A Method of Wetland Planning and Design Scheme Decision Making

HUO Xiangli, MA Cong
Luoyang Water Resources Surveying & Designing Co., Ltd, Luoyang, Henan, 471000, China
lizhenfang@jonhon.cn

Abstract: In the bidding process of wetland planning and design scheme, in order to obtain the optimal solution through comprehensive trade-off from multiple bidding schemes, this paper proposes a comprehensive evaluation and decision-making method of wetland planning and design scheme based on the wetland planning and construction objectives and the commonly used evaluation index system of wetland planning and design scheme. The fuzzy correlation coefficient from the bidding scheme to the optimal and inferior wetland planning and design scheme is used to determine the relative advantage fuzzy correlation degree of each bidding scheme, and the priority degree of each bidding scheme is ranked according to the relative fuzzy correlation degree, so as to realize the evaluation and decision-making of wetland planning and design scheme. The application shows that the method can effectively solve the uncertainty problem in the comprehensive evaluation and decision-making process of wetland planning and design scheme, and has strong operability. It can provide a reference for similar problems in the process of engineering practice.

1. Introduction
The construction of ecological wetland is based on the local vegetation conditions, scientific planning of arbor, shrub, hygrophyte and aquatic plants, building a harmonious and stable wetland plant community with multi-level, multi-structure and multi-function, providing good conditions for water purification and biological conservation, and promoting a virtuous cycle of ecological environment.

A wetland is located in the upper mountain section of Ganquan River, 13.9km away from Fandian reservoir in the south, 0+000 starting point at the junction of Yiyang County, Ganquan River Wetland in the north, and railway at 3+900, with a length of 3.9km from north to south. According to the flood control standard (GB 50201-2014) and the flood control and drainage planning of Luoyang City, the flood control standard of Ganquan river is determined as 20-50 years, and the design flood standard with 20-year return period is adopted [1]. The design flood of the project is composed of the discharge flood of Fandian reservoir and the flood of the corresponding period from the reservoir to the end of the project. The design flood with 20-year return period is 641 m3/s. The total length of the wetland is 3.9km from the north to the south. The Ganquan river is designed according to the flood control standard with a return period of 20 years. The wetland area can be 480 mu.

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The water quality and ecological environment along the wetland are good, cool wind is blowing, insects and birds are singing; the traffic is convenient and the vegetation is dense; there are several large villages and towns (Hekou village, Dongpo village, etc.) within 100 meters along the line. The wetland is located at 1+300 sites, covering an area of 4900 m². It is close to the main road and has a good view. It can be used as a garden, square, hydrophilic platform and supporting infrastructure for residents' leisure and entertainment. The lower reaches of 1+850 are flat and open with intact vegetation, covering an area of about 5700 m². It is close to the main road. It can be used as a wide shallow subsurface flow wetland combined with trestle and stone placement to provide the residents with activity space for hydrophilic play.

The goal of the design is to let visitors walk through the forest and realize the three realms of "habitable, touring and expectant" in the landscape of "high quality of Linquan".

Around the design objectives, under the constraints of the total investment of the project, decompose the evaluation indicators of the planning and design scheme: ①Ecological, relying on the existing conditions of the wetland topography, geomorphic characteristics, water environment, vegetation and so on, through ecological restoration and improvement, improve the ecological environment and achieve ecological diversity. ②Differences, on the premise of reflecting the characteristics of local vegetation, wetland plants, especially aquatic plants, should be introduced appropriately to form local landscape differences and harmonious landscape with wetland characteristics on the whole. ③Functionality, fully learn from the characteristics of Urban Wetland Park, the construction of different functional areas, reasonable arrangement of road traffic and service facilities. ④Science popularization, wetland plants play an important role in popular science education because they both display landscape effect and popular science function. ⑤Economy, it is economical to select varieties with low cost, fast growth and easy management as far as possible, reduce the investment in the early stage and the maintenance cost in the later stage as far as possible, and create an economical wetland.

There is a common feature of these evaluation indexes, that is, there are many qualitative descriptions, but it is difficult to quantify them. How to comprehensively weigh several alternative design schemes and give intuitive priority ranking is a typical multi-attribute decision-making problem [2]. For the evaluation and decision-making of wetland planning and design scheme, if the single factor comparison is biased, it is necessary to comprehensively consider the contribution degree of ecology, difference, functionality, popularization and conservation of each design scheme to the overall design objective. This brings difficulties to the actual operation of the project, and there may be some potential risks when making decisions by subjective "clapping".

In view of this problem, the author uses the fuzzy mathematics theory[3][4] to describe the qualitative indicators quantitatively, and studies the ideal point method [5] in the multi-attribute decision-making method[6], and solves the problem effectively by using the fuzzy ideal point method to evaluate the decision-making method.

