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RESEARCH ARTICLE

The cooperative development relationship between Nature Reserves and local communities

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Abstract

The coordinated relationship between Nature Reserves (NRs) and adjacent communities has a significant impact on both these local communities and conservation management practices. However, the precise relationship between NRs and their surrounding communities remains poorly understood, whether it is coordinated or unbalanced? This study employed a matrix analysis approach alongside a coordination degree model to assess the relationship and the degree of coordination between the Xiaoheishan NRs (Xhs NRs) and local communities. In addition, a structural equation model was used to analyze the factors that influence the degree of coordination between the Xhs NRs and adjacent communities. Taking into account the willingness of these communities, a prospective development model was proposed. The results of the study revealed that: (1) the relationship between the Xhs NRs and their surrounding communities was predominantly characterized by a protection-oriented approach, particularly in the subprotected regions of Xhs, Dxs, and Jzs. (2) The path analysis revealed that the level of dependence, knowledge, and cost perception among the Xhs NRs communities had a direct negative influence on the degree of coordination. Conversely, the attitudes and perceived benefits to the Xhs NRs had a direct positive effect. (3) The pathway to future development involves a triple model approach: a public participation model, an economic model that focuses on mutual benefits and a protection and poverty alleviation model. The relationship between NRs and surrounding communities should be accurately defined; and the contradiction between protection and development should be fully coordinated. To achieve coordinated development of NRs and communities that reside close by, the Xhs NRs, along with other smaller and scattered NRs, should actively involve the public, particularly local communities, in conservation management.

KEYWORDS

community livelihoods, conservation management, coordinated development, structural equation modeling, unbalanced relationship

Plain language summary

There are conflicts between the Longling Xiaoheishan Nature Reserves (Xhs NRs) in Yunnan, China, and their surrounding communities. Comprehending the precise nature of this relationship and the factors

contributing to these conflicts is crucial for enhancing the effectiveness of conservation management. Our findings indicate that the Xhs NRs predominantly adhere to a conservation model that compromises local community development. The establishment and policies of the Xhs NRs have significantly impacted the traditional livelihoods of local communities. Furthermore, the tensions arising from these impacts on livelihoods pose a considerable threat to the effectiveness of conservation management. Our study also revealed that the local communities' perception of negative impacts associated with the establishment of the Xhs NRs, such as loss of income and wildlife destruction, had a more substantial influence on their attitudes toward the Xhs NRs and their perception of harmony, compared to the perceived positive impacts. We believe that to resolve the conflicts between the Xhs NRs and adjacent communities, conservation managers should engage some external forces. This includes the introduction of external projects aligned with local development needs, with particular emphasis on the involvement of local communities. In this way, conservation and development can be better coordinated.

1 | INTRODUCTION

Nature Reserves (NRs) are intended to preserve biodiversity and achieve sustainable development in collaboration with local communities (Mavah et al., 2018). They play a crucial role in the in-situ conservation of specific flora and fauna in their natural habitats (Narain et al., 2022; Xu et al., 2022). According to the latest edition of the "Protect the Earth Report," the coverage of protected areas globally has increased by 4.2% since 2010, with NRs accounting for approximately 15.66% of the total area (Academy of Ocean of China, 2021). However, the effectiveness of conservation management in NRs can be influenced by social and economic factors, including human population density and the activities of local communities (Auliz-Ortiz et al., 2022). Similarly, the existence of NRs can have a myriad of impacts on neighboring communities. These include offering various benefits, such as biodiversity protection, provision of clean air and water, and recreational opportunities for the local population (Allendorf, 2020). In addition, NRs can attract government projects, nongovernmental organizations, and economic activities like ecotourism (Mariyam et al., 2021; Mbise, 2022a, 2022b). Nevertheless, the protection of natural resources is often perceived as a barrier to the societal and economic progress of neighboring communities (Buckley, 2016; Cobbinah et al., 2015).

This trade-off requires a balance between the protection of natural resources and the promotion of community economic development (Nyumba et al., 2020; Sampson et al., 2021). Moreover, community development inherently requires the use of these natural resources (Tollefson, 2020). However, implementing restrictive policies within NRs can hinder local socio-economic development and exacerbate poverty levels (Farkas & Kovács, 2021; Hinojosa et al., 2018). Consequently, it is crucial to note that areas of rich biodiversity often coincide with high poverty rates (Dai et al., 2023).

Practitioner points

- Understanding the precise relationship between Nature Reserves and communities is a crucial part of Nature Reserve–community conflict resolution.
- Conservation managers should strive to mitigate the perceived negative impacts of Nature Reserves on local communities and take active steps to address these adverse effects.
- Involving the public, particularly local communities, in conservation management is pivotal. The introduction of external projects, such as ecotourism initiatives or local infrastructure enhancements, represents a future pathway for achieving coordinated development between Nature Reserves and adjacent communities.

Numerous studies have thoroughly documented the conflicts that arise between NRs and local communities. These conflicts encompass a range of issues, including resource protection and utilization, ambiguities in land ownership, human–wildlife conflicts, restrictions on access, as well as limitations in communication and community participation (Gerten et al., 2020; Matema & Andersson, 2015; Resende et al., 2021; Shyamsundar et al., 2021; Zimmermann et al., 2020). Specifically, human–wildlife conflicts have been associated with physical injuries, fatalities, crop damage, and increased labor costs for crop defense (Subakanya et al., 2018a, 2018b). To enhance global conservation efforts, it is imperative to increase the

number of NRs worldwide and implement effective management strategies within these protected areas (Maxwell et al., 2020). Additionally, strategies that promote synchronized development between NRs and surrounding communities should be explored. Some researchers have used models to describe the relationship between conflict sources and resulting damage (De Pourcq et al., 2017). The successful advancement of conservation efforts heavily relies on the key relationship between NR managers and the surrounding communities, as well as the attitudes, perspectives, and perceptions of these communities toward NRs (Angwenyi et al., 2021). Attitudes are influenced by various factors, such as income, age, education, gender, participation in NR management, conservation awareness, and cost–benefit perception (Bragagnolo et al., 2016; Larson et al., 2016; Ma & wen, 2016). Furthermore, conservation support is often compromised when community benefits are threatened, especially in terms of access to natural resources, production constraints, and human–wildlife conflict (Ma & wen, 2016). The impact of protected areas on a community's livelihood shapes their opinions and subsequent actions regarding conservation efforts (Abukari & Mwalyosi, 2018).

Recent years have witnessed heightened scientific interest in the role of social engagement in nature conservation (Bai et al., 2021; Buijs et al., 2019; Kujala et al., 2022). This attention is particularly focused on the importance of collaboration between authorities and stakeholders to effectively conserve nature in areas where there is public support for policy implementation (Buijs et al., 2022). Naturally, this integration should extend to economic sectors and individual actions, encompassing aspects, such as joint management of natural resources (Frantzeskaki & Kabisch, 2016) and active participation in the construction and policy formulation of NRs (Fors et al., 2015; Nagendra & Ostrom, 2012). Community co-management and community-based tourism initiatives can help to address the conflict between NRs and local communities (Kujala et al., 2022; Ma & wen, 2016). Studies have found that tourism development can lead to increased regional income, population growth, and enhanced living standards, thereby significantly improving community livelihoods (Ferraro & Hanauer, 2014; Job & Paesler, 2013). However, certain studies have also highlighted the negative impacts of ecotourism, including the emergence of conflicts within local communities (Ma & wen, 2016) and increased income inequality (Ma & wen, 2016). To devise effective solutions, a comprehensive understanding of the relationship between NRs and neighboring communities is essential, necessitating targeted research on influencing factors. Unfortunately, the limited scholarly attention to this issue has made it challenging to establish a connection between these two entities, reducing the effectiveness of proposed solutions.

The Xiaoheishan NRs (Xhs NRs) in Yunnan, China, were established with the aim of protecting local biodiversity. However, the long-standing tradition of villagers harvesting plants and insects for various purposes has caused conflicts with reserves (Allendorf & Yang, 2013a). These conflicts have had a significant impact on the stability of local communities and the effectiveness of the conservation framework within the reserves (Longling Xiaoheishan Provincial Nature Reserve Management and Conservation Bureau 2022 annual departmental final accounts). Previous studies on the Xhs NRs have mainly centered on qualitative analysis, focusing on identifying factors affecting the relationship between the reserves and surrounding communities (Allendorf & Yang, 2013a, 2013b, 2015; Chaplin, 2005). However, there remains a notable gap in the quantitative analysis of the relationship and the degree of coordination between the Xhs NRs and their neighboring communities.

