Calculation and Evaluation of Ecological Flow of Hydropower Station Based on Fuzzy Evaluation Model

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Abstract The reasonable determination of ecological flow is of great significance for the efforts to promote the transformation of water ecological environmental protection from pollution management to synergistic management of water resources, water ecology and water environment, and to promote them in an integrated manner. This paper analyzed and calculated the ecological flow process of the Bangsha River diversion power station using the minimum ecological flow method, the annual spreading method, the improved annual spreading method, the NGPRP method, and the month-by-month frequency method, and evaluated the reasonableness of the process and results of the ecological flow calculations by using the fuzzy evaluation model established. The study showed that the minimum ecological flow rate determined by improving the coupling of the spreading method and the NGPRP method was the best, and the suitable ecological flow rate determined by the month-by-month frequency method was the best; the minimum ecological flow rate of the Bangsha River diversion power station was at 0.43 -4.21 m^3/s, and the suitable ecological flow rate was at 0.56 -4.94 m^3/s, and the trend of its change showed the trend of first increasing and then decreasing, and the trend of change from January to July showed the trend of first increasing and then decreasing. Its trend of change showed an increasing and then decreasing trend, from January to July showed a gradually increasing trend, from August to December showed a gradually decreasing trend. It aimed to provide a theoretical basis for the reasonable determination of the ecological flow of the river hydropower station.

Key words Ecological flow; Fuzzy evaluation model; Minimum ecological flow; Optimal ecological flow

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With the continuous development of the economy, the demand for water for living and production in the region is increasing, which makes a large amount of ecological water squeezed, resulting in the flow in the river channel is difficult to maintain the basic function of the river ecosystem[1-2]. In order to ensure the basic form of the river channel and maintain the basic function of the river ecosystem from being damaged, the ecological flow of the river has been increasingly emphasized[3-4]. Ecological flow is the flow of water needed to maintain the river ecosystem and to ensure that human beings are healthy and stable to obtain the basic flow needed for survival from it[5-6]. Therefore, in the process of river water resources development and utilization, keeping enough flowing base flow in the river channel can effectively prevent the phenomenon of river breakage or shrinkage[7-8].

Due to the urgent need of human beings for rapid social development, many small and medium-sized diversion hydropower stations have been developed on rivers, and hydropower development has played an important role in promoting the optimization of China's energy structure and the promotion of economic development[9-10]. However, most of the small and medium-sized hydropower stations were constructed a long time ago, and over the past decades, the uncontrolled development of hydropower and the relatively weak comprehensive management of rivers have triggered a series of ecological and environmental problems, and consequently, the original river flow dynamics have been altered, and the living environment of various aquatic organisms has been destroyed, which in turn affects the stability of river ecosystems[11-13]. How to rationally coordinate the flow demand of human production water and river ecosystem health has become an important challenge for river management[14-15].

At present, common ecological flow analysis methods include hydrological method, hydraulics method, habitat simulation method and overall analysis method[16]. In recent years, in the face of the continuous construction of friendly ecological environment and the sustainable use of water resources, how to effectively strengthen the supervision and management of ecological flow of river hydropower stations, improve the long-term mechanism of guaranteeing ecological flow, and comprehensively implement the ecological flow of hydropower stations is of great significance for focusing on promoting the transformation of water ecological environmental protection from pollution management to the synergistic management and integrated promotion of water resources, water ecology and water environment. Based on this, this paper takes the Bangsha River, a tributary of the Weihe River, as an example, and adopts the minimum ecological flow method, the intra-year spreading method, the improved intra-year spreading method, the NGPRP method, and the month-by-month frequency method, to analyze and calculate the ecological flow of the Bangsha River. Moreover, it establishes a fuzzy evaluation model to evaluate the reasonableness of the ecological flow calculation process and the results, with the aim of providing a reasonable determination of ecological flow of the hydropower station of the river with a theoretical basis.

