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Exploring the relationship between local participation and perceived Co-management performance: Evidence from China's Giant Panda National Park

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ABSTRACT

Understanding local perceptions is essential to ensure the good functioning of co-management in protected areas (PAs). However, more research is required quantitatively to assess the extent locals are empowered. This paper seeks to investigate the effects of varied participation types and levels on perceived performance in a centralized co-management regime in Giant Panda National Park, China. Using 353 survey questionnaires, we identified six co-management subtypes that were classified into four empowerment levels: instruction, consultation, agreement, and cooperation. Notably, our analysis suggests that involvement at the cooperation level was not clearly linked with more favorable local perceptions of conservation. In contrast, local residents engaged in the instruction level of co-management (support, training, and employment subtypes) were more inclined to develop positive perceptions across the ecological, social, and livelihood dimensions. This study suggests the conclusion that merely empowering locals might not facilitate favorable perceptions of conservation. Instruction co-management intended to enhance social well-being if it is tailored to the needs of local residents.

1. Introduction

Governing PAs based on top-down and centralized government interventions has often been proven to be inadequate in safeguarding conservation success (Gelcich et al., 2009). One prominent flaw of this approach is that it overlooks the benefits to the most economically disadvantaged communities, thereby generating a locally uneven distribution of PA-related socioeconomic impact (Brockington et al., 2006; Berkes, 2009). Consequently, hostile attitudes and anti-conservation activities (e.g., poaching, logging, and agricultural encroachment) among locals could be triggered, jeopardizing biological goals by heightening conflicts between PA managers and adjacent communities (Lane, 2001). Conversely, much evidence has shown that PAs with meaningful and effective participation are more likely to deliver positive biodiversity and livelihood outcomes (Plummer & FitzGibbon, 2004; Plummer & Armitage, 2007; Andrade & Rhodes, 2012; De Vente et al., 2016; Oldekop et al., 2016).

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To reduce such adverse social effects, recent decades have witnessed a global shift toward a more participatory PA governance approach, and more bottom-up collaborative endeavors, which more extensively engage people living in and around PAs (Berkes, 2004; Armitage et al., 2010; Kimengsi et al., 2019). The emphasis has been on more co-management paradigm, which refers to the formal sharing of accountabilities, responsibilities, and benefits among the state, local resource users, and other stakeholders in cooperatively governing PAs (Carlsson and Berkes, 2005; Borrini-Feyerabend et al., 2007). This innovative co-governance system seeks to fuse two typically opposing objectives, biological conservation and local livelihood development. It is regarded by many as an indispensable instrument to replace the conventional command-and-control conservation model (Gelcich et al., 2009; Kimengsi et al., 2019). Under these circumstances, it has become increasingly important to understand the current status and prospective potential of co-management policies to deliver better conservation outcomes. (Borrini-Feyerabend et al., 2012; Ward et al., 2018; Zhang et al., 2020). Participation is complex; its level, channel, and forms vary from here to there (Stringer et al., 2006). Participation can range from brief consultations to full involvement in the daily decision-making process (Sterling et al., 2017). However, participation can also be problematic if not properly managed, the disadvantages of which include increased time and costs for decision-making, the risk of elite capture, and the potential for conflict among different stakeholders (Persha and Andersson, 2014; Sterling et al., 2017; Ward et al., 2018). Perceived or actual shortcomings in participation can impede the achievement of socioeconomic and biological goals for PAs.

Over the last two decades, our theoretical understanding of participation in conservation has been grown (Berkes, 2004; Plummer and FitzGibbon, 2004; Plummer and Armitage, 2007), more studies of practices have been assembled (Evans et al., 2011; Cinner et al., 2012; Brooks et al., 2013), and performance of cases have been evaluated (Plummer and Armitage, 2007; Oldekop et al., 2016). Nevertheless, we need more insights into the consequences of participation in conservation for rural communities (De Vente et al., 2016). Can higher empowerment levels facilitate more favorable performance? Are less empowering co-management arrangements likely to generate more local resistance and negative judgment? Will the variation in co-management engagement amongst local dwellers contribute to diversified outcomes?. Previous studies suggested that local communities are more likely to be satisfied with co-management policies when their knowledge and opinions are incorporated into the PA decision-making process (Andrade and Rhodes, 2012). However, higher levels of frustration and discontent have been documented among active participants and forest officials in joint forest management programs (Laval, 2008; Islam et al., 2019). Despite these studies we need more insights into how to achieve better perceptions by fostering local participation (Nunan et al., 2012; Franco-Meléndez et al., 2021).