This study aimed to investigate the relationship between the Xhs NRs and adjacent communities, and specifically whether this relationship is characterized by harmony, imbalance, or conflict. Structural equation modeling was used to examine the driving forces that influence the coordinated development of the two entities. The results were then assimilated with the inclination of local communities toward progress, with the goal of devising a model for sustainable development. This study helps decision-makers understand the relationship between NRs and communities, resolve existing conflicts, and achieve coordinated development. The research was organized into three main parts: (1) evaluating the relationship and degree of coordination between the Xhs NRs and surrounding communities, (2) identifying the factors that influence the degree of coordination, and (3) investigating potential models for future development.

2 | MATERIALS AND METHODS

2.1 | Study area

The Xhs NRs are located in Longling County, Baoshan City, Yunnan Province, China, between 98°38′–99°10′E and 24°15′–24°51′N. This area has a humid plateau monsoon climate, with an average annual precipitation of about 1699 mm, an average yearly temperature of 15°C, and an altitude of 660–1960 m. Established in 1995 by the Yunnan Provincial People's Government, these reserves, covering an area of 5805.0 hm^2, are designated as provincial NRs, focusing on the conservation of forest ecosystems. This region is recognized as a significant biodiversity hotspot within the Indo-Burma region and is situated in the central hinterland of the Gaoligongshan National Nature Reserve. It comprises five distinct and geographically dispersed subprotected regions extending from north to south: Guchengshan (Gcs), Yiwanshui (Yws), Daxueshan (Dxs), Xiaoheishan (Xhs), and Jiangzhongshan (Jzs). Owing to constraints imposed during the pandemic,

our interviews were confined to the four subprotected regions of Xhs, Dxs, Gcs, and Jzs (Figure 1).

During the 1950s, as part of a nationwide collectivization movement, the local communities were relocated from the mountainous region, which is now designated as a protected area. This relocation occurred 30 years before the area was officially given protection status. The surrounding communities are mainly Han, and the minorities are Lisu, Yi, and Dai. The majority of people in this region are engaged in farming, with the most common crops being maize, tobacco, tea, rice, and sugar cane. Migrant work and aquaculture constitute the main sources of local income (Supporting Information S1: Figure S1).

2.2 | Field survey

The subprotected regions of Xhs, Dxs, Gcs, and Jzs are relatively small and dispersed, each existing under different conditions. Hence, in accordance with the cardinal directions of north, south, east, and west, we employed a random sampling technique to select communities residing within a 5-km radius of the NRs' boundaries in each respective direction. A questionnaire survey was conducted, with a sample size of 30–40 participants in each cardinal direction. This approach was designed to ensure that the questionnaire indices accurately reflected the actual conditions of the Xhs NRs. The presurvey was conducted in the Xhs NRs from November 17 to 28, 2021, yielding a total of 159 valid responses. Based on the feedback from the presurvey, combined with the unique characteristics of the surrounding communities, the indicators and structure of the questionnaire were partially modified to ensure the universality of the survey and the validity of the questionnaire.

Then, from June 25 to July 7, 2022, a formal survey was conducted in the four subprotected regions. A total of 476 valid questionnaires were obtained, with an effective response rate of 95%. Most respondents were male (74.8%), aged 50–59 years, with most having received primary education (44.7%). A significant proportion lived in villages 1–3 km (42.4%) from the border of the NRs, which could be reached in approximately 30 min on foot (52.1%). On average, respondents reported living in households of about three to five people (56.9%), with approximately 2 of the household members being laborers (62.8%). The majority of respondents (59.7%) reported not entering the NRs at all (Supporting Information S1: Table S1).

Before conducting interviews with the local communities, this study first conducted structured interviews with personnel from the management and protection bureau, the management and protection stations of each subdistrict, and the administrative staff of the village committees. The purpose was to gather some basic information to facilitate more informed and effective interviews with community

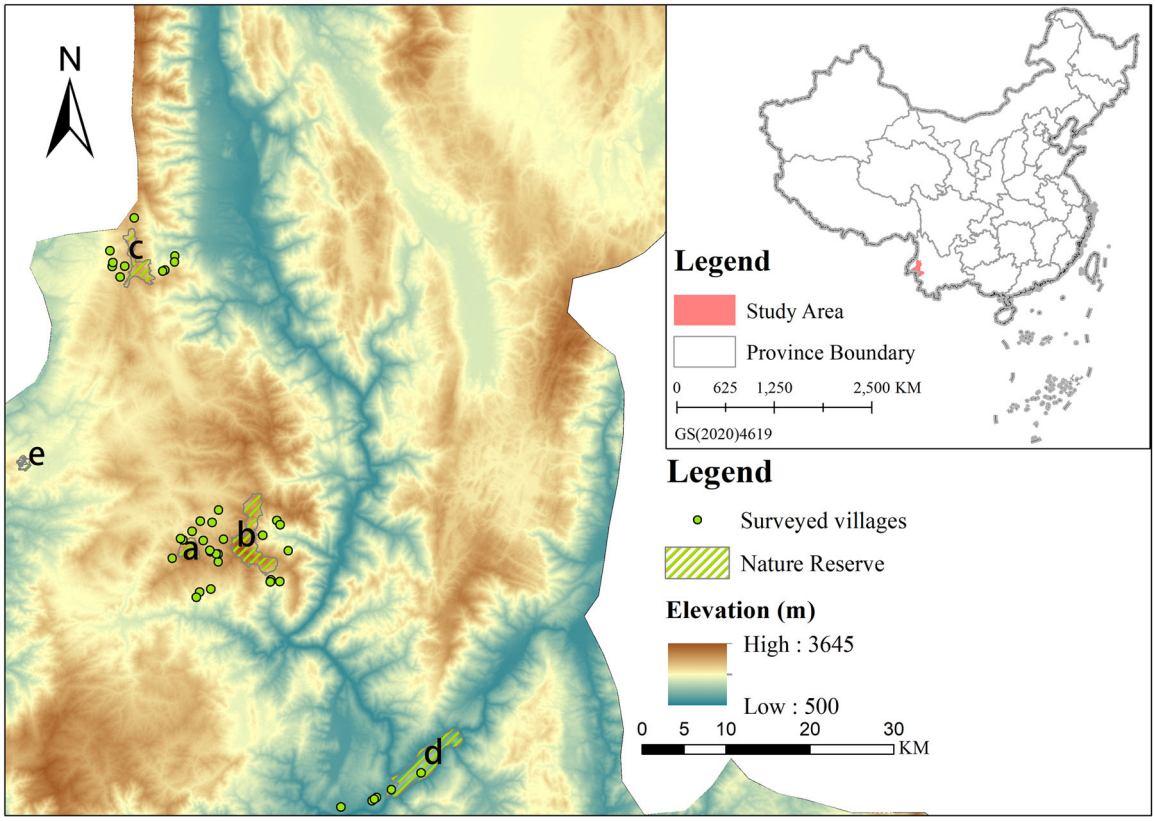

FIGURE 1 Location of Xiaoheishan (Xhs) Nature Reserves. (a) Xiaoheishan, (b) Daxueshan, (c) Guchengshan, (d) Jiangzhongshan, and (e) Yiwanshui.

members. Only one adult per household, typically the household head, was interviewed.

The questionnaire was divided into 10 parts: (1) socioeconomic indicators, (2) knowledge (people's knowledge about the NRs), (3) accessibility, (4) dependence (frequency: annual frequency of community residents entering NRs), (5) benefit perception, (6) cost perception, (7) attitude, (8) willingness for development, (9) impact of protected areas on communities, and (10) impact of community residents on protected areas. Most of the questions were closed-ended (Supporting Information S1: Table S2 and Material 1).

2.2.1 | Index selection

In this study, a set of indicators encompassing environment, income, work, wildlife destruction, herb, plantation, harvest, and travel/folklore was selected to elucidate the relationship between local communities and the NRs. The criteria for selecting indicators were mainly based on three points: (1) representativeness and relevance, ensuring the indicators could accurately reveal the key characteristics of the relationship between NRs and communities; (2) operability, with a focus on indicators that could be expressed quantitatively; (3) stakeholder concerns, ensuring that the indicators reflected the individual preferences and perspectives of community members, management bureaus, and local governments. These indicators were proposed based on a large number of publications and field investigations (Supporting Information S1: Table S2), in which the intricate relationship between the Xhs NR communities could be specifically elucidated.

