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Deviation between willingness and actual behavior regarding community participation in protected areas: A case study in Shengjin lake national nature reserve in China

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Introduction: The deviation between high willingness and poor actual behaviors in community participation has become an obstacle to achieving effective management and resource protection of protected areas. Therefore, it is necessary to investigate this deviation and its influencing factors.

Methods: Based on a field survey of community residents in the Shengjin Lake National Nature Reserve (SJLNNR) in Anhui Province, China, this study uses a Logistic-ISM model to analyze the key factors influencing the deviation and the hierarchical structure supporting those key factors.

Results: There is a significant deviation between participation willingness and actual behavior in SJLNNR. This deviation is characterized by eight key factors. Among these, awareness of the necessity of establishing SJLNNR is a direct factor at the surface level. Participation of important or recognizable people; average annual family income; understanding of environmental protection laws and regulations; realization of environmental improvement effect; satisfaction with SJLNNR authority; and future earnings expectations are all intermediate indirect factors. Furthermore, resident member is a fundamental factor. Resident members refer to those who live at home for six months or more during a calendar year.

Discussion: These results indicate that there are three possible practical reasons for the deviation: 1) The lack of young and middle-aged adults is the root cause. 2) Inadequate ecological compensation is the direct trigger. 3) Individual internal psychological factors have significant effects. Furthermore, this study provides policy implications for converting willingness into actual participation in the community and promoting sustainable development.

KEYWORDS

protected areas, sustainable development, community participation, willingness and behavior, deviation, China

1 Introduction

Protected areas (PAs) play a critical role in protecting landscapes, safeguarding wildlife habitats, and conserving biodiversity (Watson et al., 2014; Schirpke et al., 2017; Liu et al., 2022; Wu et al., 2022). Over the past few decades, the establishment of PAs has become a worldwide conservation strategy (Liévano-Latorre et al., 2021), and PAs have undergone significant expansion, both in area and quantity (Watson et al., 2014; Wang and Liu, 2022). However, wide variation still exists in the quality of conservation management, which hinders PAs from achieving their conservation goals (Chidakel and Child, 2022). Many researchers have noted that the effective management of PAs is crucial for successful conservation outcomes and sustainable development (Coad et al., 2013; Rezende Oliveira et al., 2019; Riggio et al., 2019; Lwin et al., 2022).

Community participation stems from the concept of community development, which refers to the process of promoting the development of communities through the spontaneous involvement of residents in various community activities and affairs (Zhang et al., 2020b). Community participation in the management of PAs is of great importance for effective management (Islam et al., 2017; Zhang et al., 2020b; Sagoe et al., 2021; Freitas et al., 2022), and is regarded as a precondition for success (Huber and Arnberger, 2021). In addition, it reduces conflict between the local community and the management agency by considering the basic needs of residents (Zhang J et al., 2020), and working to alleviate poverty (Jiang and Wu, 2021), achieving a win-win scenario in nature protection and socioeconomic development (Peng et al., 2021; Masud et al., 2022).Nowadays, it is widely recognized that local community members should be entitled to and encouraged to participate in PA management. Specifically, community members should first abide by PA regulations and rules. In terms of the formulation and implementation of policies and plans for PAs, they have decision-making powers through consultation, meetings, negotiations, and public hearings (Niedziałkowski et al., 2018). In daily life, they can supervise and report human activity that has harmful influences on the environment (Lai, 2022). Furthermore, they are encouraged to actively engage in the eco-tourism business, ecological projects, and development projects of PAs, carried out by government or Non-Governmental Organizations (NGO) to share benefits (e.g., economic earnings, skill training, PA employment, and other job opportunities) while promoting PA construction (Sirivongs and Tsuchiya, 2012; Ma et al., 2017).

However, several studies have found that meaningful community participation in the management of PAs is far from adequate (Trimble et al., 2014; Bockstael et al., 2016; Zhang et al., 2020b; Gordon-Cumming and Mearns, 2020), although most local communities and residents are willing to participate in nature conservation (Trimble et al., 2014; Araia and Chirwa, 2019; Gordon-Cumming and Mearns, 2020; Hing and Riggs, 2021; Jiang and Wu, 2021). For example, small-scale fishers in PAs have shown great interest in participating in fisheries management; however, the number of fishers that attend the meetings related to policy decision-making with the government has been very low (Trimble et al., 2014). Furthermore, under the premise that 90% of the local people

investigated showed a willingness to be involved in conservation, approximately 73% not only took no action but also violated indigenous forests rules (Araia and Chirwa, 2019). This puzzling phenomenon has also been observed in China. For instance, Lan (2020) discovered that community residents around Giant Panda National Park have accumulated deep feelings toward giant pandas and have high enthusiasm for the protection of giant pandas and national park management. However, residents rarely expressed opinions or suggestions in relevant public hearings held by the community. In Wanglang National Nature Reserve in Sichuan Province, farmers were highly supportive of participating in community grazing management, but they took no action (Lai, 2022).

Thus, previous research has revealed that there is a huge deviation between willingness and actual behavior in terms of community participation in PAs. Specifically, community residents who are highly willing to participate in the management and construction of PAs tend to take no action. Subsequently, two intuitive questions that resulted from this finding were as follows: 1) What caused the contradiction between the high willingness of community residents and their poor participation behavior? 2) How can participation willingness be transformed into actual behavior? The answers to these two questions are important for promoting effective community participation and realizing sustainable development.

Generally, willingness predicts and leads to the realization of the corresponding actual behavior of an individual; however, many previous studies have confirmed that there is a deviation between willingness and behavior in real life, such as in commodity consumption (Wang and Li, 2022), services purchases (Qu et al., 2022), e-commerce adoption (Li et al., 2020), and land transfer (Zhang et al., 2020a). This deviation has been further identified in the field of pro-environmental behaviors such as green consumption (Rausch and Kopplin, 2021; Wang et al., 2021; Ma et al., 2022; Qiu et al., 2022), green agriculture (Guo et al., 2021; Li et al., 2021), garbage classification (Kuang and Lin, 2021; Zhang et al., 2022; Zhou et al., 2022), bird conservation donation (Eylering et al., 2022), and renewable energy development support (Fang et al., 2021). All these studies concluded that the willingness of an individual is higher than the actual behavior demonstrates. In other words, some people with pro-environmental willingness do not take practical actions, which means that there may be obstacles in the conversion from willingness to behavior. Therefore, researchers have investigated the factors influencing the pro-environmental willingness-behavior connection. For instance, Li et al. (2021) exploited the theory of planned behavior (TPB) (Ajzen et al., 1991), and reveal that the deviation between the willingness of farmers to adopt photovoltaic agriculture and actual adoption centers around seven factor: farming experience, production specialization, distance to nearest photovoltaic enterprises, usefulness perception, ease of use perception, technical training, and photovoltaic investment cost. Rausch and Kopplin (2021) focused on the purchasing behavior of consumers toward sustainable clothing. The study determined that perceived aesthetic risk has a negative impact on the willingness-behavior relationship.