Measuring people's views instead of solely emphasizing more distant indicators is critical for safeguarding conservation success (Bennett, 2016). Perceptions are important in assessing judgements of fairness (Pascual et al., 2014), evaluating local well-being (Cuya et al., 2021), and understanding conservation attitudes (J. He and Wei, 2022; S. He and Wei, 2022). Perceptions are effective in assessing co-management performance, and perceptions should be carefully considered when formulating or implementing relevant policies (Gelcich et al., 2005; Evans et al., 2011; Enengel et al., 2014; Ward et al., 2018; Islam et al., 2019). The most frequently used framework to assess co-management performance was introduced by Plummer and Armitage (2007), who proposed ecology, economics, and society as the three basic dimensions for evaluating its outcomes. This classification approach was widely adopted in later researches conducted by Uddin et al. (2007), Evans et al. (2011), Bong et al. (2019), and Kovács et al. (2021). In this study, we evaluated local residents' perceptions toward the ecological, economic, and social outcomes of co-management and investigated how participation type and level shapes perception. The results of this study may contribute to the promotion of existing co-management policies (Islam et al., 2019).

We specifically addressed this question by conducting a quantitative survey in a top-down co-management regime of a national park in China. The aims of this study were to (1) understand locals' perceptions of performances by a centralized co-management regime, (2) statistically measure the consequences of participation types and levels, and (3) assess the impact of participation variation on perceived ecological, economic, and social performances. We hope that these analyses will inform related policy development intended at incorporating or prioritizing co-management policies.

2. Materials and methods

2.1. Conceptual approach

As co-management of protected areas (PAs) is premised on partial devolution to local communities, it is essential to consider the extent to which local residents are empowered by such collaborative arrangements (Ballet et al., 2009). The variety of empowerment represented in numerous participatory attempts reflects the relationship between the state and local actors (Carlsson and Berkes, 2005). In some instances, co-management has been viewed as a new form of tyranny, especially in cases where conservation authorities only symbolically operate community-based efforts or allow local elites to monopolize power that should be shared (Cooke and Kothari, 2001). In other instances, when this decentralization process occurs, co-management can act as a catalyst for social change in PAs (Lund et al., 2018).

To address such complexities, a substantial body of literature sheds light on the division of conservation accountability between the state and local resource users (Sen and Nielsen, 1996; Sandström and Widmark et al., 2007). Agarwal (2001) proposed a tool for evaluating six participatory behaviors in community forestry, ranging from nominal to interactive (empowering) participation. Andrade and Rhodes (2012) proposed a framework for identifying three principal subcategories of local participation: included, partially included, and excluded. In the context of PAs, the International Union for Conservation of Nature (IUCN) has declared five empowerment levels in this co-governance continuum: instruction, consultation, agreement, cooperation, and empowerment, as depicted in Fig. 1 (Borrini-Feyerabend et al., 2007; Borrini-Feyerabend et al., 2013). In this study, we adopted the latter framework to

shed light on the co-management typology of China's newly established national parks (Zhang and Yang, 2021).