2.2.2 | Index weight

This study used the Critic method and expert evaluation method to determine the weight scores for each index system. The Critic methodology calculates the weight of each index based on index variation and conflict. The degree of variation was quantified using standard deviation. The greater the standard deviation of an index, the higher its corresponding weight in the overall analysis. Conflict among indicators was calculated using the correlation coefficient. A higher correlation coefficient indicates a reduced conflict between indicators, which, in turn, results in a decrease in weight being assigned to those indicators (Diakoulaki et al., 1995) (Supporting Information S1: Material 2 and Table S3).

2.2.3 | Relationship characteristics

In this study, four key indicators—environment, income, work, and wildlife destruction—were used to assess the influence of local communities on NRs, specifically the protection indicator. A different four indicators—herd, plantation, harvest, and travel/folklore—were employed to assess the influence of NRs on local communities, with a particular emphasis on the development indicator. The impact score of the two was obtained by multiplying the index score matrix derived from the questionnaire, with the corresponding weight assigned to each index (Supporting Information S1: Material 3)

$$X = (w_1 w_2 \ldots w_4)\begin{bmatrix} a_{11} & \cdots & a_{14} \\ \vdots & \ddots & \vdots \\ a_{1n} & \cdots & a_{n4} \end{bmatrix}.$$

In the formula, X is the score, $X \in [-2, 2]$; w_n is the index weight, and a_n is the index score, $a_n \in [-2, 2]$.

The degree of coordination refers to the coordination between the two systems, the object element group (x) and the object element group (y), in the development process (Yang et al., 2020)

$$X = \sqrt{OT}.$$

In the formula, X is the coordination score, $X \in [0, 1]$, $T = \alpha Z_1 + \beta Z_2$, α and β represent the comprehensive index of contribution to protection and development, respectively. This study demonstrated that protection and development are equally significant. O is the coupling degree value, and the calculation method is as follows:

$$O = \left\{ \frac{Z_1 \times Z_2 \times Z_3 \times \cdots \times Z_n}{\prod (Z_1 + Z_2 + Z_3 + \cdots + Z_n)} \right\}^{\frac{1}{n}}.$$

The coupling degree of protection and development indicators is

$$O = \left\{ \frac{f(X) \times f(Y)}{([f(X) + f(Y)]/2)^2} \right\}^{\frac{1}{2}}.$$

In the formula, $O \in [0,1]$, the larger the value, the closer the relationship between the two, $f(X)$ is the protection index, $f(Y)$ is the development index, and n is the number of types of computing systems (Supporting Information S1: Table S4–7).

2.3 | Analysis of influencing factors

This study used a structural equation model to measure the coordination between protection and development efforts. In the field, there are a multitude of intangible concepts that are not easily measured or observed through simple approaches. Structural equation modeling provides a feasible solution to this challenge. It allows for the examination of causal relationships between variables and the mechanisms

underlying their influence while also accounting for measurement error (Martynova et al., 2018). This study is based on an existing theory from social psychology, which posits that an individual's behavior is influenced by their intention to engage in that behavior, which, in turn, is shaped by their attitude toward the behavior (Ajzen, 1980). Utilizing this theoretical framework, a structural equation model was constructed, and Amos 22 software was used to quantitatively analyze how various factors—such as socioeconomic indicators, knowledge, dependence, accessibility, benefit perception, cost perception, and attitudes—influence the degree of coordination (Abukari & Mwalyosi, 2020; Allendorf & Yang, 2013a, 2013b; Bennett & Deaeden, 2014; Constant & Bell, 2017). After a simple statistical analysis, the following hypotheses were put forward:

H1: Communities' knowledge has a positive impact on the degree of coordination.

H2: Communities' dependence has a negative impact on the degree of coordination.

H3: Communities' benefit perception has a positive impact on the degree of coordination.

H4: Communities' cost perception has a negative impact on the degree of coordination.

H5: Communities' attitude has a positive impact on the degree of coordination.

H6: Communities' education has a positive impact on the degree of coordination.

H7: Residents' gender has a negative impact on the degree of coordination.

2.4 | Future development model

In this study, four indicators were used to gauge the future development intentions of communities surrounding the NRs. These indicators included infrastructure construction, ecotourism, community participation in the management of the NRs, and external projects. Based on the distribution of respondents' preferences, the future development modes were divided into four models: coordinating agency, a combination of protection and poverty alleviation, economic win-win, and public participation. Among these four indicators, infrastructure construction was used as a metric for the "combination of protection and poverty alleviation" model, ecotourism was used to assess the "economic win-win" model, participation in the management of the NRs was used to measure the "coordinating agency" model, and external project support was used to determine the "public participation" model (Supporting Information S1: Material 4).

3 | RESULTS

3.1 | Relationship characteristics

The study, conducted across four subprotected regions, revealed that a significant proportion of the respondents, amounting to 39%, held the perception that the relationship between development and protection was predominantly directed toward coordinated development. Similarly, another 39% of respondents emphasized that the relationship favored protection. Furthermore, 11% of the participants evaluated the connection as beneficial for strengthening the community, while an equal proportion of 11% perceived it as characterized by conflict and competition (Supporting Information S1: Table S8). The subprotected regions Xhs, Dxs, and Jzs exhibited a significant tendency toward protection-oriented practices, while the Gcs subprotected regions were principally associated with a focus on coordinated development. Nevertheless, irrespective of the particular protected region, there was a notable and concerning level of wildlife destruction (Figure 2).

The study revealed varying proportions for the four relationship patterns— development-coordinated type, community-friendly type, protection-friendly type, and conflict-competitive type—across the four subprotected regions. In Xhs, the distribution was 40.3%, 9.3%, 43.4%, and 7.0%, with the protection-friendly type occupying the dominant position, followed closely by the development-coordinated type. The proportions in Dxs were 37.8%, 5.0%, 53.8%, and 3.4%, with the protection-friendly type being the most prominent, followed by the development-coordinated type. In Gcs, the figures were 42.0%, 16.0%, 21.4%, and 20.6%. The development-coordinated type came out on top, followed by the conflict–competition type. The proportions of the four types in Jzs were 34.1%, 13.7%, 37.5%, and 14.8%, with the protection-friendly type occupying the dominant position (Figure 3 and Supporting Information S1: Table S9).

3.2 | Analysis of driving factors

This study tested the significance of the structural equation model. The resulting p values of the four areas were 0.177, 0.212, 0.090, and 0.249, all of which exceeded the threshold of 0.050 (Table 1). Therefore, based on these results, the original model hypothesis was accepted (Liang & Bentler, 2004). The model's goodness-of-fit indices were all greater than 0.900, indicating an optimal fit between the model and the data. In addition to the above two indices, more indicators also demonstrated that both the structural configuration of the model and the data fit satisfied the established standards (Supporting Information S1: Material 5).

The seven hypotheses were all partially supported. Attitude, benefit–cost perception, and frequency directly influenced the degree of coordination, while