In terms of willingness and behavior to participate in PA management, there are few relevant studies. On the one hand, some researchers have investigated the factors influencing the

FIGURE 1
Location and function zones distribution of study site.
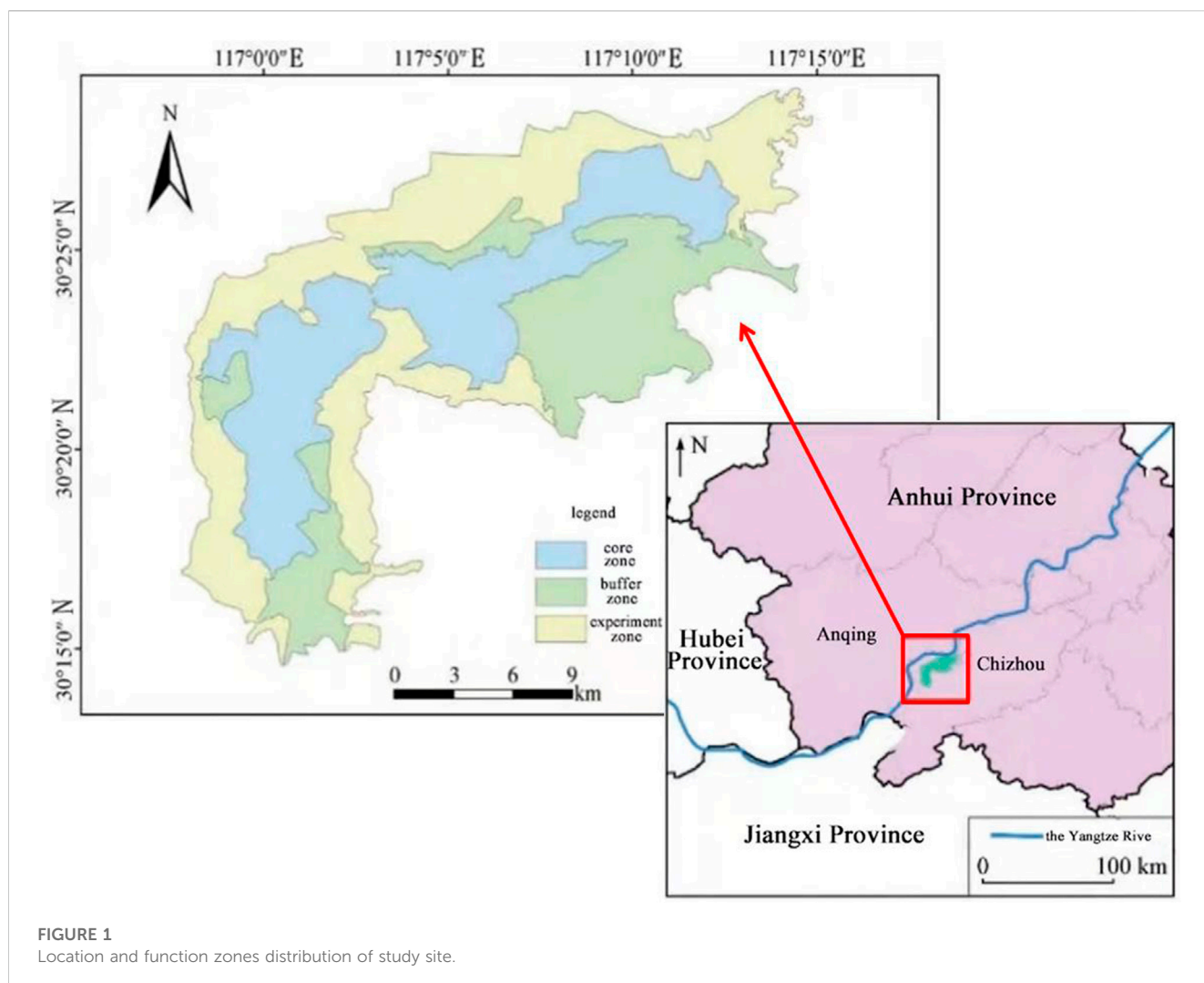
willingness to participate using the structural equation model (SEM). Feng et al. (2022) used the Giant Panda National Park in China as an example, and their qualitative study reflected that community governance and financial awareness have a positive effect on the willingness of residents to participate. The three main factors of TPB (attitude, subjective norms, and perceptual behavioral control) can also influence the willingness to participate (Jia et al., 2022). Furthermore, based on the extended TPB model, Zhao et al. (2022) added that the emotional factors of AWE and place attachment showed direct and mediating impacts on willingness, respectively. On the other hand, there has been a focus on the factors influencing actual behavior. Huber and Arnberger (2021) argued that the three main factors of the TPB significantly influence the level of local participation. In the context of eco-migration in China, Wang et al. (2020) examined the conservation behavior of local residents and reached a similar conclusion. Meanwhile, positive perceptions of PAs from community residents, according to Sirivongs and Tsuchiya (2012), significantly influence their participation. Additionally, socioeconomic factors also exert significant effects on participation behavior, including age, gender, occupation, years of

residence in a community, household income, and expense (Smith, 2012; Belkayali et al., 2015; Apipoonyanon et al., 2019).

In conclusion, the topic of deviation between willingness and behavior has been explored. However, in terms of community participation, existing studies have mainly focused on the factors that influencing willingness or behavior separately. No studies have focused on the deviations between them. Hence, to fill this research gap and answer two questions mentioned above, a case study was conducted in a national nature reserve in Anhui Province, which is the main component of PAs in China (Jiang and Wu, 2021; Liu et al., 2022). First, this study aims to determine the deviation between willingness to participate and actual behavior in the management of PAs from community residents in the study area. Next, the logistic model is used to empirically analyze the factors that significantly influence the willingness-behavior deviation based on TPB. Finally, the Interpretative Structural Modeling Method (ISM) is used to clarify the hierarchical structure among these influencing factors and further analyze the internal mechanisms that affect the conversion from

TABLE 1 Distribution of the valid samples.

County	Town	Sample size	Proportion (%)	Village	Sample size	Proportion (%)	Function zone involved
Dongzhi	Shengli	46	23.35	Xinhua	21	10.66	buffer, experiment zone
				Jiangdong	25	12.69	buffer, experiment zone
	Dongliu	26	13.20	Jinshan	13	6.60	experiment zone
				Changling	13	6.60	buffer, experiment zone
	Zhangxi	31	15.74	Chentuan	16	8.12	buffer, experiment zone
				Bailian	15	7.61	buffer, experiment zone
	Dadukou	28	14.21	Xinfengwei	14	7.11	buffer, experiment zone
				Qingfeng	14	7.11	experiment zone
Guichi	Niutoushan	25	12.69	Niutoushan	14	7.11	experiment zone
				Mushan	11	5.58	experiment zone
	Tangtian	41	20.81	Wutian	20	10.15	buffer zone
				Shashan	21	10.66	buffer zone
Total		197	100	-	197	100	-

willingness to actual behavior. This study offers theoretical support and practical guidance for policymakers to formulate reasonable and effective measures to promote substantive community participation and sustainable development.