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1 Overview of the study area

Weihe River is a first-class tributary of the upper reaches of the Yellow River, with a total length of 818 km and a watershed area of 134 766 km^2, of which 360 km is in Gansu Province, with a watershed area of 25 879 km^2, which accounts for 44% of the area of the Weihe River basin (Fig. 1). There are two hydropower stations in the Bangsha River from top to bottom: Nanyang Hydropower Station and Wangjiamen Hydropower Station. Nanyang Hydropower Station has an installed capacity of 0.16 million kW and an annual power generation of 0.03 billion kW · h, while Wangjiamen Hydropower Station has an installed capacity of 0.05 million kW and an annual power generation of 0.02 billion kW · h. After the investigation, there is no hydrological station in the Bangsha River, and the hydropower station diversion cross-section of the river lacks the measured hydrological runoff data. The study used the main stream of the Weihe River as the basis. In this study, the hydrological runoff data of Wushan Hydrological Station in the main stream of the Weihe River from 1956 to 2017 are used to calculate the average runoff volume of the Bangsha River at the diversion section of hydropower station by hydrological comparison method.

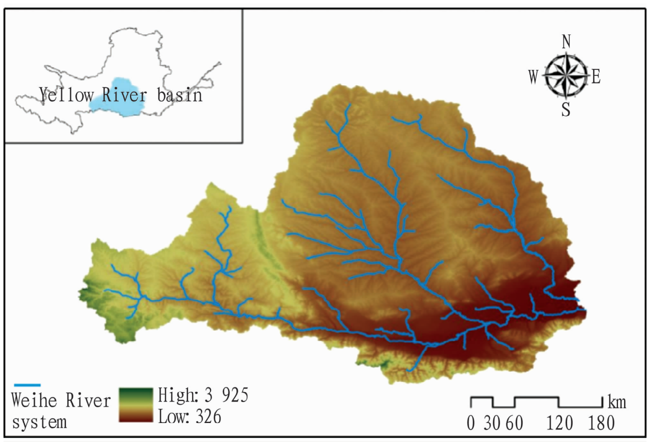

Fig. 1 Water system of the Weihe River basin

2 Research methods

2.1 Methods of calculating ecological flows In this paper, the minimum ecological flow method, the intra-annual spreading method, the improved intra-annual spreading method, the NGPRP method, and the month-by-month frequency method were selected to analyze and calculate the ecological flow of the Bangsha River.

2.2 Ecological flow process evaluation model At present, different ecological flow methods are usually used to calculate the ecological flow of the river, and the appropriate ecological flow calculation method for the study area is determined after qualitative analysis month by month. However, due to the differences in the natural geographic conditions of the study area, the subjective factors are large, and there is no clear evaluation standard for different ecological flow methods, so it is difficult to accurately judge the applicability of different ecological flow calculation methods. Therefore, it is necessary to establish a suitable ecological flow process evaluation model to comprehensively evaluate the calculation results of different ecological flow calculation methods. In this study, the evaluation model is established by the object element analysis method to evaluate the calculation results of different ecological flow calculation methods. The specific process of establishing the evaluation model is as follows:

(1) Constructing the object element to be evaluated. The 12-month ecological flow data of the study area were selected as the evaluation index of the ecological flow process, and the matter element was established.

$$R = \begin{bmatrix} P_0 & C_1 & X_1 \\ & C_2 & X_2 \\ & \vdots & \vdots \\ & C_n & X_n \end{bmatrix} \quad (1)$$

where $n=12$; P_0 is the ecological flow process to be evaluated; C_n is the n feature of ecological flow to be evaluated; X_n is the value of the corresponding evaluation index C_n.

(2) Constructing classical domain object elements. The classical domain matter element R_j is expressed as:

$$R_j = \begin{bmatrix} N_j & C_1 & X_{j1} \\ & C_2 & X_{j2} \\ & \vdots & \vdots \\ & C_n & X_{jn} \end{bmatrix} = \begin{bmatrix} N_j & C_1 & [a_{j1}, b_{j1}] \\ & C_2 & [a_{j2}, b_{j2}] \\ & \vdots & \vdots \\ & C_n & [a_{jn}, b_{jn}] \end{bmatrix} \quad (2)$$

where N_j is the j^{th} evaluation grade; $X_{jn} = [a_{jn}, b_{jn}]$ is the percentage of the ecological flow in the first month to the multi-year average flow in the study area when it is in the j^{th} evaluation level.

