678    | 0.807    |
| Space microclimate                                | 0.248    | 0.354    | 0.544    | 0.328    | 0.423    | 0.769    |
| Distribution of rest facilities                   | 0.324    | 0.445    | 0.314    | 0.330    | 0.490    | 0.751    |
| Comfort of facilities and materials               | 0.422    | 0.281    | 0.309    | 0.595    | 0.255    | 0.771    |
| Environmental health                              | 0.378    | 0.161    | 0.216    | 0.797    | 0.096    | 0.860    |
| Spatial acoustic environment                      | 0.191    | 0.508    | 0.351    | 0.568    | -0.027   | 0.741    |
| Toilet distribution                               | 0.190    | 0.431    | 0.349    | 0.568    | 0.235    | 0.721    |
| Spatial scale                                     | 0.263    | 0.706    | 0.126    | 0.310    | 0.295    | 0.766    |
| Space circumference and degree                    | 0.234    | 0.739    | 0.218    | 0.259    | 0.139    | 0.735    |
| Diversity of plant landscape                      | 0.745    | 0.205    | 0.099    | 0.163    | 0.399    | 0.793    |
| Spatial type diversity                            | 0.509    | 0.679    | 0.135    | 0.076    | 0.238    | 0.800    |
| Color richness                                    | 0.724    | 0.227    | 0.225    | 0.295    | 0.259    | 0.780    |
| Waterscape richness                               | 0.752    | 0.358    | 0.213    | 0.218    | 0.219    | 0.834    |
| Parent-child space                                | 0.503    | 0.608    | 0.300    | 0.234    | 0.042    | 0.770    |
| Signpost                                          | 0.286    | 0.153    | 0.780    | 0.092    | 0.013    | 0.722    |
| Regional cultural embodiment                      | 0.678    | 0.273    | 0.332    | 0.308    | -0.148   | 0.761    |
| Eigenvalue (before rotation)                      | 12.107   | 1.418    | 0.909    | 0.825    | 0.662    | -        |
| Variance interpretation rate% (before rotation)   | 57.654%  | 6.751%   | 4.331%   | 3.928%   | 3.152%   | -        |
| Cumulative variance interpretation rate% (before rotation) | 57.654%  | 64.405%  | 68.736%  | 72.664%  | 75.816%  | -        |
| Eigenvalue (after rotation)                       | 3.633    | 3.540    | 3.485    | 3.386    | 1.877    | -        |
| Variance interpretation rate% (after rotation)    | 17.302%  | 16.855%  | 16.597%  | 16.126%  | 8.937%   | -        |
| Cumulative variance interpretation rate% (after rotation) | 17.302%  | 34.157%  | 50.753%  | 66.880%  | 75.816%  | -        |
| KMO value                                         | 0.938    | -        | -        | -        | -        |
| Bart spherical value                              | 2537.806 | -        | -        | -        | -        |

3.4. Determine the evaluation index weight
After normalizing the data, using formulas (2)-(5) of the entropy method, the entropy values and weights of the indicators in the evaluation of Yanji City's landscape aging can be obtained.
In this paper, the entropy method is used to calculate the weight of the evaluation index. The weight of each landscape index in Yanji, China is shown in Figure 2. It can be seen from the figure that the entropy method is used to calculate the weight of a total of 21 items such as site height difference protection treatment. From the above table, we can see: The weights of these 21 indicators are 0.038, 0.050, 0.032, 0.048, 0.047, 0.118, 0.043, 0.042, 0.034, 0.025, 0.030, 0.032, 0.056, 0.052, 0.042, 0.053, 0.046, 0.046, 0.045, 0.033, 0.086. And the weights among the items are relatively uniform, all around 0.048.