2 Materials and methods

2.1 Study site

The Shengjin Lake National Nature Reserve (SJLNNR), which is located in Chizhou City in Anhui Province in China, facing Anqing City across the Yangtze River, was chosen as the study site (Figure 1). It is located at the junction of Dongzhi County and Guichi District, covering a total area of 33,340 ha. Known as "China Crane Lake," SJLNNR is a representative wetland protected area that was established with the aim of protecting the freshwater wetland ecosystem and the rare and endangered waterfowl. Before the establishment of the SJLNNR, local residents closely relied on natural resources and supported themselves through agricultural cultivation, fishing and hunting. To achieve the protection goal of the SJLNNR, local residents are prohibited from catching fish in Shengjin Lake and hunting rare birds. In 2017, a total of 1,331 fishers stopped fishing, resettled, and went ashore to support themselves through other means. Meanwhile, the hunting of rare birds disappeared.

For better conservation, SJLNNR implements zoning control. It has been divided into core, buffer, and experiment zones, with areas of 10,150 ha, 10,300 ha, and 12,890 ha, respectively, accounting for 30.44%, 30.90%, and 38.66% of the total area of SJLNNR. The core zone is covered almost entirely by the lake and is under strict protection. In principle, all human activity is prohibited in the core zone, and no one is allowed to enter. The living areas of local residents in SJLNNR are mainly the buffer and experiment zones, involving 49 administrative villages in six towns (Shenli, Dongliu,

Zhangxi, Dadukou, Niutoushan, and Tangtian), with a total population of approximately 64,200. Only scientific research containing no destructive influence is allowed in the buffer zone (Liu et al., 2022). In the experiment zone, multiple activities related to nature protection and sustainable development are permitted, such as scientific experiments, teaching practices, and ecotourism. In addition, crop farming and livestock breeding can only be conducted in the experiment zone. Currently, the agricultural population is approximately 22,000, whereas the rest mainly work away from their hometowns, especially young and middle-aged adults.

2.2 Data collection

The data used in this study were collected from survey questionnaires administered to community residents in SJLNNR. The field survey was conducted in January 2022 by three field workers, and a stratified random sampling method was used to select the respondents. First, two administrative villages were randomly selected from each town in SJLNNR (Table 1). Community residents were randomly selected, with the family considered as the unit from each administrative village. Upon arrival in each administrative village, field workers first visited village cadres who were chosen and organized to serve community residents. Accompanied by village cadres, field workers gained more trust from residents and successfully completed the questionnaire survey. They read the questions and then participants gave them answer verbally. All respondents voluntarily participated in this survey, and most were the main decision-making members of their families.

In this study, community participation was defined as the willingness and behavior of local community residents to improve the management and construction of SJLNNR. Actual participation referred to community residents taking action in SJLNNR management, and participation behaviors mainly

TABLE 2 Variable definition and descriptive statistics.

Variable name	Symbol	Variable meaning and assignment	Mean	Standard deviation	Index sources
Explained variables					
Deviation between willingness and behavior	y	Does the deviation exist between community residents' actual behaviors and their willingness to participate in the management of SJLNNR?	0.32	0.468	Zhang et al. (2020a), Guo et al. (2021)
		Yes = 0, No = 1			
Explanatory variables					
Attitude(four variables)					
Awareness of the necessity of establishing SJLNNR	x_1	Do you think that the establishment of SJLNNR is necessary?	4.25	0.923	Sirivongs and Tsuchiya (2012), Zhang and Li (2017)
		Not necessary at all = 1, Not necessary = 2, Generally necessary = 3, Quite necessary = 4, Fully necessary = 5			
Awareness of the importance of self-participation	x_2	Do you think that your self-participation is important for the successful conservation outcome of SJLNNR?	4.05	0.973	
		Not important at all = 1, Not important = 2, Generally important = 3, Quite important = 4, Fully important = 5			
Understanding of environmental protection laws and regulations	x_3	Do you understand the environmental protection laws and regulations?	2.48	1.072	
		Not understand at all = 1, Not understand = 2, Generally understand = 3, Quite understand = 4, Fully understand = 5			
Satisfaction with SJLNNR authority	x_4	Are you satisfied with SJLNNR authority?	3.36	1.511	
		Not satisfied at all = 1, Not satisfied = 2, Generally satisfied = 3, Quite satisfied = 4, Fully satisfied = 5			
Subjective norms(two variables)					
Participation of important or recognizable people	x_5	Many important or recognizable people have participated in the management and construction of SJLNNR, such as decision-making, daily supervision and benefit sharing	1.59	1.109	Apipoonyanon et al. (2019), Li et al. (2021)
		Strongly disagree = 1, Disagree = 2, No preference = 3, Agree = 4, Strongly agree = 5			
Technical training	x_6	Have you received technical training?	0.11	0.309	
		Yes = 1, No = 0			
Perceived behavioral control(nine variables)					
Ecological knowledge	x_7	I have ecological knowledge	2.35	1.001	Sirivongs and Tsuchiya (2012), Zhang and Li (2017), Zhou et al. (2017), Gonçalves et al. (2021), Feng et al. (2022)
		Strongly disagree = 1, Disagree = 2, No preference = 3, Agree = 4, Strongly agree = 5			
Government support	x_8	The government has supported the construction of SJLNNR.	2.12	1.394	
		Strongly disagree = 1, Disagree = 2, No preference = 3, Agree = 4, Strongly agree = 5			

TABLE 2 (*Continued*) Variable definition and descriptive statistics.

Variable name	Symbol	Variable meaning and assignment	Mean	Standard deviation	Index sources
Risk appetite	x_9	Risk aversion = 1, risk neutral = 2, risk preference = 3	1.60	0.747	
Future earnings expectations	x_{10}	I could get satisfactory earnings from SJLNNR in the future	2.76	0.947	
		Strongly disagree = 1, Disagree = 2, No preference = 3, Agree = 4, Strongly agree = 5			
Right to land proceeds	x_{11}	Do you retain the land proceeds right after the establishment of SJLNNR?	0.85	0.360	
		Yes = 1, No = 0			
Participation contents	x_{12}	I know what to do when participating in the management of SJLNNR.	1.98	1.147	
		Strongly disagree = 1, Disagree = 2, No preference = 3, Agree = 4, Strongly agree = 5			
Environmental improvement effect	x_{13}	SJLNNR has improved the surrounding environment of villages	4.00	1.105	
		Strongly disagree = 1, Disagree = 2, No preference = 3, Agree = 4, Strongly agree = 5			
Information	x_{14}	Do you know that the village committee has released related information on local participation in the management of SJLNNR?	0.65	0.477	
		Yes = 1, No = 0			
Ways to participation	x_{15}	Do you know how to participate in the management of SJLNNR?	1.48	0.726	
		No = 1, Unsure = 2, Yes = 3			
Individual and family characteristics (six variables)					
Age	x_{16}	Actual age	58.4	12.562	Zhang et al. (2020a), Li et al. (2021), Zhou et al. (2022)
Gender	x_{17}	Male = 1, Female = 2	1.26	0.439	
Education level	x_{18}	Primary school and below = 1, Junior high school = 2, Senior high school = 3, University and above = 4	1.85	0.955	
Resident members	x_{19}	Number of members living at home 6 months or more during the year per family	3.86	1.955	
Income	x_{20}	Average annual income per family	6.57	7.851	
Identity	x_{21}	Whether a village cadres or not: Yes = 1, No = 0	0.07	0.249	