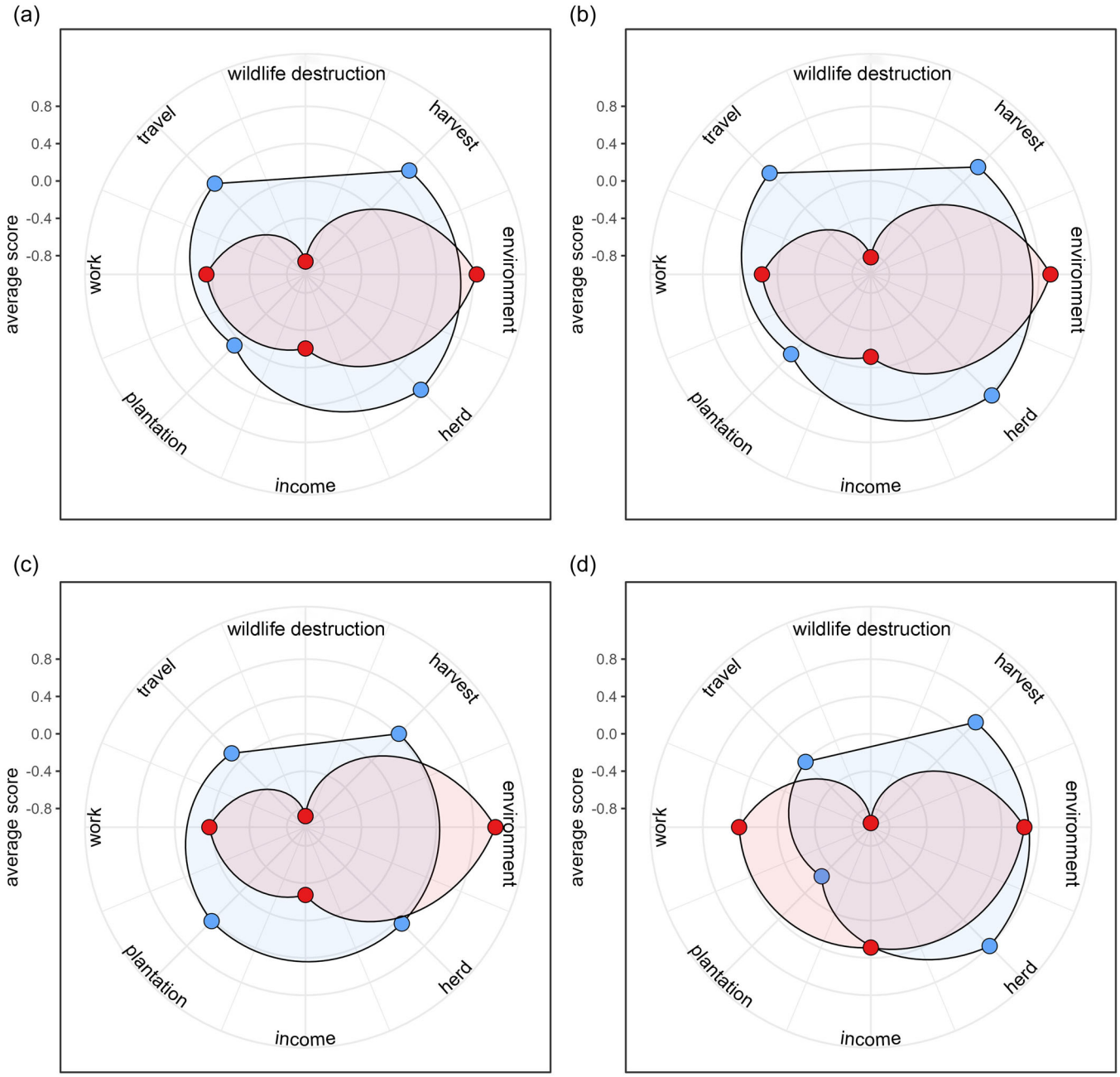

FIGURE 2 Relational characteristics between Xiaoheishan (Xhs) Nature Reserves and communities. Blue indicates the development index; red indicates the protection index. (a) Xiaoheishan, (b) Daxueshan, (c) Guchengshan, and (d) Jiangzhongshan.

gender, education, and knowledge indirectly affected it. Specifically, the attitude of communities in the Xhs had a substantial positive impact on the degree of coordination, with a standard path coefficient of 0.20 ($p < 0.05$). Dependency had a direct negative effect, with a standard path coefficient of –0.24 ($p < 0.01$). Residents' gender, education, and knowledge indirectly affected coordination. The benefit–cost perception in the Dxs had a substantial positive impact on the degree of coordination, and the standard path coefficients were 0.26 ($p < 0.01$) and 0.21 ($p < 0.05$), respectively. Residents' gender, education, and knowledge indirectly affected coordination. Cost perception in the Gcs had a direct and significant positive impact on the degree of coordination, with a standard path coefficient of 0.26 ($p < 0.01$). Knowledge had a direct and adverse negative impact, with a standard path coefficient of –0.22 ($p < 0.05$). Community gender and education indirectly affected the degree of coordination. Cost perception in Jzs had a positive and significant impact, with a standard path coefficient of 0.28 ($p < 0.01$) (Figure 4).

3.3 | Future development model

Within the four subprotected regions, external project support constituted the highest proportion. However, the majority of respondents advocated for future development through a multifaceted approach: a combination of external project support (public participation model), infrastructure construction (protection and poverty alleviation model), and ecotourism (economic win-win model). The

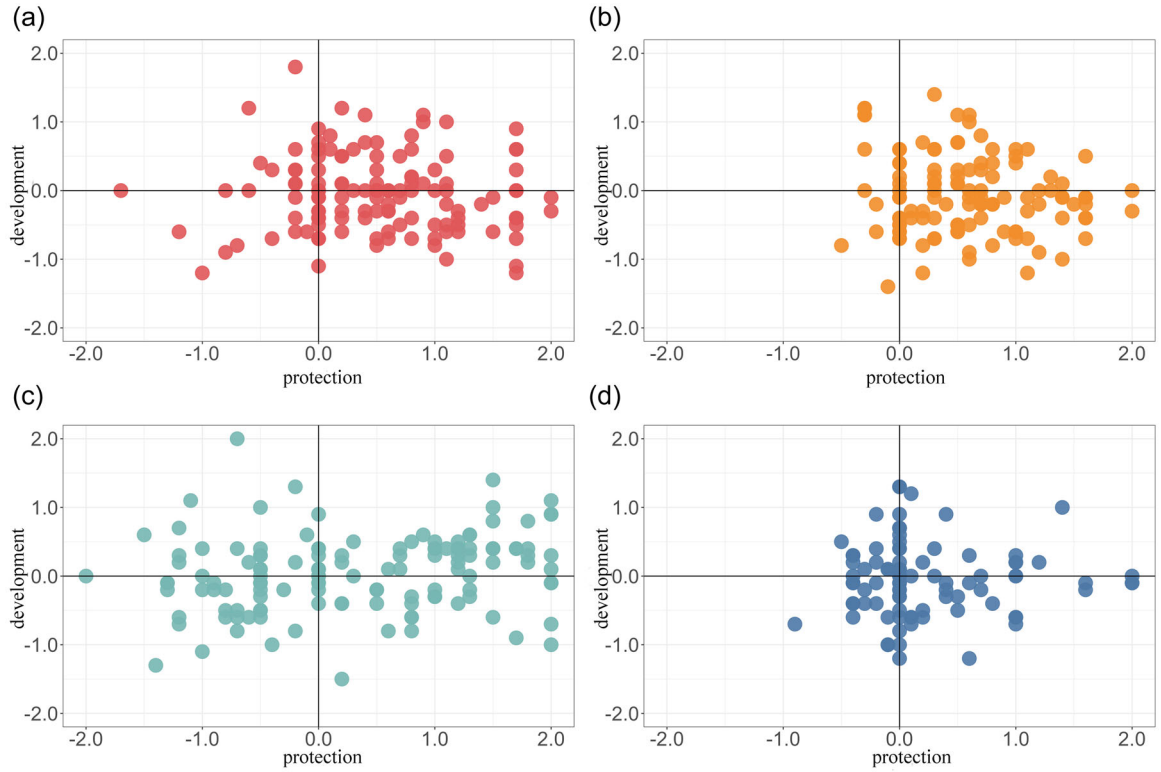

FIGURE 3 Relational characteristics between Xiaoheishan (Xhs) Nature Reserves and communities. (a) Xiaoheishan, (b) Daxueshan, (c) Guchengshan, and (d) Jiangzhongshan.

TABLE 1 Structural model results and parameters for the hypothesized model.

Area	χ^2	*df*	*p* Value	χ^2/df	GFI	AGFI	RMSEA
Xhs	15.111	11	0.177	1.374	0.973	0.912	0.054
Dxs	14.391	11	0.212	1.308	0.972	0.908	0.051
Gcs	17.660	11	0.090	1.605	0.970	0.901	0.067
Jzs	13.710	11	0.249	1.246	0.964	0.883	0.053

Abbreviation: AGFI, adjusted goodness-of-fit index; Dxs, Daxueshan; Gcs, Guchengshan; GFI, goodness-of-fit index; Jzs, Jiangzhongshan; RMSEA, root mean square error of approximation; Xhs, Xiaoheishan.

proportions of these approaches were 32%, 29%, and 24%, respectively. Only a very small number of people, 15% of the total, expressed interest in actively participating in the establishment of NRs (Supporting Information S1: Table S10).