2. Basic definition

In the evaluation and decision-making of a wetland planning and design scheme, the wetland planning and design scheme set is used to represent the wetland planning and design scheme set participated in the bidding, and the factor set composed of the ecological, differential, functional, popular science and conservation features of the wetland combined with the expert opinions and the local development master plan, and the value of the evaluation factors of the design scheme is used to express The comprehensive evaluation matrix of planning and design schemes can be expressed as follows:

In the evaluation and decision-making of a wetland planning and design scheme, $X = \{x_1, x_2, \ldots, x_n\}$ is used to represent the wetland planning and design scheme set, and $A = \{a_1, a_2, \ldots, a_5\}$ is used to represent the factor set composed of the wetland ecological, differences, functionality, science popularization and economy based on expert opinions and local development
master plan, and \( \{r_{ij}^L, r_{ij}^R\} \) is used for evaluation factor \( \alpha_j \) of design scheme \( x_i \). According to this, the comprehensive evaluation matrix of \( n \) planning and design schemes can be expressed as follows:

\[
R = \begin{bmatrix}
\alpha_1 & \cdots & \alpha_n \\
\vdots & \ddots & \vdots \\
\alpha_n & \cdots & \alpha_n
\end{bmatrix}
\begin{bmatrix}
(x_{11}, r_{11}^L, r_{11}^R) \\
\vdots \\
(x_{n1}, r_{n1}^L, r_{n1}^R)
\end{bmatrix}
\begin{bmatrix}
\alpha_1 & \cdots & \alpha_n \\
\vdots & \ddots & \vdots \\
\alpha_n & \cdots & \alpha_n
\end{bmatrix}
\begin{bmatrix}
(x_{12}, r_{12}^L, r_{12}^R) \\
\vdots \\
(x_{n2}, r_{n2}^L, r_{n2}^R)
\end{bmatrix}
\cdots
\begin{bmatrix}
(x_{15}, r_{15}^L, r_{15}^R) \\
\vdots \\
(x_{n5}, r_{n5}^L, r_{n5}^R)
\end{bmatrix}
\]

\( \omega = (\omega_1, \omega_2, \ldots, \omega_5) \) represents the weight of each evaluation factor of Dongpo wetland planning and design scheme.

Definition 1: optimal and inferior wetland planning and design scheme \( x_0^+ \) and \( x_0^- \). It refers to the ideal design scheme which is composed of the relative highest (lower) value of the evaluation factors of the wetland planning and design schemes participating in the bidding.

Definition 2: fuzzy correlation degree \( \delta \) refers to the closeness between the wetland planning and design scheme \( x_i \) and the optimal (inferior) wetland planning and design scheme \( x_0^+ (x_0^-) \).

Based on the theory of fuzzy mathematics, the qualitative evaluation mapping relationships of ecological, differences, functionality, science popularization and economy indexes are established, as shown in Table 1.

| Factor evaluation grade | Fuzzy number |
|-------------------------|-------------|
| excellent               | 0.95, 1.0   |
| good                    | 0.85, 0.94  |
| secondary               | 0.80, 0.84  |
| commonly                | 0.70, 0.79  |

3. Mathematical model of decision evaluation

(1) The factor values of comprehensive evaluation matrix \( R \) of wetland planning and design schemes participating in the bidding were normalized [7]. The attributes of evaluation schemes were all positive indicators, that is, the higher the evaluation value, the greater the system contribution. Therefore, the normalization method of benefit index was selected for treatment.

\[
b_{ij}^L = \frac{x_{ij}}{\sum_{i=1}^{n} (x_{ij})}, \quad i = 1, 2, \ldots, n; j = 1, 2, \ldots, 5
\]

\[
b_{ij}^R = \frac{r_{ij}^R}{\sum_{i=1}^{n} (r_{ij}^R)}, \quad i = 1, 2, \ldots, n; j = 1, 2, \ldots, 5
\]

(2) By introducing weight, the weighting matrix \( B \) is established:

\[
B = [\omega_j b_{ij}^L, \omega_j b_{ij}^R]
\]

\( i = 1, 2, \ldots, n, \quad j = 1, 2, \ldots, 5 \)

(3) Optimal and inferior wetland planning and design scheme \( x_0^+ \) and \( x_0^- \):

\[
x_0^+ = \left\{ \left( \max_{1 \leq i \leq n} \omega_j b_{ij}^L, \max_{1 \leq i \leq n} \omega_j b_{ij}^R \right), j = 1, 2, \ldots, 5 \right\}
\]

\[
x_0^- = \left\{ \left( \min_{1 \leq i \leq n} \omega_j b_{ij}^L, \min_{1 \leq i \leq n} \omega_j b_{ij}^R \right), j = 1, 2, \ldots, 5 \right\}
\]

(4) By using the ideal point method and fuzzy mathematical operation rules, the fuzzy correlation coefficient \( \gamma_{0i}, \gamma_{0j} \) from each bidding scheme \( x_i \) to the optimal and inferior wetland planning and design scheme \( x_0^+ \) and \( x_0^- \) is calculated.
The optimal and inferior wetland planning and design scheme \( x_0^+ \) and \( x_0^- \) is taken as the access and ideal optimal benchmark for evaluation.