included decision-making, benefit-sharing, and daily supervision. At the beginning of this survey, the meaning of community participation and specific participation actions were fully explained to the respondents by every fieldworker. The respondents were then asked two questions: 1) Are you willing to participate in the management and construction of SJLNNR? 2) Have you ever actually participated in? If they chose "yes," field workers would continue to ask about their specific willingness to participate or actual actions. If the answer was "no," field workers would also ask respondents about their understanding of participation in SJLNNR. Thus, whether these respondents understood the meaning of participation willingness and actual behavior could be determined according to their responses. If not, field workers would correct the variation in how respondents interpreted the meaning of "participation." During the survey, respondents could ask fieldworkers about technical terms in the questionnaire or other relevant questions at any time. Each questionnaire took 40 min to 1 h 200 questionnaires were distributed, and 197 were recovered, including 135 from Dongzhi County and 62 from Guichi District, with an effective rate of 98.50%. According to the total population in SJLNNR, the minimum sample size should be 100, at a confidence level of 95% and a precision level of 10% (Sarmah and Hazarika, 2012). A total of 197 valid questionnaires were collected, which was much greater than the minimum sample size.

2.3 Variable selection and descriptive statistics

The TPB was proposed by Ajzen et al. (1991), and was widely used to predict the willingness and behavior of an individual. According to the TPB, three main factors can directly influence behavioral intent: attitude, subjective norms, and perceived behavioral control. Behavioral intent, in turn, can directly determine the actual behavior of an individual (Ajzen, 1985) when the actual control conditions (e.g., individual capabilities, opportunities, resources) are sufficient. A deviation of behavior from willingness in individuals takes place owing to low facilitating conditions and intervening events (Gonçalves et al., 2021).Thus, the TPB connects individual willingness with behavior and provides theoretical support for the possibility of deviation between willingness and actual behavior of community residents in SJLNNR management.

Based on the TPB, attitude, subjective norms, and perceived behavioral control are the three dimensions that influence deviation in this study. In detail, attitude refers to the positive or negative evaluation of participation by community residents (Zhao et al., 2022); subjective norms refer to the external impetus and pressure caused by others when community residents make decisions on whether to participate (Jia et al., 2022); and perceived behavioral control refers to the perceived ease or difficulty based on personal control over resources, opportunities desires, and motives (Sultan et al., 2020) when community residents participate in the management of SJLNNR. In addition, relevant studies have also considered individual and family characteristics as potential influencing factors (Smith, 2012; Huber and Arnberger, 2021; Qiu et al., 2022). Therefore, this study analyzed the factors

influencing deviation using four dimensions: attitude, subjective norms, perceived behavioral control, and individual and family characteristics. The deviation between participation willingness and the actual behavior of community residents in SJLNNR was taken as the explained variable, and its influencing factors were considered as explanatory variables.

From the descriptive statistics shown in Table 2, we can see that the average age of these community residents was approximately 58 years. Men and women accounted for approximately 74% and 26%, respectively, representing a large gap. This may be because the residents surveyed were mainly heads of households or family decision-makers, which were typically men in rural families in China. The education level of the samples generally reached that of junior high school. The average number of members living at home for six or more month during the year per family was four, and the average annual family income was approximately 65,700¥. Moreover, the proportion of village cadres was only approximately 7%.

2.4 Methods

As the explained variable (deviation between willingness and actual behavior) is dichotomous, a binary logistic regression model was used for the analysis. The logistic regression model was set as follows:

$$p_i = F(y_i) = \beta_0 + \sum_{j=1}^{n} \beta_j X_{ij} = \frac{e^{\beta_0 + \sum_{j=1}^{n} \beta_j X_{ij}}}{1 + e^{\beta_0 + \sum_{j=1}^{n} \beta_j X_{ij}}} \quad (1)$$

where y_i is the deviation between the willingness and actual behavior of community residents in SJLNNR, defined as either 0 or 1, and X_{ij} denotes the value of the jth variable of the ith local resident. Furthermore, p_i is the probability of deviation, $F(y_i)$ is the probability distribution function, n is the number of explanatory variables, β_j is the regression coefficient of the jth explanatory variable, and β_0 is the intercept. Next, we calculate logarithms on both sides of Eq. 1 to transform the non-linear relationship between the explained and explanatory variables into a linear relationship. The simplified form is as follows:

$$y_i = ln\left(\frac{p_i}{1 - p_i}\right) = \beta_0 + \sum_{j=1}^{n} \beta_j X_{ij} \quad (2)$$

Based on Eq. 2, the probability of deviation between willingness and actual behavior to participate can be estimated, and the influencing factors can be further determined.

This study analyzes the hierarchical relationship among the influencing factors and discovers the direct, intermediate, and deep-rooted factors. The ISM was used to analyze the correlation between influencing factors. First, we determined the adjacency matrix R among the factors. It is assumed that the number of significant influencing factors is k, where S is used to denote the deviation between willingness and actual behavior and S_i (S_j) (i, j = 1, 2, $\cdots$, k) is used to denote the factors affecting this deviation. The constituent elements of junction matrix R are defined as follows:

$$r_{ij} = \begin{cases} 1, & s_i \ is \ related \ to \ s_j \\ 0, & s_i \ isn't \ related \ to \ s_j \end{cases} \quad i = 0, 1, \cdots, k; \ j = 1, 2, \cdots, k. \quad (3)$$

TABLE 3 Willingness and actual behavior of respondents to participate in the management of SJLNNR.

		Willingness			
		Willing	Percentage	Unwilling	Percentage
Behavior	Participate	32	16.24%	0	—
	Not participate	133	67.52%	32	16.24%
Total		165	83.76%	32	16.24%

Note: total samples = 197.

TABLE 4 The results of sample data test.