Infrastructure construction, ecotourism, participation in NRs management, and external project support accounted for 28.7%, 22.8%, 14.2%, and 34.3% in Xhs, and 28.8%, 23.3%, 12.3%, and 35.6% in Dxs. Notably, the willingness to participate in the construction of natural reserves was the least preferred option across the four areas. The proportions in Gcs were 29.7%, 24.5%, 16.0%, and 29.7%, with the proportion of infrastructure construction the highest in the four areas. The proportions in Jzs were 27.8%, 25.9%, 15.1%, and 31.2%, respectively. The proportion of people willing to engage in ecotourism was the highest in the four areas (Figure 5 and Supporting Information S1: Table S11).

4 | DISCUSSION

4.1 | Alleviating conflicts between NRs and adjacent communities

The study revealed that more than 70% of respondents in the four areas had a positive attitude toward the Xhs NRs (Supporting Information S1: Table S12). Moreover, 97% of respondents believed that the establishment of the Xhs NRs had yielded benefits to varying extents. However, with the exception of the Gcs, where the development-coordinated type was dominant, the other three subprotected regions exhibited a protection-friendly orientation. Further analysis identified the reasons for this contradiction: First, respondents expressed dissatisfaction with the current management policies. Second, over 50% of the participants preferred an adaptable NR policy that allows them to participate in specific activities without compromising conservation goals (Supporting Information S1: Table S13).

Furthermore, it was observed that people's perception of protection is often based on practical values (Boonzaaier, 2010; Mika et al., 2019). The results showed that the communities engaged in certain activities that relied on their practical need (Supporting Information S1: Table S14). The establishment of NRs not only hindered their access to resources but wildlife destruction was also a major hindrance to their production and daily lives (Supporting Information S1: Tables S15 and S16). The emergence of contradictions between the NRs and neighboring communities occurred as a result

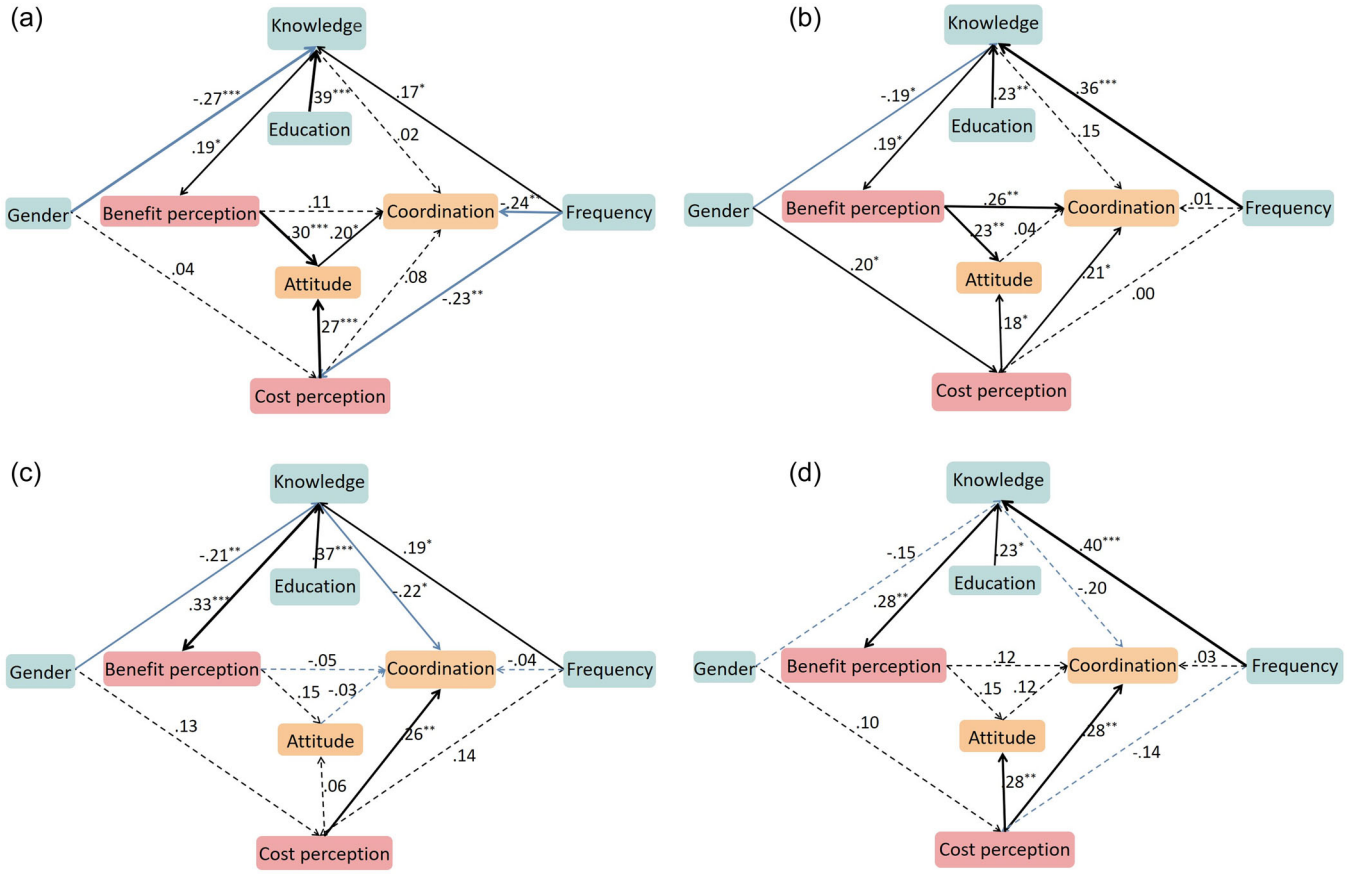

FIGURE 4 Influencing factors of coordination degree between Xiaoheishan (Xhs) Nature Reserves and communities. (a) Xiaoheishan, (b) Daxueshan, (c) Guchengshan, and (d) Jiangzhongshan. Dotted lines represent no significant relationships; black lines are positive relationships; blue lines are negative relationships. $*p<0.05$; $**p<0.01$; $***p<0.001$.

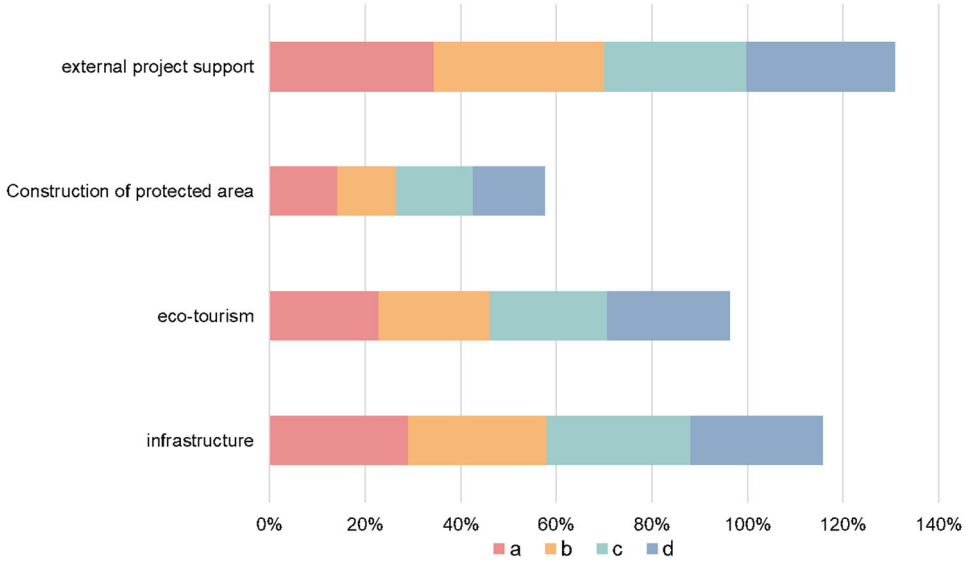

FIGURE 5 Future development model of Xiaoheishan (Xhs) Nature Reserves. (a) Xiaoheishan, (b) Daxueshan, (c) Guchengshan, and (d) Jiangzhongshan.

of the adverse effects of protected areas on local communities, primarily due to their restricted access to resources essential for their livelihoods (Soliku & Schraml, 2018). This also explains why community-friendly and conflict–competitive types account for a certain proportion of the four districts.