3.5. Fuzzy comprehensive evaluation results
According to the scores of each criterion level and target level in Yanji City, China, use the formula \( R_i = m/n \) to construct the fuzzy evaluation matrix. According to the formula, the membership degree matrix can be obtained. From the scores of 230 survey samples (elderly people), \( r_i = m/230 \). According to the first-hand data collected in the survey, we get the membership matrix of evaluation base indicators \( U_1, U_2, U_3, U_4, U_5 \) are:

\[
R_1 = \begin{bmatrix}
0.01 & 0.08 & 0.46 & 0.33 & 0.12 \\
0.02 & 0.09 & 0.44 & 0.31 & 0.14 \\
0.01 & 0.12 & 0.43 & 0.32 & 0.12
\end{bmatrix}
\]

\[
R_2 = \begin{bmatrix}
0.01 & 0.10 & 0.46 & 0.33 & 0.10 \\
0.01 & 0.07 & 0.45 & 0.37 & 0.10 \\
0 & 0.05 & 0.46 & 0.39 & 0.10
\end{bmatrix}
\]
(1) Conduct preliminary judgment

\[ B_1 = A_1 \cdot R_1 = (0.015, 0.093, 0.444, 0.318, 0.130) \]
\[ B_2 = A_2 \cdot R_2 = (0.010, 0.085, 0.455, 0.350, 0.100) \]
\[ B_3 = A_3 \cdot R_3 = (0.012, 0.117, 0.449, 0.308, 0.114) \]
\[ B_4 = A_4 \cdot R_4 = (0.010, 0.088, 0.482, 0.320, 0.100) \]
\[ B_5 = A_5 \cdot R_5 = (0.007, 0.080, 0.429, 0.372, 0.111) \]

(2) Carry out secondary judgment

\[ B = A \cdot R = (0.010, 0.091, 0.446, 0.342, 0.111) \]

According to the principle of maximum subordination, the evaluation results of the elderly in Yanji's landscape environment are mainly in the three levels of "normal", "good" and "very good", indicating that the elderly's satisfaction with the landscape environment in Yanji City is above the average. If the hierarchical value is \( F = (0.1, 0.3, 0.5, 0.7, 1.0) \) T, Then the fuzzy comprehensive evaluation value of the landscape environment for the elderly in Yanji City is:

\[ D = BF^T = (0.010, 0.091, 0.446, 0.342, 0.111) \cdot \begin{bmatrix} 0.1 \\ 0.3 \\ 0.5 \\ 0.7 \\ 1.0 \end{bmatrix} = 0.6017 \]

4. Analysis results and discussion

4.1. Strengthen the attention to the landscape of ethnic minority elderly

In recent years, the country has paid more and more attention to the issue of aging, and all localities
have paid more and more attention to the landscape for the elderly. The overall score of the landscape aging in Yanji City is 0.6017. The landscape environmental aging of minority areas still faces many problems. Studies have shown that due to the cultural concept of having more children and more happiness in ethnic minority areas, most of the young and middle-aged people go out to work, and there are problems in the old-age life of the remaining old people. In order to ensure active aging, the government should pay attention to the problem of the landscape of the elderly in ethnic minority areas, and improve the form, content and infrastructure of the landscape in accordance with the actual situation, so as to ensure the spiritual and healthy life of the elderly and enhance the happiness of life. The current situation of old-age care in ethnic minority settlements is even more severe. The burden coefficient of the elderly population increases, and the demand for the elderly landscape increases. There is an urgent need to build a corresponding elderly landscape system. In order to better take care of the elderly and provide a higher level of landscape environment for the elderly, the area of landscape aging should be expanded through new construction, expansion of the status quo and use of other facilities.

4.2. Increasing the sense of belonging of the elderly from minority
The indicators with the highest weights in the evaluation system of landscape aging in ethnic minority areas are the degree of spatial identification of 0.118 and the regional cultural embodiment of 0.086. It can be seen that the two are important factors affecting the aging of landscape in ethnic minority areas. We should insist on respecting the customs of ethnic minorities. For areas where the ethnic minority population gather but the landscape facilities and environment for the elderly are not perfect, the government and the region should increase support and investment to build a landscape environment that meets the preferences of the local ethnic minority elderly.