(3) Constructing the section domain object element. The nodal domain matter element R_p is expressed as:

$$R_p = \begin{bmatrix} N_p & C_1 & X_{p1} \\ & C_2 & X_{p2} \\ & \vdots & \vdots \\ & C_n & X_{pn} \end{bmatrix} = \begin{bmatrix} N_p & C_1 & [a_{p1}, b_{p1}] \\ & C_2 & [a_{p2}, b_{p2}] \\ & \vdots & \vdots \\ & C_n & [a_{pn}, b_{pn}] \end{bmatrix} \quad (3)$$

where N_p is the whole of the evaluation grade; $X_{pn} = [a_{pn}, b_{pn}]$ is the sum of the value range of each evaluation index in all classical domains.

(4) Determination of the correlation function for evaluation indicators. It defines the localities of points x_i to $X_{ji} = [a_{ji}, b_{ji}]$ and $X_{pi} = [a_{pi}, b_{pi}]$ as:

$$\rho(x_i, X_{ji}) = |x_i - \frac{1}{2}(a_{ji}+b_{ji})| - \frac{1}{2}(b_{ji}-a_{ji}) = \begin{cases} a_{ji}-x_i, & x_i \leqslant \frac{a_{ji}+b_{ji}}{2} \\ x_i - b_{ji}, & x_i > \frac{a_{ji}+b_{ji}}{2} \end{cases} \quad (4)$$

$$\rho(x_i, X_{pi}) = |x_i - \frac{1}{2}(a_{pi}+b_{pi})| - \frac{1}{2}(b_{pi}-a_{pi}) = \begin{cases} a_{pi}-x_i, & x_i \leqslant \frac{a_{pi}+b_{pi}}{2} \\ x_i - b_{pi}, & x_i > \frac{a_{pi}+b_{pi}}{2} \end{cases} \quad (5)$$

The calculation formula of correlation function $K_i(x_i)$ is:

$$K_j(x_i) = \begin{cases} \frac{-\rho(x_i, X_{ji})}{|X_{ji}|}, & x_i \in X_{ji} \\ \frac{\rho(x_i, X_{ji})}{\rho(x_i, X_{pi}) - \rho(x_i, X_{ji})}, & x_i \notin X_{ji} \end{cases} \quad (6)$$

where $|X_{ji}| = a_{pi} - b_{pi}$.

(5) Determining the weights of evaluation indicators. In this study, fuzzy hierarchical analysis was used to determine the weights of ecological flow data for different months in the study area.

(6) Determining the relevance of evaluation ratings.

$$K_j(P_0) = \sum_{i=1}^{n} \omega_i K_j(x_i) \quad (7)$$

where ω_i is the weight of the ecological flow data in the i month.

(7) Grade estimation. When $K_j = \max\{K_j(P_0)\}$ $(j = 1, 2, \cdots, m)$, it means that the ecological flow process is the j^{th} level; when $0 \leqslant K_j(P_0) \leqslant 1$, it means that the calculated ecological flow process meets the requirements of the evaluation level of the selected criteria; when $-1 \leqslant K_j(P_0) \leqslant 0$, it means that it does not meet the requirements of the evaluation level of the selected criteria but meets the conditions of the transformation of the evaluation level of the selected criteria, and the smaller the value is, the easier it is to be transformed; when $K_j(P_0) \leqslant -1$, it means that it does not meet the requirements of the evaluation level of the selected criteria and cannot be transformed; and when $K_j(P_0) > 1$, it means that it exceeds the upper limit of the evaluation level of the selected criteria.

(8) Determining the ecological flow process. Based on the ecological flow calculated by different calculation methods, combined with the ecological water demand requirements of the rivers in the study area, the appropriate ecological flow process is comprehensively determined.