Ultimately, individuals might continue to illegally extract resources from parks despite having a positive attitude toward the NRs. This behavior can be attributed to the fact that they do not realize that their actions have negative consequences or because they do not have any viable alternatives

(Thapa Karki & Hubacek, 2015). The analysis pertaining to "productive and living behaviors expected to be preserved in it" revealed that activities, such as tourism, fungus picking, grazing, and plantation all accounted for a relatively high proportion (Supporting Information S1: Table S17).

4.2 | Understanding the factors that affect coordination

Based on our model, the relationship between communities' knowledge and the degree of coordination was found to be complex, exhibiting both positive and negative aspects. This meant that an increased understanding of NRs did not automatically translate into higher coordination scores. However, it should not be overlooked that increased understanding typically leads to improved perceived benefits, and these factors collectively contribute to a positive synergy. With the exception of Xhs, communities' attitudes did not significantly influence the degree of coordination, indicating that more supportive attitudes did not necessarily increase coordination scores.

There was a significant positive correlation between the education of the communities and their understanding of NRs. It was found that higher levels of education were associated with increased knowledge of the NRs, subsequently fostering a more positive attitude. This finding aligns with the research of Kaltenborn and Kideghesho (Kideghesho et al., 2007; Southern et al., 1999). There was a significant negative relationship between gender and knowledge of NRs, with men demonstrating greater awareness about NRs. This result stands in contrast to the findings of Ngonidzashe Mutanga et al. (2015). Benefit perception significantly improved attitudes. This conclusion was partly consistent with Sirivongs & Tsuchiya's research (Sirivongs & Tsuchiya, 2012), the difference being that this study showed that negative cognition could also impact attitudes.

4.3 | Coordinating the relationship between protection and development

Biodiversity conservation and poverty alleviation are two major issues in NR management in developing countries (De Pourcq et al., 2017). Community co-management emerges as a crucial process in harmonizing the objectives of protected areas conservation within community development. The lack of community capacity stands as one of the main factors restricting sustainability. However, studies have confirmed that social capital is a key factor in encouraging participation in conservation behaviors and avoiding infringement of collective interests. It has been shown to exert a significant positive influence on the conservation behaviors of rural households (Atshan et al., 2020; Dai et al., 2023). The initial poverty alleviation initiatives implemented by Xhs NRs have resulted in notable enhancements in the local infrastructure and livelihood conditions. This has made local people more inclined to support external projects in future development endeavors (Supporting Information S1: Tables S10 and S11).

Mounting evidence suggests that protected areas can address poverty through mechanisms beyond the modification of ecosystem services. A prime avenue for this is through infrastructure changes, which can be enhanced or impeded by the establishment of protected areas (Ferraro & Hanauer, 2014). Road networks are critical in this context, as they greatly affect the input, output, and consumption costs of the rural poor (Gibson & Rozelle, 2003). This explains why infrastructure construction occupies a high proportion of future models (Supporting Information S1: Tables S10 and S11). Community-based tourism aims to generate income and reduce poverty on a small scale by engaging local populations and utilizing local resources. In terms of sustainable tourism development, community tourism combines the human and natural assets of the community. This can result in long-term improvements in local living standards. Some studies (Job & Paesler, 2013) even point out that tourism can reduce poverty by more than half (Ferraro & Hanauer, 2014).

These factors explain why local communities tend to focus on external project support, infrastructure improvement, and ecotourism as models for future development. At the same time, it has been observed that the selection of some development projects in Xhs NRs lacked sufficient justification. For example, the initiative involving walnut planting failed. While these projects incurred economic losses for the farmers, they also dampened their enthusiasm. This caused the community to distrust the Xhs NRs, resulting in a generally negative attitude toward participating in the construction of the NRs (Supporting Information S1: Tables S10 and S11).

4.4 | Management implications

To achieve sustainable conservation goals, managers must recognize communities as active participants in the management process (Angwenyi et al., 2021; Than et al., 2022). First, this approach proposes that relevant departments prioritize external projects, infrastructure construction, and ecotourism initiatives as part of their future work plan to improve the quality of life of local communities (Supporting Information S1: Tables S10 and S11). Studies have confirmed that agriculture accounts for the largest proportion of poverty reduction in protected areas (Ferraro & Hanauer, 2014). Therefore, it is advisable for relevant departments to internalize some characteristics of agricultural and tourism projects as sustainable driving forces for community

development. This approach should be based on comprehensive project demonstrations and tailored to align with local conditions.

When local people express satisfaction with protection policies, the associated costs of conservation efforts tend to decrease (Bragagnolo et al., 2016; Mbise, 2022a, 2022b) (Figure 4). In this context, management agencies can cooperate with local governments to evaluate the compatibility between livelihood activities that communities want to preserve and the overarching conservation objectives. For activities deemed compatible with conservation goals, agencies may consider their retention (He & Jiao, 2023). Additionally, in response to the issue of limited community capacity (Baghai et al., 2018), some studies have proposed public-private partnerships, where governments formulate policy but empower NGOs to manage, which can provide long-term financial assistance to underfunded and under capacitated institutions.

Second, it is suggested that relevant organizations facilitate interactive group engagements to increase public awareness and knowledge (Dai et al., 2023), especially nature education (Gong et al., 2021), with the aim of enhancing communities' appreciation of the benefits of protected areas while mitigating their perception of the associated costs (Figure 4). Improving livelihoods through livelihood substitution should not be seen as a panacea for conservation success. Enhanced livelihoods can only have a positive impact when coupled with increased awareness and understanding of wildlife and conservation issues (Epanda et al., 2019).

For the content of such publicity efforts, it is crucial to emphasize the improvements to the local environment and the protection of species within the NRs. It is also important to underscore the benefits to local communities, such as the protection of water sources, water purification, and the reduction of natural disasters (Supporting Information S1: Material 1 and Table S3). Based on the information provided by the traditional household heads, it is vital to strengthen advocacy efforts among female groups (Figure 4). In terms of the mode of dissemination, when adhering to traditional text propaganda, it is important to take into account the educational background, psychological needs, and receptiveness of the local communities. The adoption of visual methods, such as promotional videos, simulated scenes, and so forth, is vital for enhancing communities' understanding of the NRs.

Third, decision-makers are encouraged to contemplate the implementation of a cumulative compensation system in light of significant losses to local communities due to destruction caused by wildlife (Figure 2 and Supporting Information S1: Table S3). First of all, decision-makers should estimate protected areas' species carrying capacity in advance and implement measures to control wild animals' spillover from the root. For species with particularly wide-ranging activities, an effective buffer zone should be established along the boundary of the protected area. This would aid in reducing wild animal damage to residents' crops and livestock.

At the same time, it is necessary to improve the processes for damage identification and compensation (Supporting Information S1: Table S18). Beyond mere economic compensation, consideration should also be given to compensation through policy support. The study found that there were a large number of cases in various areas of the Xhs NRs where damages, although not meeting established wildlife destruction standards, still resulted in losses to communities. In response, decision-makers could consider the implementation of a cumulative compensation system. Under this system, compensation could be awarded when multiple incidents surpass a specific threshold.

4.5 | Strengths and limitations

The novelty of this study lies in its provision of empirical evidence using a selection of representative indicators to clarify the relationship between NRs and adjacent communities. Specifically, it reveals that areas such as Xhs, Dxs, and Jzs present protection-oriented approach. Based on these findings, we suggest that the government first delineate the relationship between NRs and communities. Subsequently, it should consider adopting the public participation model, combined with an economic win-win approach, protection and poverty alleviation, as the future development trajectory. In addition, this study offers an empirical reference for the systematic study of the relationship between NRs and the surrounding communities. The scientific investigation begins by defining the current relationship model, followed by an in-depth analysis of the various factors that influence it. Ultimately, the study concludes by proposing a model for future development.

However, this study is subject to four major limitations that need to be addressed to continue expanding our knowledge in this field: (i) The disparity between districts needs to be further tested and analyzed. (ii) Given the education levels within the community and the year the Xhs NRs were established, we focused on household heads as the primary subjects of our interviews to gather more accurate information about pre- and post-establishment relationships between the Xhs NRs and surrounding communities. This survey method may introduce certain biases, which, while not the central focus of our study, are nonetheless unavoidable. (iii) There is a need to extensively study successful cases of the coordinated development model to build a comprehensive evaluation index system for such development. (iv) Further research is required on the scenario inspection algorithm that allows for visualization of the input results from different development patterns.