Cronbach's α					
Cronbach's α		0.815			
KMO and **Bartlett's** Test					
KMO			0.840		
Bartlett		Approx. Chi-Square	943.674		
		df	136		
		Sig	0.000		
VIF					
Variable	VIF	Variable	VIF	Variable	VIF
x_1	1.776	x_8	1.177	x_{15}	1.860
x_2	1.642	x_9	1.230	x_{16}	1.538
x_3	2.113	x_{10}	1.162	x_{17}	1.354
x_4	1.695	x_{11}	1.520	x_{18}	1.735
x_5	1.466	x_{12}	2.321	x_{19}	1.167
x_6	1.999	x_{13}	1.430	x_{20}	1.371
x_7	1.728	x_{14}	1.392	x_{21}	1.331
Hosmer-Lemeshow Test					
Approx. Chi-Square			11.894		
df			8		
Sig			0.156		

Eq. 3 is used to determine the accessibility matrix M among the factors. The specific calculation formula for M is:

$$M = (R + I)^{\lambda+1} = (R + I)^{\lambda} \neq (R + I)^{\lambda-1} \neq \cdots \neq (R + I)^2 \neq (R + I) \tag{4}$$

where I is the identity matrix, $2 \leq \lambda \leq k$, and Boolean calculation is used for the power operation of the matrix. Next, we determine the level of influence of each factor. The basic calculation formula is as follows:

$$P(S_i) = \{S_i | m_{ij} = 1\}, Q(S_i) = \{S_i | m_{ji} = 1\} \tag{5}$$

$$L_1 = \{S_i | P(S_i) \cap Q(S_i) = P(S_i), i = 1, 2, \cdots, k\}. \tag{6}$$

According to Eq. 5, the accessibility matrix is divided into an accessibility set $P(S_i)$ and an antecedent set $Q(S_i)$, comprising the set of all factors that can be obtained from factor S_i in the

accessibility matrix. Further, m_{ij} and m_{ji} both denote the factors in the accessibility matrix. The highest level L_1 and the influencing factors that L_1 contains are determined by Eq. 6; then, the other level factors are determined. The specific operation is that rows and columns of the most influencing factors are removed from the accessibility matrix M to form the accessibility matrix M_1, and the steps of Eqs 5, 6 are repeated to obtain the influencing level of the next factor, for all factors. Finally, a directed arrow is used to link the factors with the same level of influence and between adjacent levels.

3 Results

3.1 Deviation between willingness and actual behavior

As shown in Table 3, 83.76% of the respondents were willing to participate in SJLNNR management. In sharp contrast to the high willingness, only 16.24% of the respondents actually took actions. The willingness of community residents to participate did not fully translate into actual participation behavior. According to Rausch and Kopplin (2021), the deviation between willingness and actual behavior is generally divided into two different categories: 1) individuals that have willingness but no behavior and 2) individuals that have no willingness but behavior. In this study, 133 respondents expressed their willingness to participate but failed to perform actual behavior, accounting for approximately 67.52%. And these 133 respondents were considered for the following analysis. None of the respondents had no willingness but took action. Thus, a deviation exists between the willingness and actual behavior of local participation in SJLNNR, and there may be some factors that prevent willingness from completely converting into actual participation.

3.2 Regression analysis of the factors influencing the deviation

To ensure the reliability and validity of the empirical results, a sample data test must be conducted before using a binary logistic regression model. The test results are listed in Table 4, showing that the Cronbach's α is 0.815 and the KMO coefficient is 0.840 (which is close to 1), with $p < 0.05$. This indicates that the questionnaire has good reliability and validity, and it is suitable to continue with the factor analysis. The variance inflation factors (VIF) of all explanatory variables were less than five, indicating that there

TABLE 5 Results of the logistic regression model.

Variable dimensions	Variable name	B	*p*-value	EXP B)
Attitude	Awareness of the necessity of establishing SJLNNR	0.792***	0.008	0.453
	Awareness of the importance of self-participation	0.321	0.259	0.725
	Understanding of environmental protection laws and regulations	−0.528*	0.060	1.696
	Satisfaction with SJLNNR authority	−0.328*	0.086	1.388
Subjective norms	Participation of important or recognizable people	−0.721***	0.008	2.057
	Technical training	−0.645	0.454	1.906
Perceived behavioral control	Ecological knowledge	0.191	0.505	0.826
	Government support	−0.173	0.389	1.189
	Risk appetite	−0.349	0.279	1.418
	Future earnings expectations	−0.599**	0.030	1.820
	Right to land proceeds	−0.164	0.781	1.178
	Participation contents	0.139	0.617	0.870
	Environmental improvement effect	0.645***	0.008	0.525
	Information	0.650	0.187	0.522
	Ways to participation	−0.407	0.306	1.502
Individual and family characteristics	Age	−0.001	0.967	1.001
	Gender	−0.577	0.271	1.780
	Education level	0.161	0.611	0.851
	Resident members	−0.357***	0.003	1.429
	Income	0.116**	0.020	0.891
	Identity	23.461	0.998	0.000

Note: Total samples = 133.

*, ** and *** represent significance at 10%, 5% and 1% levels, respectively.

was no multicollinearity problem among the explanatory variables. The *p*-value of the Hosmer-Lemeshow test is 0.156, which suggests that the null hypothesis of "the observation data and regression model fit well" is accepted and the results given by the binary logistic regression model to be analyzed next could reflect the true relationship between the original variables.

Binary logistic regression analysis was carried out on the sample data using the SPSS 26.0 software. As shown in Table 5, eight influencing factors were identified from the four dimensions. The detailed results are as follows:

(1) Attitude: The awareness by community residents of the necessity of establishing SJLNNR has a significant positive impact on deviation at the 1% level. This means that the more necessary community residents think the establishment of SJLNNR is, the more likelihood there is of a deviation between their willingness to participate and actual behavior. Their understanding of environmental protection laws and regulations and their satisfaction with SJLNNR both negatively affected the deviation at the 10% level. Specifically, community residents who are

more familiar with laws and regulations on environmental protection and are satisfied with the governance of the SJLNNR authority are more likely to convert their willingness into actual participation. Additionally, awareness of the importance of self-participation had no significant impact on deviation.

(2) Subjective norms: The participation of important or recognizable people is negatively correlated with deviation at the 1% level. This signifies that the more neighbors, relatives, friends, or other important people participate in the management of SJLNNR, the more likely community residents are to engage in actual participation behaviors. However, technical training (e.g., ecological cultivation technology, green pesticide application, and freshwater aquaculture technology) did not significantly influence deviation.

(3) Perceived behavioral control: Future earnings expectations have a significant negative effect on deviation at the 5% level. This indicates that if residents have better future earnings expectations from SJLNNR, they will usually tend to participate. The realization of environmental improvement effect is positively correlated with deviation at the 1% level. The more obvious the environmental improvement effect of SJLNNR is, the more difficult

FIGURE 2
The logical relationship of the eight influencing factors.
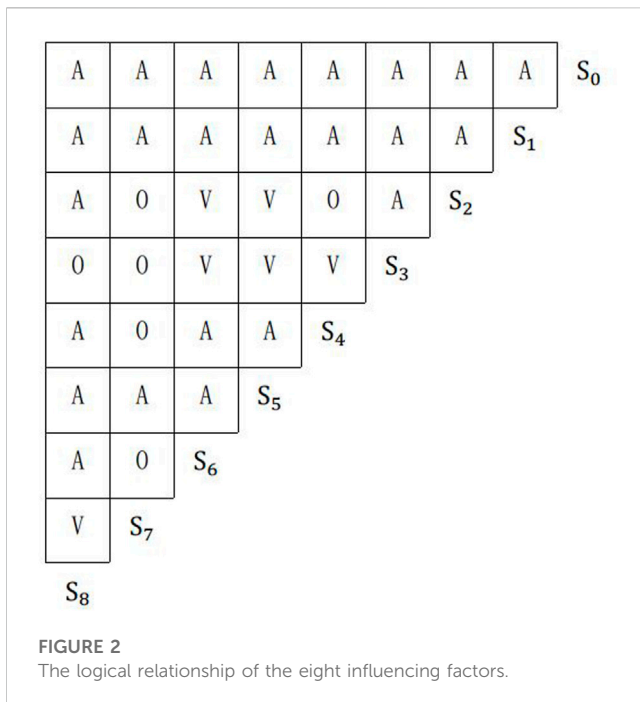
it is for community residents to convert their willingness into actual behaviors. In addition, the effects of the other seven variables were not significant, even at the 10% level.