3 Ecological flow calculation and evaluation analysis

3.1 Ecological flow calculations In this paper, the minimum ecological flow method, the intra-annual spreading method, the improved intra-annual spreading method, the NGPRP method, and three different month-by-month frequency methods were used to calculate the determined ecological flow calculations for each month, which are shown in Table 1.

Table 1 Calculation results of ecological flow by month using different methods

Methods	Calculated ecological flows by month // m^3/s											
	January	February	March	April	May	June	July	August	September	October	November	December
Minimum ecological flow method	0.50	0.52	0.63	0.95	1.23	1.19	3.48	3.25	2.61	1.12	0.81	0.63
Intra-annual spreading method	0.48	0.52	0.62	1.01	1.60	2.93	4.13	3.75	3.26	1.57	0.92	0.59
Improved intra-annual spreading method	0.55	0.60	0.72	1.16	1.84	3.39	4.77	4.33	3.76	1.81	0.59	0.68
NGPRP method	0.61	0.64	0.79	1.20	1.76	3.21	4.67	4.17	3.12	2.41	1.19	0.81
Method 1 of the month-by-month frequency method	0.59	0.73	0.88	1.39	2.02	4.50	6.40	4.83	3.98	1.98	1.08	0.76
Method 2 of the month-by-month frequency method	0.72	0.78	0.95	1.53	2.39	4.50	6.40	5.53	4.85	2.32	1.38	0.91
Method 3 of the month-by-month frequency method	0.64	0.70	0.85	1.37	1.88	4.50	6.40	5.53	3.84	1.95	1.24	0.82

3.2 Ecological flow process evaluation According to the ecological status of the downstream section of Bangsha River hydropower station and the goal of releasing ecological flow, considering the distinct rainfall seasons in the Bangsha River basin, the importance of the ecological flow status in each month is: dry period > flat period > rich period, and the more withered the month, the higher the importance (Table 2). According to the evaluation process of fuzzy hierarchical analysis, the fuzzy consistent judgment matrix is established to reflect the importance of ecological flow in different months, and the matrix is:

$$R = \begin{bmatrix} 0.50 & 0.53 & 0.70 & 0.72 & 0.75 & 0.77 & 0.90 & 0.87 & 0.83 & 0.74 & 0.76 & 0.51 \\ 0.47 & 0.50 & 0.68 & 0.69 & 0.72 & 0.74 & 0.87 & 0.84 & 0.80 & 0.71 & 0.73 & 0.48 \\ 0.29 & 0.32 & 0.50 & 0.51 & 0.54 & 0.56 & 0.69 & 0.66 & 0.62 & 0.53 & 0.55 & 0.30 \\ 0.28 & 0.31 & 0.49 & 0.50 & 0.53 & 0.55 & 0.68 & 0.65 & 0.61 & 0.52 & 0.54 & 0.29 \\ 0.25 & 0.28 & 0.46 & 0.47 & 0.50 & 0.39 & 0.52 & 0.49 & 0.45 & 0.36 & 0.38 & 0.13 \\ 0.23 & 0.26 & 0.44 & 0.45 & 0.61 & 0.50 & 0.51 & 0.48 & 0.44 & 0.35 & 0.37 & 0.12 \\ 0.10 & 0.13 & 0.31 & 0.32 & 0.48 & 0.49 & 0.50 & 0.47 & 0.43 & 0.34 & 0.36 & 0.11 \\ 0.13 & 0.16 & 0.34 & 0.35 & 0.51 & 0.52 & 0.53 & 0.50 & 0.46 & 0.37 & 0.39 & 0.14 \\ 0.17 & 0.20 & 0.38 & 0.39 & 0.55 & 0.56 & 0.57 & 0.54 & 0.50 & 0.51 & 0.53 & 0.28 \\ 0.26 & 0.29 & 0.47 & 0.48 & 0.64 & 0.65 & 0.66 & 0.63 & 0.49 & 0.50 & 0.56 & 0.31 \\ 0.24 & 0.27 & 0.45 & 0.46 & 0.62 & 0.63 & 0.64 & 0.61 & 0.47 & 0.44 & 0.50 & 0.49 \\ 0.49 & 0.52 & 0.70 & 0.71 & 0.87 & 0.88 & 0.89 & 0.86 & 0.72 & 0.69 & 0.51 & 0.50 \end{bmatrix}$$