5 | CONCLUSIONS

The study aimed to evaluate the relationship and the degree of interaction between the Xhs NRs and the surrounding communities. This was accomplished through the implementation of surveys and structural equation modeling analyses. Additionally, the research investigated the factors that influence the degree of coordination among these organizations. Based on the current findings, a proposed model for future development was suggested. The results reveal that the relationship between the Xhs NRs and their respective communities is characterized primarily by a protection-oriented approach. This is particularly evident in the subprotected regions of Xhs, Dxs, and Gcs. Although the Xhs NRs did offer some employment opportunities to local communities, there was noted neglect in addressing broader community development. This oversight has subsequently led to increased tension and conflict between conservation objectives and development needs.

In future efforts toward conservation management, it is imperative to prioritize the factors influencing coordination. A central focus should be placed on improving the livelihoods of local communities. Adopting a public participation model, an economic win-win strategy, combined with protection and poverty alleviation, is recommended as the next direction for development. Before any future studies on NRs and surrounding communities, a clear understanding of their interrelationship is vital for addressing issues in a targeted way. Despite some methodological limitations, this study has demonstrated that the traditional conservation model, which compromises community development, is not sustainable. Ensuring comprehensive engagement of local residents is essential for sustainable management of the Xhs NRs. For smaller and more dispersed NRs, or those lacking community capacity, fostering public participation is advised as the optimal approach for achieving coordinated development in the future.

AUTHOR CONTRIBUTIONS

Xueyan Guo: Conceptualization; Data curation; investigation; methodology; software; writing—original draft. **Zhongde Huang:** Investigation; methodology; writing—review and editing. **Yang Bai:** Conceptualization; writing-review and editing; supervision. **Yiwei Lian:** Investigation. **Wei Yang:** Investigation. **Xinyao Lu:** Investigation. **Wei Shi:** Investigation. **Naiju Wu:** Investigation. **Maroof Ali Turi:** Writing—review and editing.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

Data are available on request from the authors.

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REFERENCES

Abukari, H. & Mwalyosi, R.B. (2018) Comparing conservation attitudes of park-adjacent communities: the case of Mole National park in Ghana and Tarangire National Park in Tanzania. *Tropical Conservation Science*, 11, 1–14.

Abukari, H. & Mwalyosi, R.B. (2020) Local communities' perceptions about the impact of protected areas on livelihoods and community development. *Global Ecology and Conservation*, 22, e00909.

Academy of Ocean of China. (2021) *"Protect the earth report" reveals the status of protected areas and reserves around the world [EB]*. http://aoc.ouc.edu.cn/2021/0531/c9829a325117/page.htm

Ajzen, I. (1980) *Understanding attitudes and predicting social behavior*. Englewood Cliffs, NJ: Prentice-Hall, pp. 249–259.

Allendorf, T.D. (2020) A global summary of local residents' attitudes toward protected areas. *Human Ecology*, 48(1), 111–118.

Allendorf, T.D. & Yang, J.M. (2013a) The role of ecosystem services in park–people relationships: the case of Gaoligongshan Nature Reserve in southwest China. *Biological Conservation*, 167, 187–193.

Allendorf, T.D. & Yang, J.M. (2013b) The role of ecosystem services in park–people relationship: the case of Gaoligongshan Nature Reserves in Southwest China. *Biological Conservation*, 167, 187–193.

Allendorf, T.D. & Yang, J.M. (2015) The role of gender in local residents' relationships with Gaoligongshan Nature Reserves, Yunnan, China. *Environment Development and Sutainability*, 167, 187–193.

Angwenyi, D., Potgieter, M. & Gambiza, J. (2021) Community perceptions towards nature conservation in the eastern cape province, South Africa. *Nature Conservation*, 43, 41–53.

Atshan, S., Bixier, R., Ral, V. & Springer, D. (2020) Pathways to urban sustainability through individual behaviors: the role of social capital. *Environmental Science and Policy*, 112, 330–339.

Auliz-Ortiz, D.M., Arroyo-Rodríguez, V., Mendoza, E. & Martínez-Ramos, M. (2022) Conservation of forest cover in Mesoamerican biosphere reserves is associated with the increase of local non-farm occupation. *Perspectives in Ecology and Conservation*, 20(3), 286–293.

Baghai, M., Miller, J.R.B., Blanken, L.J., Dublin, H.T., Fitzgerald, K.H., Gandiwa, P. et al. (2018) Models for the collaborative management of Africa's protected areas. *Biological Conservation*, 218, 73–82.

Bai, Y., Fang, Z. & Hughes, A.C. (2021) Ecological redlines provide a mechanism to maximize conservation gains in Mainland Southeast Asia. *One Earth*, 4(10), 1491–1504.

Bennett, N.J. & Dearden, P. (2014) Why local people do not support conservation: community perceptions of marine protected area livelihood impacts, governance and management in Thailand. *Marine Policy*, 44, 107–116.

Boonzaaier, C. (2010) Rural people's perceptions of wildlife conservation—the case of the Masebe Nature Reserve in Limpopo Province, South Africa. *Anthropology Southern Africa*, 33(1–2), 55–64.

Bragagnolo, C., Malhado, A.M., Jepson, P. & Ladle, R. (2016) Modelling local attitudes to protected areas in developing countries. *Conservation and Society*, 14(3), 163–182.

Buckley, R.C. (2016) Triage approaches send adverse political signals for conservation. *Frontiers in Ecology and Evolution*, 4(39), 1–5.

Buijs, A., Hansen, R., Van der Jagt, S. & Ambrose-Oji, B. (2019) Mosaic governance for urban green infrastructure: upscaling active citizenship from a local government perspective. *Urban Forestry & Urban Greening*, 40, 53–62.

Buijs, A., Kamphorst, D., Mattijssen, T., van Dam, R., Kuindersma, W. & Bouwma, I. (2022) Policy discourses for reconnecting nature with society: the search for societal engagement in Dutch nature conservation policies. *Land Use Policy*, 114, 105965.

Chaplin, G. (2005) Physical geography of the Gaoligong Shan area of southwest China in relation to biodiversity. *Proceedings of the California Academy of Sciences*, 56(27/37), 527.

Cobbinah, P.B., Black, R. & Thwaites, R. (2015) Biodiversity conservation and livelihoods in rural Ghana: impacts and coping strategies. *Environmental Development*, 15, 79–93.

Constant, N.L. & Bell, S. (2017) Governance, participation and local perceptions of protected areas: unwinding traumatic nature in the Blouberg Mountain Range. *Environmental Values*, 26(5), 539–559.

Dai, J., Chen, J., Luo, Z. & Zhou, W. (2023) Coping with giant panda protection dilemmas in China: social capital's role in forest conservation. *Global Ecology and Conservation*, 42, 1–14.

Diakoulaki, D., Mavrotas, G. & Papayannakis, L. (1995) Determining objective weights in multiple criteria problems: the critic method. *Computers & Operations Research*, 22(7), 763–770.

Epanda, M., Mukam Fotsing, A., Bacha, T., Frynta, D., Lens, L., Tchouamo, I. et al. (2019) Linking local people's perception of wildlife and conservation to livelihood and poaching alleviation: a case study of the Dja biosphere reserve, Cameroon. *Acta Oecologica*, 97, 42–48.

Farkas, J.Z. & Kovács, A.D. (2021) Nature conservation versus agriculture in the light of socio-economic changes over the last half-century—case study from a Hungarian national park. *Land Use Policy*, 101, 105131.

Ferraro, P.J. & Hanauer, M.M. (2014) Quantifying causal mechanisms to determine how protected areas affect poverty through changes in ecosystem services and infrastructure. *Proceedings of the National Academy of Sciences of the United States of America*, 111(11), 4332–4337.

Fors, H., Molin, J.F., Murphy, M.A. & van den Bosch, C.K. (2015) User participation in urban green spaces—for the people or the parks? *Urban Forestry & Urban Greening*, 14(3), 722–734.

Frantzeskaki, N. & Kabisch, N. (2016) Designing a knowledge co-production operating space for urban environmental governance—lessons from Rotterdam, Netherlands and Berlin, Germany. *Environmental Science & Policy*, 62, 90–98.