(4) Individual and family characteristics: The number of members with long-term residence in SJLNNR per family negatively influenced the deviation at the 1% level. This shows that community residents are more likely to take action when they have more family members permanently living in the village. Income was positively correlated with the deviation at the 5% level. In detail, Residents with more annual family income are less likely to convert their willingness into behaviors. The other four variables have no significant impact on the deviation.

3.3 Hierarchical structure of these influencing factors

From the results of the logistic regression model, eight factors that significantly influence the deviation between the willingness and actual behaviors of community residents to participate in the management of SJLNNR can be extracted. S_0 denotes the deviation, and $S_1, S_2, \cdots, S_8$ denote the awareness of community residents of the necessity to establish SJLNNR, understanding of environmental protection laws and regulations, participation of important or recognizable people, future earnings expectations, satisfaction with SJLNNR authority, realization of environmental improvement effect, number of members living at home for 6 months or more during the year per family, and average annual family income. The logistic relationships of the eight factors were determined based on theoretical support and expert opinions. As shown in Figure 2, "V" indicates that row factors directly or indirectly affect column factors, "A" indicates that column factors directly or indirectly affect row factors, and "0"

indicates that there is no direct or indirect relationship between row and column factors.

According to Figure 2 and Eq. 3, adjacency matrix R among the nine factors can be obtained as follows:

$$
R = \begin{array}{c} S_0 \\ S_1 \\ S_2 \\ S_3 \\ S_4 \\ S_5 \\ S_6 \\ S_7 \\ S_8 \end{array}
\begin{bmatrix}
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
1 & 1 & 0 & 0 & 0 & 1 & 1 & 0 & 0 \\
1 & 1 & 1 & 0 & 1 & 1 & 1 & 0 & 0 \\
1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
1 & 1 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\
1 & 1 & 0 & 0 & 1 & 1 & 0 & 0 & 0 \\
1 & 1 & 0 & 0 & 0 & 1 & 0 & 0 & 1 \\
1 & 1 & 1 & 0 & 1 & 1 & 1 & 0 & 0
\end{bmatrix}
$$

Then, accessibility matrix M is calculated from adjacency matrix R, according to Eq. 4, using MATLAB software:

$$
M = \begin{array}{c} S_0 \\ S_1 \\ S_2 \\ S_3 \\ S_4 \\ S_5 \\ S_6 \\ S_7 \\ S_8 \end{array}
\begin{bmatrix}
1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
1 & 1 & 1 & 0 & 1 & 1 & 1 & 0 & 0 \\
1 & 1 & 1 & 1 & 1 & 1 & 1 & 0 & 0 \\
1 & 1 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\
1 & 1 & 0 & 0 & 1 & 1 & 0 & 0 & 0 \\
1 & 1 & 0 & 0 & 1 & 1 & 1 & 0 & 0 \\
1 & 1 & 1 & 0 & 1 & 1 & 1 & 1 & 1 \\
1 & 1 & 1 & 0 & 1 & 1 & 1 & 0 & 1
\end{bmatrix}
$$

Next, according to accessibility matrix M, Eqs 5, 6, this study obtains the highest-level element set, which is $L_1 = \{S_0\}$. Furthermore, the 2nd-8th level element set can be obtained in turn, which are $L_2 = \{S_1\}$, $L_3 = \{S_4\}$, $L_4 = \{S_5\}$, $L_5 = \{S_6\}$, $L_6 = \{S_2\}$, $L_7 = \{S_3, S_8\}$, and $L_8 = \{S_7\}$. Reordering the rows and columns of accessibility matrix M according to $L_1, L_2, \ldots, L_8$, backbone matrix N can be obtained as follows:

$$
N = \begin{array}{c} S_0 \\ S_1 \\ S_4 \\ S_5 \\ S_6 \\ S_2 \\ S_3 \\ S_8 \\ S_7 \end{array}
\begin{bmatrix}
1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
1 & 1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\
1 & 1 & 1 & 1 & 0 & 0 & 0 & 0 & 0 \\
1 & 1 & 1 & 1 & 1 & 0 & 0 & 0 & 0 \\
1 & 1 & 1 & 1 & 1 & 1 & 0 & 0 & 0 \\
1 & 1 & 1 & 1 & 1 & 1 & 1 & 0 & 0 \\
1 & 1 & 1 & 1 & 1 & 1 & 0 & 1 & 0 \\
1 & 1 & 1 & 1 & 1 & 1 & 1 & 0 & 1
\end{bmatrix}
$$

Finally, from backbone matrix N, it can be concluded that these nine factors were divided into eight layers. According to established logical relationships, the factors at the same level and between adjacent levels are connected by directed edges, and the hierarchical structure and correlation among the eight factors can be determined.