Then the weight of each month:

$$W = (\omega_1, \omega_2, \omega_3, \cdots, \omega_{12}) = (0.199, 0.114, 0.084, 0.083, 0.065, 0.066, 0.056, 0.061, 0.072, 0.083, 0.081, 0.116)$$

Taking the calculation process of the minimum ecological flow method as an example, the ecological flow data of different months are calculated by formula (1), (2) and (3). Based on the analysis of the correlation degree of each evaluation grade, the comprehensive correlation degree of each evaluation grade is calculated by formula (7) (Table 3).

Table 2 Evaluation criteria for ecological flow processes

Grade	Percentage of ecological flow versus multi-year average flow//%		
	Dry period (December – February)	Flat period (March – June, October – November)	Rich period (July – September)
Max	[100, 200]	[100, 200]	[100, 200]
Best	[60, 100]	[70, 100]	[80, 100]
Very good	[40, 60]	[50, 70]	[60, 80]
Good	[30, 40]	[40, 50]	[50, 60]
Better	[20, 30]	[30, 40]	[40, 50]
General	[10, 20]	[20, 30]	[30, 40]
Poor	[0, 10]	[0, 20]	[0, 30]

Table 3 Combined relevance of each evaluation level

Ecological flow status by month	Grade						
	Poor	General	Better	Good	Very good	Best	Max
C_1	−0.262 1	0.007 9	−0.003 9	−0.265 7	−0.396 5	−0.527 3	−0.632 1
C_2	−0.101 4	0.291 2	−0.125 0	−0.259 7	−0.347 5	−0.434 3	−0.503 9
C_3	−0.073 9	0.176 8	−0.241 8	−0.406 8	−0.505 9	−0.619 0	−0.704 0
C_4	−0.248 7	−0.152 9	−0.010 3	0.042 2	−0.139 5	−0.310 7	−0.439 4
C_5	−0.213 4	−0.190 2	−0.162 9	−0.130 6	−0.042 7	0.120 2	−0.114 4
C_6	−0.173 0	−0.152 7	−0.128 9	−0.101 0	−0.026 7	0.121 7	−0.063 4
C_7	−0.628 6	−0.540 8	−0.436 6	−0.310 8	0.152 6	−0.038 1	−0.360 3
C_8	−1.019 7	0.893 4	0.814 8	−0.203 7	−0.804 6	−1.491 3	−2.006 2
C_9	2.327 0	−2.327 0	−3.694 3	−4.377 6	−4.787 7	−5.256 3	−5.607 9
C_{10}	0.506 3	0.506 3	−1.092 5	1.385 9	−1.561 6	−1.762 5	−1.913 4
C_{11}	−0.428 5	0.807 0	−0.403 5	−0.829 4	−1.042 3	−1.255 4	−1.425 7
C_{12}	−0.294 5	0.538 2	−0.504 5	−0.834 6	−0.999 7	−1.164 8	−1.296 8
Comprehensive correlation	−0.050 9	−0.011 9	−0.499 1	−0.755 3	−0.875 1	−1.051 6	−1.255 6

According to Table 3, $K_j = \max\{K_j(P_0)\}\ (j=1, 2, \cdots, 7) = -0.125$, the ecological flow calculated by the minimum ecological flow method is evaluated by the fuzzy evaluation model. The evaluation grade of the ecological flow process determined by this method is general. Using the same analysis process, the evaluation results of different ecological flow methods are shown in Table 4.