4.3. Improving the greening environment and enhancing the aging of plant landscape design
The indicators with higher scores in the evaluation system of landscape aging in ethnic minority areas are traffic organization rationality of 0.806, diversity of plant landscape of 0.808, parent-child space of 0.814, signpost of 0.802, and regional cultural embodiment of 0.906. The elderly in ethnic minority areas especially have these indicators Satisfied. Horticulture therapy can meet the rehabilitation needs of the elderly. It is proposed in the theory of rehabilitation landscape. It is a therapy aimed at restoring bodily functions and social adaptability through various gardening activities or plant-related activities. This method can be used to divide the horticultural planting space in the green space between houses, provide corresponding planting activities for the elderly, and cooperate with the community to carry out colorful flower planting competitions. Gardening and planting activities can not only enable the elderly to review nature, kill time, cultivate interests, but also promote communication between people. Related departments should expand green planting area by demolishing illegal buildings and simple sheds, replant plants in existing green planting areas and increase green landscape service facilities (Such as sketches, gallery frames, pavilions) to meet the needs of the elderly for activities such as appreciation, entertainment and rest.

4.4. Add aging outdoor seats
The lowest score indicator in the evaluation system of landscape aging in minority areas is the distribution of rest facilities, with a score of 0.579. This aspect needs to be optimized. Most of the seats found in the survey are relatively simple, generally made of stone or wood, with inappropriate dimensions due to lack of post-management and regular maintenance, and most of seats are seriously damaged. Most of the seats should be made of wood, but they need to be treated with anti-corrosion to facilitate later maintenance. Setting the backrest will share part of the weight of the elderly and protect their lumbar spine. It is best to use softer material for the laying of the cushion at the bottom of the seat, so that the cold winter or summer will not affect the normal rest of the elderly. Flower ponds or tree ponds of appropriate size can also replace seats to a certain extent, providing short-term rest for the elderly.
5. Conclusion

5.1. Establish a landscape environment design compatible with an aging society
At a time when global aging is becoming more and more serious, in order to protect the legitimate rights of the elderly, actively respond to the aging of the population, promote the Chinese nation’s virtues of respecting and providing for the elderly, landscape architects need to conduct landscape design from the perspective of the elderly. Environmental design also needs to meet the characteristics of people of other age groups and provide a landscape environment suitable for both the elderly and the young. "Smart pension" can improve the quality of voluntary service organizations for the elderly, actively develop human resources for the elderly and improve the comprehensive quality of personnel cadres that meet the development requirements of the new era. This provides a suitable space for the elderly to raise their old age and live a rich life.

5.2. The elderly use smart technology to achieve landscape needs
Many elderly people do not know how to access the Internet or use smart phones. They encounter inconveniences in daily life such as travel, medical treatment and consumption, and cannot fully enjoy the convenience brought by intelligent services. The elderly can interact with the natural environment in the virtual scene. In the virtual landscape world, they can get the same mental and physical recovery effect as in the real environment. This virtual reality landscape environment can be used for the elderly at different stages, providing them with opportunities to connect with nature, and can be used in hospitals, nursing homes and other places. Combined with rehabilitation equipment and fitness equipment, it can not only promote rehabilitation the effect can also bring fun to the elderly and help them to promote the habit of exercise. We can also apply smart devices to the medical system to monitor various physical indicators of the elderly in real time and provide voice guidance, manual consultation and other services for the elderly. This gradually realizes online medical services and payment of medical institutions.

5.3. All departments should set up special senior landscape work agencies or joint organizations.
Senior citizens association can cooperate with government departments, scientific research institutes, senior-related organizations, and technology companies to form working committees and expert committees to form an effective working mechanism. Senior citizens association can organize large-scale academic exchanges and seminars, establish landscape pensions forums and formulate reasonable standards and regulations. Senior citizens association can cooperate with related units jointly to promote the establishment of industry standards and system specifications for landscape care and standardize industry and market operations. In order to better attract forces from all walks of life to participate in landscape elderly care and accelerate the implementation of landscape elderly care to benefit the vast number of elderly people, we should promote the preparation and establishment of industry organizations such as technology elderly care associations, build platforms, integrate resources, broaden strengths and promote rapid development of technology elderly care.

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