1. Fuzzy correlation coefficient \( Y_{0t}^+ \) between bidding scheme \( x_t \) and optimal wetland planning and design scheme \( x_0^+ \):

\[
\Delta_{ij}^+ = \left\{ \max_{1 \leq i \leq n} \omega_i b_{ij}^+, \max_{1 \leq j \leq 5} \omega_j b_{ij}^+ \right\} - \left( \omega_i b_{ij}^+, \omega_j b_{ij}^+ \right)
\]

The correlation coefficient is as follows:

\[
Y_{0t}^+ = \frac{\sum_{i=1}^{n} \sum_{j=1}^{5} \Delta_{ij}^+ + \zeta \max_{1 \leq i \leq n} \omega_i b_{ij}^+}{\sum_{i=1}^{n} \sum_{j=1}^{5} \Delta_{ij}^+ + \zeta \max_{1 \leq i \leq n} \omega_i b_{ij}^+}
\]

2. Fuzzy correlation coefficient \( Y_{0t}^- \) from bidding scheme \( x_t \) to worst wetland planning and design scheme \( x_0^- \):

\[
\Delta_{ij}^- = \left\{ \min_{1 \leq i \leq n} \omega_i b_{ij}^-, \min_{1 \leq j \leq 5} \omega_j b_{ij}^- \right\} - \left( \omega_i b_{ij}^-, \omega_j b_{ij}^- \right)
\]

The correlation coefficient is as follows:

\[
Y_{0t}^- = \frac{\sum_{i=1}^{n} \sum_{j=1}^{5} \Delta_{ij}^- + \zeta \max_{1 \leq i \leq n} \omega_i b_{ij}^-}{\sum_{i=1}^{n} \sum_{j=1}^{5} \Delta_{ij}^- + \zeta \max_{1 \leq i \leq n} \omega_i b_{ij}^-}
\]

Among them: \( \zeta \in [0,1] \), \( \zeta \) usually takes 0.5.

5. The relative fuzzy correlation degree \( G \) between each bidding scheme \( x_t \) and the optimal and inferior wetland planning and design scheme \( x_0^+ \) and \( x_0^- \) is calculated:

\[
G = \{ g_t \}, \quad i = 1, 2, \ldots, n
\]

Among them: \( g_t = \frac{Y_{0t}^+}{Y_{0t}^+ + Y_{0t}^-} \)

6. Referring to the relative correlation degree \( G \), the advantages and disadvantages of each bidding scheme can be determined.

4. Implementation of project evaluation decision

According to the preliminary evaluation of the planning and design schemes participated in the bidding by experts, the qualitative evaluation results of relevant factors indicators are shown in Table 2:

| Programme / Indicators | Ecological Differences |
|------------------------|------------------------|
|                        | \( a_1 \) | \( a_2 \) | Functionality | \( a_3 \) | Science popularization | \( a_4 \) | Economy | \( a_5 \) |
| Option 1(\( x_1 \))   | good     | secondary | excellent     | excellent   |
| Option 2(\( x_2 \))   | excellent | secondary | excellent     | good        |
| Option 3(\( x_3 \))   | good     | excellent | good          | secondary   |

Weight \( \omega = [0.35, 0.1, 0.15, 0.25, 0.15] \) is based on local development planning and obtained by consulting experts. Based on this, the evaluation decision of this case is as follows:

(1) Each index is normalized, and the decision-maker's weight \( \omega \) is introduced, and the weighting matrix B is established.
The relative fuzzy correlation degree $G$ between each bidding scheme $x_i$ and the optimal and inferior wetland planning and design scheme $x^*_o$ and $x^*_\omega$ is calculated:

$$G = \{0.703, 0.778, 0.691\}$$

If the scheme is ranked as $g_2 > g_1 > g_3$, it is suggested that scheme 2 should be given priority in the selection of bidding schemes.

5. Conclusion
In this paper, a comprehensive evaluation and decision-making method of wetland planning and design scheme is proposed by using fuzzy mathematics theory and multi-attribute decision-making ideal point method based on the goal of wetland planning and construction and the commonly used evaluation index system of wetland planning and design scheme, and the corresponding theoretical basis and operation steps are given. The application shows that the method can effectively solve the uncertainty problem in the comprehensive evaluation and decision-making process of wetland planning and design scheme, and has strong operability. It can provide a reference for similar problems in the process of engineering practice.

Author
Brief introduction to the author: Huo Xiangli (1983 - ), female, from Henan Province, Ph.D. candidate, mainly engaged in the planning, design and research of water conservancy and hydropower projects.

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