Gerten, D., Heck, V., Jägermeyr, J., Bodirsky, B.L., Fetzer, I., Jalava, M. et al. (2020) Feeding ten billion people is possible within four terrestrial planetary boundaries. *Nature Sustainability*, 3(3), 200–208.

Gibson, J. & Rozelle, S. (2003) Poverty and access to roads in Papua New Guinea. *Economic Development and Cultural Change*, 52(1), 159–185.

Gong, Y., Li, Y., Zhang, L. & Sun, Y. (2021) Informal learning in nature education promotes ecological conservation behaviors of nature reserve employees—a preliminary study in China. *Global Ecology and Conservation*, 31, 1–10.

He, J. & Jiao, W. (2023) Conservation-compatible livelihoods: an approach to rural development in protected areas of developing countries. *Environmental Development*, 45, 1–14.

Hinojosa, L., Lambin, E.F., Mzoughi, N. & Napoléone, C. (2018) Constraints to farming in the Mediterranean Alps: reconciling environmental and agricultural policies. *Land Use Policy*, 75, 726–733.

Job, H. & Paesler, F. (2013) Links between nature-based tourism, protected areas, poverty alleviation and crises—the example of Wasini Island (Kenya). *Journal of Outdoor Recreation and Tourism*, 1–2, 18–28.

Kideghesho, J., Røskaft, E. & Kaltenborn, B. (2007) Factors influencing conservation attitudes of local people in Western Serengeti, Tanzania. *Biodiversity and Conservation*, 16(7), 2213–2230.

Kujala, H., Maron, M., Kennedy, C.M., Evans, M.C., Bull, J.W., Wintle, B.A. et al. (2022) Credible biodiversity offsetting needs public national registers to confirm no net loss. *One Earth*, 5(6), 650–662.

Larson, L., Conway, A., Hernandez, S. & Carroll, J. (2016) Human–wildlife conflict, conservation attitudes, and a potential role for citizen science in Sierra Leone, Africa. *Conservation and Society*, 14(3), 205–217.

Liang, J. & Bentler, P.M. (2004) An EM algorithm for fitting two-level structural equation models. *Psychometrika*, 69, 101–122.

Ma, B. & Wen, Y. (2016) Impact of ecotourism management on rural households' income: based on propensity score matching method. *China Population, Resources and Environment*, 26(10), 152–160.

Mariyam, D., Puri, M., Harihar, A. & Karanth, K.K. (2021) Benefits beyond borders: assessing landowner willingness-to-accept incentives for conservation outside protected areas. *Frontiers in Ecology and Evolution*, 9, 1–11.

Martynova, E., West, S.G. & Liu, Y. (2018) Review of principles and practice of structural equation modeling. *Structural Equation Modeling: A Multidisciplinary Journal*, 25(2), 325–329.

Matema, S. & Andersson, J.A. (2015) Why are lions killing us? Human–wildlife conflict and social discontent in Mbire District, northern Zimbabwe. *The Journal of Modern African Studies*, 53(1), 93–120.

Mavah, G.A., Funk, S.M., Child, B., Swisher, M.E., Nasi, R. & Fa, J.E. (2018) Food and livelihoods in park-adjacent communities: the case of the Odzala Kokoua National Park. *Biological Conservation*, 222, 44–51.

Maxwell, S.L., Cazalis, V., Dudley, N., Hoffmann, M., Rodrigues, A.S.L., Stolton, S. et al. (2020) Area-based conservation in the twenty-first century. *Nature*, 586(7828), 217–227.

Mbise, F.P. (2022a) Coexistence with large carnivores in relation to livestock depredation in the Eastern Serengeti Ecosystem, Tanzania. *Human Ecology*, 50, 1143–1147.

Mbise, F.P. (2022b) Perspective chapter: a perspective on the resettlement of Maasai communities from the Ngorongoro Landscape in Tanzania. New Insights into Protected Area Management and Conservation Biology, pp. 1–14.

Mika, M., Zawilińska, B. & Kubal-Czerwińska, M. (2019) Exploring the determinants of local people's attitude towards national parks in Poland. *Folia Geographica*, 61(1), 5–16.

Nagendra, H. & Ostrom, E. (2012) Polycentric governance of multifunctional forested landscapes. *International Journal of the Commons*, 6(2), 104–113.

Narain, D., Teo, H.C., Lechner, A.M., Watson, J.E.M. & Maron, M. (2022) Biodiversity risks and safeguards of China's hydropower financing in Belt and Road Initiative (BRI) countries. *One Earth*, 5(9), 1019–1029.

Ngonidzashe Mutanga, C., Vengesayi, S., Gandiwa, E. & Muboko, N. (2015) Community perceptions of wildlife conservation and tourism: a case study of communities adjacent to four protected areas in Zimbabwe. *Tropical Conservation Science*, 8(2), 564–582.

Nyumba, T.O., Emenye, O.E. & Leader-Williams, N. (2020) Assessing impacts of human-elephant conflict on human wellbeing: an empirical analysis of communities living with elephants around Maasai Mara National Reserve in Kenya. *PLoS One*, 15(9), e0239545.

De Pourcq, K., Thomas, E., Arts, B., Vranckx, A., Léon-Sicard, T. & Van Damme, P. (2017) Understanding and resolving conflict

between local communities and conservation authorities in Colombia. *World Development*, 93, 125–135.
Resende, F.M., Cimon-Morin, J., Poulin, M., Meyer, L., Joner, D.C. & Loyola, R. (2021) The importance of protected areas and indigenous lands in securing ecosystem services and biodiversity in the Cerrado. *Ecosystem Services*, 49, 101282.
Sampson, C., Rodriguez, S.L., Leimgruber, P., Huang, Q. & Tonkyn, D. (2021) A quantitative assessment of the indirect impacts of human–elephant conflict. *PLoS One*, 16(7), e0253784.
Shyamsundar, P., Sauls, L.A., Cheek, J.Z., Sullivan-Wiley, K., Erbaugh, J.T. & Krishnapriya, P.P. (2021) Global forces of change: implications for forest-poverty dynamics. *Forest Policy and Economics*, 133, 102607.
Sirivongs, K. & Tsuchiya, T. (2012) Relationship between local residents' perceptions, attitudes and participation towards national protected areas: a case study of Phou Khao Khouay National Protected Area, central Lao PDR. *Forest Policy and Economics*, 21, 92–100.
Soliku, O. & Schraml, U. (2018) Making sense of protected area conflicts and management approaches: a review of causes, contexts and conflict management strategies. *Biological Conservation*, 222, 136–145.
Southern, I., Author, N., Kaltenborn, B., Riese, H. & Hundeide, M. (1999) National park planning and local participation: some reflections from a mountain region. *International Mountain Society*, 51–61.
Subakanya, M., Tembo, G. & Richardson, R. (2018a) Land use planning and wildlife-inflicted crop damage in Zambia. *Environments*, 5(10), 110.
Subakanya, M., Tembo, G. & Richardson, R. (2018b) Land use planning and wildlife-inflicted crop damage in Zambia. *Environments*, 5(10), 110.
Than, K.Z., Zaw, Z. & Hughes, A.C. (2022) Integrating local perspectives into conservation could facilitate human–crocodile coexistence in the Ayeyarwady Delta, Myanmar. *Oryx*, 56(1), 82–90.
Thapa Karki, S. & Hubacek, K. (2015) Developing a conceptual framework for the attitude-intention-behaviour links driving illegal resource extraction in Bardia National Park, Nepal. *Ecological Economics*, 117, 129–139.
Tollefson, J. (2020) Why deforestation and extinctions make pandemics more likely. *Nature*, 584(7820), 175–176.
Xu, L., Xu, W., Jiang, C., Dai, H., Sun, Q., Cheng, K. et al. (2022) Evaluating communities' willingness to participate in ecosystem conservation in Southeast Tibetan Nature Reserves, China. *Land*, 11(2), 207.
Yang, C., Zeng, W., & Yang, X. (2020) Coupling coordination evaluation and sustainable development pattern of geo-ecological environment and urbanization in Chongqing municipality, China. *Sustainable Cities and Society*, 61, 1–19.
Zimmermann, A., McQuinn, B. & Macdonald, D.W. (2020) Levels of conflict over wildlife: understanding and addressing the right problem. *Conservation Science and Practice*, 2(10), e259.

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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