Table 4 Evaluation results of ecological flow processes by different methods

Methods	Combined relevance of the evaluation levels							Evaluation results
	Poor	General	Better	Good	Very good	Best	Max	
Minimum ecological flow method	−0.050 9	−0.011 9	−0.499 1	−0.755 3	−0.875 1	−1.051 6	−1.255 6	General
Intra-annual spreading method	−0.079 6	−0.011 9	0.142 4	−0.445 8	−0.710 7	−1.218 6	−1.348 2	Better
Improved intra-annual spreading method	−0.121 0	0.063 6	0.277 6	−0.187 9	−0.543 6	−1.004 6	−1.117 7	Better
NGPRP method	−0.094 7	0.005 7	0.219 8	−0.319 2	−0.481 8	−0.897 5	−1.145 7	Better
Method 1 of the month-by-month frequency method	−0.113 4	0.075 5	−0.126 8	−0.251 6	−0.446 4	−0.789 7	−0.868 1	General
Method 2 of the month-by-month frequency method	−0.127 1	0.100 8	−0.780 0	−0.584 2	0.203 7	−0.260 4	−0.491 4	Very good
Method 3 of the month-by-month frequency method	−0.115 5	0.136 1	−0.333 7	−0.019 3	−0.444 0	−0.810 5	−0.836 9	General

3.3 Analysis of the results of the ecological flow process evaluation

3.3.1 Analysis of the results of the evaluation of the minimum ecological flow process. It can be seen from Table 4 that the evaluation grade determined by the minimum ecological flow method is 'general', while the evaluation grade determined by the intra-annual distribution method, the improved intra-annual distribution method and the NGPRP method is 'better'. Combined with the evaluation criteria, when the evaluation grade of ecological flow process is 'general', the ecological flow determined by this method accounts for 10% –40% of the annual average flow; when the evaluation grade is 'better', the ecological flow determined by this method accounts for 20% –50% of the average annual flow.

After comparative analysis, it can be seen that the intra-annual spreading method uses the ratio of the total minimum runoff to the total average runoff over many years as the mean ratio for the same period, but the analysis results of this method are unstable and prone to large errors; the minimum ecological flow method is often applied to the study area where there are small variations in the water flow and water quality, whereas the Bangsha River is narrow and has a large slope drop at the bottom of the river, then the analysis results of the minimum ecological flow method are less reliable. Therefore, in this study, the coupled results of the improved intra-annual spreading method and the NGPRP method were used as the minimum ecological flow process in the study area (Fig. 2).

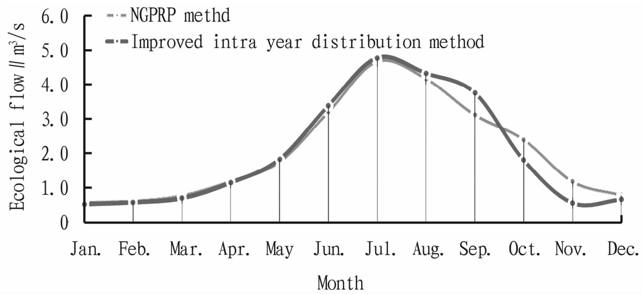

Fig. 2 Minimum ecological flow process de-plot

According to the calculation method of the minimum ecological flow determined by the evaluation, combined with the hydrological comparison method, the minimum ecological flow of the two hydropower stations in the Bangsha River is analyzed, and is 0.43 – 4.21 m^3/s. The minimum ecological flow of each month in the study area showed a trend of increasing first and then decreasing. From January to July, it showed a trend of increasing gradually, and from August to December, it showed a trend of decreasing gradually. Among them, it reached the minimum in January and reached the maximum in July (Table 5).