As shown in Figure 3, the eight influencing factors are at different levels. Most importantly, the number of members living at home 6 months or more during the year per family is a deep-rooted influencing factor. Future earnings expectations from SJLNNR, satisfaction with SJLNNR authority, realization of environmental improvement effect of SJLNNR, understanding of environmental protection laws and regulations, participation of important or recognizable people, and average annual income per family are all intermediate indirect influencing factors. Awareness of the necessity of establishing SJLNNR by community residents is a direct influencing factor at the surface level. Furthermore, the deep-
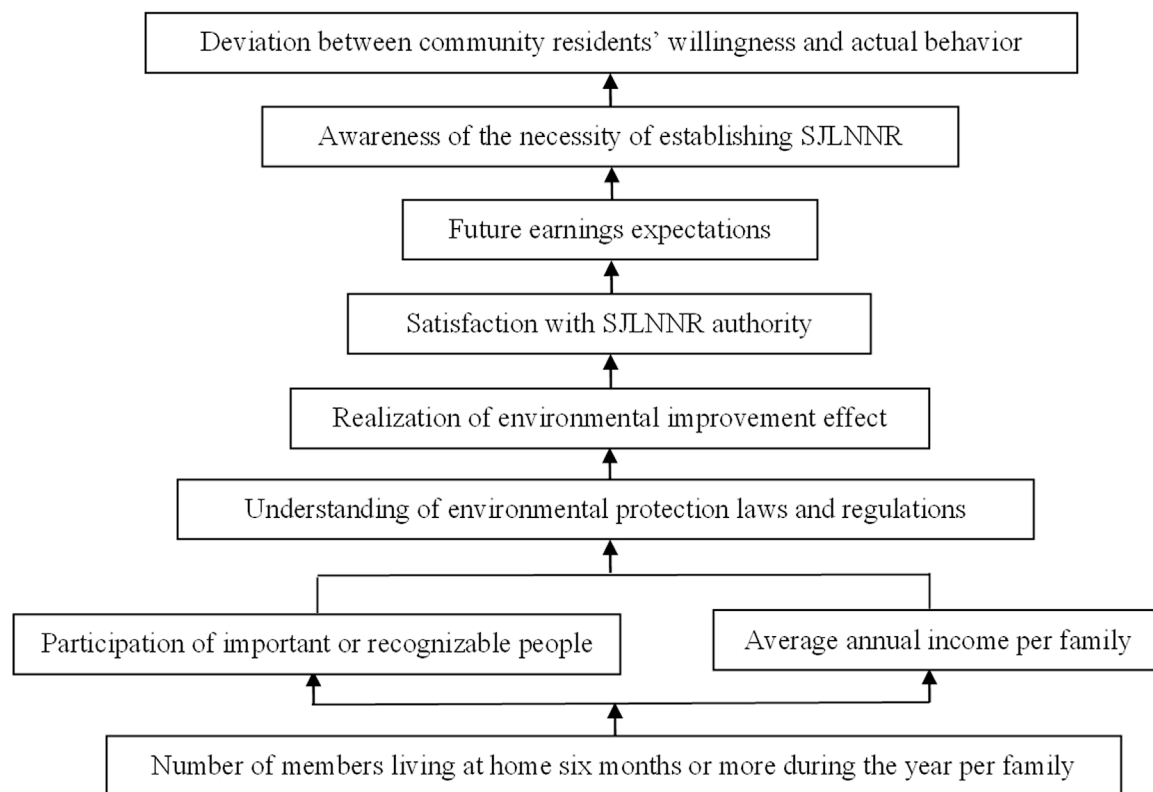
FIGURE 3
The hierarchical structure of the eight influencing factors.

rooted factor indirectly influences the deviation by affecting income and other six internal psychological factors.

4 Discussion

4.1 Influencing factors and practical reasons for the deviation

4.1.1 The lack of young and middle-aged adults is the root cause

The results from our study show that the number of resident members is a deep-rooted influencing factor that significantly decreases the deviation, which varies from the research finding of Zhou et al. (2022). This may be closely linked to the rural hollowing, which means that numerous educated young and middle-aged agricultural laborers in traditional agricultural areas transfer to non-agricultural sectors in urban areas during the process of rapid urbanization and industrialization in China (Cui et al., 2011). Rural hollowing is a widespread phenomenon throughout China and particularly exists in the area where SJLNNR is located. In addition, community residents have suffered economic loss owing to restrictions on the area of crop farming and livestock breeding since the establishment of SJLNNR. Coupled with the long-term fishing ban on Shengjin Lake, an increasing number of young and middle-aged adults in SJLNNR have left their hometowns to find jobs. Subsequently, the majority of permanent community residents in

SJLNNR are elderly people and children, and the family structure consisting of grandparents and grandchildren is extremely common. However, elderly people and children are often unable to participate in the management of SJLNNR because of a lack of time, energy, knowledge, and poor health. Compared to these residents, young and middle-aged adults are more qualified to engage in actual participation (Espinoza-Cisneros and Akhter, 2020). Clearly, community participation can be promoted only when there are a sufficient number of young and middle-aged adults in SJLNNR. Thus, the lack of young and middle-aged adults is the root cause of this deviation. A higher number of members living at home with long-term residence per family means more young and middle-aged adults in SJLNNR, which in turn means a greater potential for effective community participation.

Furthermore, contrary to many previous studies on pro-environmental behavior (Sirivongs and Tsuchiya, 2012; Apipoonyanon et al., 2019; Lin and Shi, 2022; Ma et al., 2022), annual income per family was found to be a key factor that significantly increases the deviation in this study. This may also be related to rural hollowing and a lack of young and middle-aged adults. During the survey, we found that crop farming and livestock breeding could not guarantee self-sufficiency for most community residents in SJLNNR. Their family income is mainly from working outside. Families whose young and middle-aged adults work in non-agricultural sectors in urban areas always have higher annual incomes. In other words, higher annual family income means fewer young adults in SJLNNR, resulting in a

deviation between willingness and actual behavior. Additionally, it can be seen that individual and family characteristics of community residents are fundamental driving forces for the occurrence of the deviation, which is aligned with several existing studies (Zhang et al., 2020a; Guo et al., 2021).

4.1.2 Inadequate ecological compensation is the direct trigger

Our study results indicate that the awareness by community residents of the necessity of establishing SJLNNR and the environmental improvement effect of SJLNNR are two factors that would both increase the deviation, which is different from previous research on pro-environmental behaviors (Vodouhê et al., 2010; Kuang and Lin, 2021; Li et al., 2021; Zhou et al., 2022), These unexpected results can be attributed to inadequate ecological compensation. During this survey, we found that the feelings of community residents regarding SJLNNR were complex. On the one hand, they agreed that SJLNNR plays an important role in nature protection and biodiversity conservation. After the establishment of SJLNNR, they could clearly sense the improvement in the local environment and the huge increase in wild animals, especially birds. On the other hand, they suffer economic loss from the growing number of wild animals, arising from such factors as crop destruction from wild birds and livestock injuries or deaths from other small mammals, whereby the relevant compensation is far less than the loss. They receive only 600 yuan per acre every year to mitigate the effects of crop damage from wild birds and barely receive any compensation for livestock deaths from wild animals. Some community residents regard SJLNNR as the cause of severe loss from wild animals (Ma et al., 2017). In other words, better environmental improvement means more wild animals, which in turn means more severe agricultural loss that cannot be compensated equivalently. Consequently, community residents tend not to engage in actual participation, and the deviation increases. Therefore, inadequate ecological compensation is the direct trigger for the deviation between willingness and actual participation in the management of SJLNNR. According to Ding and Qiu (2020), providing community residents with sufficient direct economic compensation may be effective.

4.1.3 Internal psychological factors significantly influence the deviation

Consistent with previous research on pro-environmental behaviors (Sultan et al., 2020; Eylering et al., 2022; Zhang et al., 2022), the results of this study also suggest that individual attitude significantly affects the deviation in behavior from willingness. Understanding of environmental protection laws and satisfaction with the SJLNNR authority are two factors that both have negative effects on the deviation. Clearly, if community residents understand environmental laws and regulations better, the concept of nature protection will be rooted in their hearts more deeply (Ding and Qiu, 2020), further promoting their conscious participation. As for their satisfaction with the SJLNNR authority, a possible reason is that the more satisfied residents are with SJLNNR, the more enthusiastic they are regarding community participation, leading to the conversion from willingness to actual behavior. As noted by Sirivongs and Tsuchiya (2012), higher satisfaction usually results in more positive participation in PA management.