Table 5 Minimum ecological flows by month at the Bangsha River diversion power station m^3/s

Power station	January	February	March	April	May	June	July	August	September	October	November	December
Wangjiamen Power Station	0.43	0.48	0.57	0.91	1.38	2.51	4.07	3.63	2.45	1.43	0.84	0.54
Nanyang Power Station	0.45	0.49	0.59	0.95	1.43	2.60	4.21	3.76	2.53	1.47	0.86	0.55

3.3.2 Analysis of the results of the evaluation of suitable ecological flow processes. For the short-term river hydrological situation, the determined minimum ecological flow process of the river can meet the requirements of river ecosystem stability. In order to maintain the sustainable development of the river ecosystem, the suitable ecological flow process should be determined for the long-term river hydrological situation. Table 4 further shows that the evaluation grade determined by the monthly frequency method 1 and 3 is 'general', while the evaluation grade determined by the monthly frequency method 2 is 'very good'. Combined with the evaluation criteria, when the evaluation grade of ecological flow process is 'general', the ecological flow determined by this method accounts for 10% – 40% of the annual average flow; when the evaluation grade is 'very good', the ecological flow determined by this method accounts for 40% – 80% of the average annual flow.

Through comparative analysis, it can be seen that when the calculated suitable ecological flow accounts for 30% – 60% of the annual average flow, the wet bottom in the river channel is obviously increased, and the reliability of the river ecosystem is also significantly enhanced. When the calculated suitable ecological flow accounts for 60% – 100% of the average annual flow, the ecological flow is determined to be the most suitable ecological flow. Therefore, in this study, the ecological flow process calculated by the monthly frequency method with an evaluation grade of 'very good' was used as the suitable ecological flow process (Fig. 3).

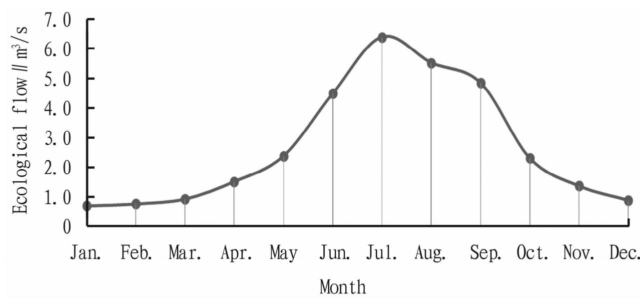

Fig. 3 Graph of suitable ecological flow processes

According to the suitable ecological flow calculation method determined by the evaluation, combined with the hydrological comparison method, the suitable ecological flow of the two hydropower stations in the Bangsha River is analyzed, and is 0.56 – 4.94 m^3/s. The suitable ecological flow of each month in the study area showed a trend of increasing first and then decreasing. From January to July, it showed a trend of increasing gradually, and from August to December, it showed a trend of decreasing gradually. Among them, it reached the minimum in January and reached the maximum in July (Table 6).

Table 6 Appropriate ecological flow by month at the Bangsha River diversion power station m^3/s

Power station	January	February	March	April	May	June	July	August	September	October	November	December
Wangjiamen Power Station	0.56	0.61	0.74	1.20	1.88	3.53	4.78	4.13	3.81	1.82	1.08	0.71
Nanyang Power Station	0.58	0.63	0.77	1.24	1.94	3.65	4.94	4.27	3.93	1.88	1.12	0.73

4 Conclusions

In this paper, the minimum ecological flow method, the annual spreading method, the improved annual spreading method, the NGPRP method, and the month-by-month frequency method were used to analyze and calculate the ecological flow of the Bangsha River, and a fuzzy evaluation model was established to evaluate the reasonableness of the ecological flow calculation process and the results. The following conclusions were mainly obtained:

(1) By comparing and analyzing the results of different calculations, the inner envelope of the results of the coupled calculations of the improved intra-annual spreading method and the NGPRP method is taken as the minimum ecological flow process, and the ecological flow process calculated by the month-by-month frequency method taking the method 2 is taken as the suitable ecological flow process.

(2) The minimum ecological flow rate of the Bangsha River diversion power station is in the range of 0.43 – 4.21 m^3/s, and the suitable ecological flow rate is in the range of 0.56 – 4.94 m^3/s.

The trend of change shows an increasing and then decreasing trend, with a gradual increasing trend from January to July, and a gradual decreasing trend from August to December, in which the minimum value reaches in January, and the maximum value reaches in July.

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