Similarly, participation of important or recognizable people in the subjective norms dimension has a significant effect on the deviation. It has demonstrated to help achieve the consistency of participation willingness and actual behavior in this study, which is in line with an existing study by Guo et al. (2021). As community residents are widely affected by herd effect within the cultural context of "guanxi" which means relationship in Chinese, especially in rural areas (Wang et al., 2022), they tend to follow the crowd and make up their minds to participate in SJLNNR management under the pressure from others (Huber and Arnberger, 2021). Briefly, when relatives, neighbors, or friends make decisions regarding the formulation of reserve regulations, shared benefits from SJLNNR, or disclose activities with harmful influences on the environment, residents are more motivated to engage in actual participation.

Moreover, in the behavioral control dimension, future earnings expectations is also a key factor that has a significant effect on the deviation. Better future earnings expectations could decrease deviation. According to rational choice theory, community residents, as rational economically oriented people, often regard the maximization of their own interests as the basis for decision-making. If they predict that they could obtain satisfactory earnings from reserve employment, eco-tourism business, or reserve development projects and ecological projects carried out by the government or NGO in SJLNNR, they will be more active in engaging in the management and construction of SJLNNR (Dolisca et al., 2006). From the above analysis, it can be concluded that the internal psychological factors of community residents have a positive effect on the conversion from willingness to actual participation behavior.

4.2 Policy implications

Based on the above analysis, policy suggestions from three dimensions are proposed to decrease the deviation and promote the conversion of willingness to actual participation by community residents.

4.2.1 Local government

To realize SJLNNR community development, attracting young and middle-aged adults from urban areas to their hometowns is crucial. The best path may be to establish a variety of ecological industries and promote community residents to share satisfactory benefits from SJLNNR. First, the rational design and promotion of eco-tourism based on the natural landscape, wild animals, and local culture of SJLNNR should be conducted. Local governments should encourage community residents to manage eco-tourism businesses or to be employed to manage visitors, thus achieving alternative livelihoods. Second, actively cooperation with NGOs to carry out eco-friendly earning generation activities and projects (Sirivongs and Tsuchiya, 2012) should be undertaken to provide community residents with more economic benefits and job opportunities. Third, ecological agriculture and aquaculture should be developed, and the brand of SJLNNR should be established to enhance the value of eco-agricultural products. Local governments should actively introduce social enterprises to help community residents sell these ecological products, providing a certain proportion of funds per year to support community development.

Furthermore, an ecological compensation system needs to be developed. Local governments should scientifically formulate ecological compensation standards according to the opinions of relevant professionals to ensure that community residents receive commensurate economic compensation, particularly compensation for wildlife incidents (Ma et al., 2017). Besides direct economic compensation, local governments should prioritize local residents in SJLNNR when there are vacant positions related to nature protection, such as lake patrols.

4.2.2 SJLNNR authority

First, the authority should take the lead in establishing a co-management system, and fully respect the decision-making power of every community resident. When formulating natural resource protection policies and regulations, authorities should consult with representatives selected from community residents and listen to their opinions. Second, a mechanism for disseminating information should be established. Authorities should increase community-centered information communication channels and publicize the principles, policies and basic knowledge of SJLNNR to local communities through community organizations represented by village committees. Moreover, ensuring the right to know of the entire process of SJLNNR construction, operation, and management for the community residents would improve their trust and satisfaction with the authority. Third, an incentive mechanism must be established. The SJLNNR authority should set up a community reward fund to provide appropriate rewards and honorary certificates to communities or individuals who actively participate in and contribute to SJLNNR management to ensure the enthusiasm of community residents to perform actual participation behaviors.

4.2.3 Local community

To ensure the smooth participation of community residents in SJLNNR management, local community should improve the awareness of the residents and their ability to participate. First, the sense of ownership for each community resident should be cultivated. Through publicity and education, community residents would realize that they enjoy the right to manage SJLNNR; meanwhile, they would be responsible for participating in SJLNNR management. Second, the local community should actively cooperate with social environmental protection organizations and jointly carry out education and training for community residents, such as ecological cultivation technology, ecological breeding technology, and green pesticide application. In addition, an atmosphere should be created for everyone in this community to participate in the management of SJLNNR. Local communities should publicize the laws and regulations to community residents and encourage them to take the initiative to supervise and report illegal human activity in daily life, including fish poaching in Shengjin Lake, endangered-waterfowl poaching, and farming or breeding in the buffer zone. Moreover, human connections and the positive influence of relatives, neighbors, or friends who have actually participated in SJLNNR management should be employed, thus prompting community residents to take practical participation actions.

4.3 Limitations and research prospects

In this study, using the question "Have you ever participated in the management of SJLNNR?" to measure whether community residents have actual participation behaviors is relatively insufficient. To avoid the misinterpretation of the word "participation," we explained its specific meaning and provided examples to increase understanding during the survey. Future research could overcome this impediment by adding multiple-choice questions to the survey questionnaire, such as "What specific participation behavior have you ever had?" and list several types of participation behaviors for respondents to choose. Another limitation is that external contextual factors were not fully considered in this study, such as the types of jobs provided by SJLNNR, individual health status (Feng et al., 2022), and distance to Shenjing Lake (Qiu et al., 2022). In addition, future research can be extended to specific types of protected areas, such as wetland protected areas.

5 Conclusion

Community participation is important for effective PA management and long-term sustainability. To promote community participation, we explored the causes of the deviation between high participation willingness and low actual behavior, and suggested practical measures to decrease the deviation. Based on a field survey of SJLNNR in Anhui Province in China, this study applies Logistic-ISM to analyze the key factors influencing the deviation and further determine the logical hierarchy among these key factors. The results showed that eight factors had significant effects on the deviation. Among these, awareness of the necessity of establishing SJLNNR is a direct factor at the surface level, and participation of important or recognizable people, average annual family income, understanding of environmental protection laws and regulations, realization of environmental improvement effect, satisfaction with SJLNNR authority, and future earnings expectations are all intermediate indirect factors. Furthermore, resident member is a fundamental factor.

By linking these influencing factors and the reality of SJLNNR, we found that the lack of young and middle-aged adults is the root cause of the deviation, and inadequate ecological compensation is the direct trigger. Thus, attracting young and middle-aged adults to return to their hometown is the first step. In the context of rural revitalization in China, local governments should coordinate nature protection and community development and design a suitable sustainable development path for local residents. Establishing various ecological industries and creating a brand for SJLNNR may be good choices for achieving alternative livelihoods and developing local economies. Moreover, an effective ecological compensation system should be established to directly promote community participation. In addition, the internal psychological factors of community residents were found to significantly affect their actual participation behaviors. To decrease the deviation, the SJLNNR authority should improve the community participation mechanism, and local communities should enhance the awareness and ability of residents, and create an atmosphere for everyone to participate in the management of SJLNNR.

Data availability statement

The raw data supporting the conclusion of this article will be made available by the authors, without undue reservation.

Author contributions

TW: Formal analysis, methodology, investigation, software, writing–original draft, writing–review and editing. WJ: Funding acquisition, investigation, project administration, supervision. QW: Conceptualization, investigation, software, writing–original draft.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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