2.2. Study site

As a developing megadiverse country, China has established more than 11,800 PAs, covering more than 18 % of its total land area (State Forestry and Grassland Administration, 2019). However, intensified conflicts between park authorities and locals have ensued, undermining the performance of rigid top-down PA management systems (Xu et al., 2017, 2019). In China, as in many other developing countries, no economic incentives have been provided to local residents to compensate for the prohibition of utilizing natural resources in PAs. Faced with these challenges, co-management has been piloted in several national nature reserves since the early 1990 s, when the Global Environment Facility, International Crane Foundation, and other international non-governmental organizations imported the co-governance notion (Zhang and Yang, 2019). The year 2006 witnessed the introduction of the Conservation Steward Program by Conservation International, which served as an updated model for community-based conservation in China. Mutual agreements between conservation authorities and local communities were consequently reached, and economic incentives were provided by the government in exchange for pro-environmental behaviors by locals (Zhang and Yang, 2021). In 2017, the emphasis on establishing community-based co-management was reinforced in the *Overall Plan for Constructing China's National Park System*, after which 11 pilot national parks began publicizing their own adaptive co-management mechanisms (S. He and Zhou, 2022; J. He and Zhou, 2022). This major co-management policy is still being implemented, but little is known about how this devolution process affects people's perceived performance and the extent to which locals should be empowered (Zhang and Yang, 2021). Therefore, studies are needed to fill this gap and inform future co-management policies.

In this study, we focused on a newly established national park in southwestern China, the Giant Panda National Park (GPNP). This PA was recognized as one of 11 pilot national parks in 2016, with the intention of improving connectivity between isolated habitat of the giant panda (*Ailuropoda melanoleuca*) (Huang et al., 2020). After a 5-year pilot period, the GPNP was officially established by consolidating 81 existing individual protected areas in 2021, covering an area of 27,134 km^2 in total (Yang et al., 2020). One of the major challenges for the GPNP is the exceedingly large local human population currently residing inside or surrounding the park. Most adjacent local residents make a living that is heavily dependent on forest resource extraction (e.g., harvesting of bamboo shoots and medicinal herbs), imposing pressure on the conservation of the giant panda habitat (Lan, 2020).

Three communities (Luoyigou, Yinping, and Dongqiao Village) were selected as our case study in the Tangjiahe area of GPNP, as presented in Fig. 2. This area belongs to a subregion of the GPNP with prominent park-people conflicts, covering an estimated 400 km^2 and providing homes for roughly 9500 forest-dependent residents. Before the establishment of the GPNP, a co-management approach was launched in the 1970 s. The past 40 years have witnessed numerous experiments by the Tangjiahe Area Authority (TAA) to collaborate with adjacent residents, including setting up community-based co-management committees, formulating wildlife conflict compensation programs, supporting community-based tourism, recruiting local rangers, and creating community cooperatives (Yang, 2022).

Based on pre-field studies, the three selected villages were judged to effectively represent the 40-year co-management endeavors surrounding the Tangjiahe region.

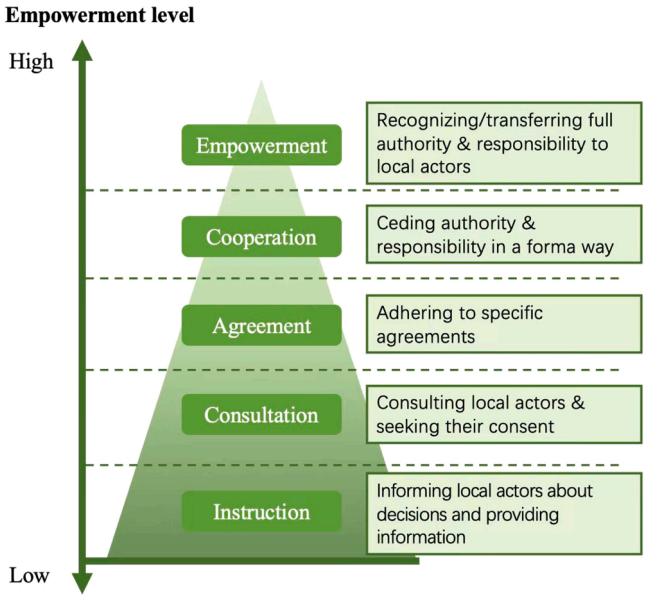

Fig. 1. The five empowerment levels of co-management declared by the International Union for Conservation of Nature (IUCN), adapted from Borrini-Feyerabend et al. (2013).

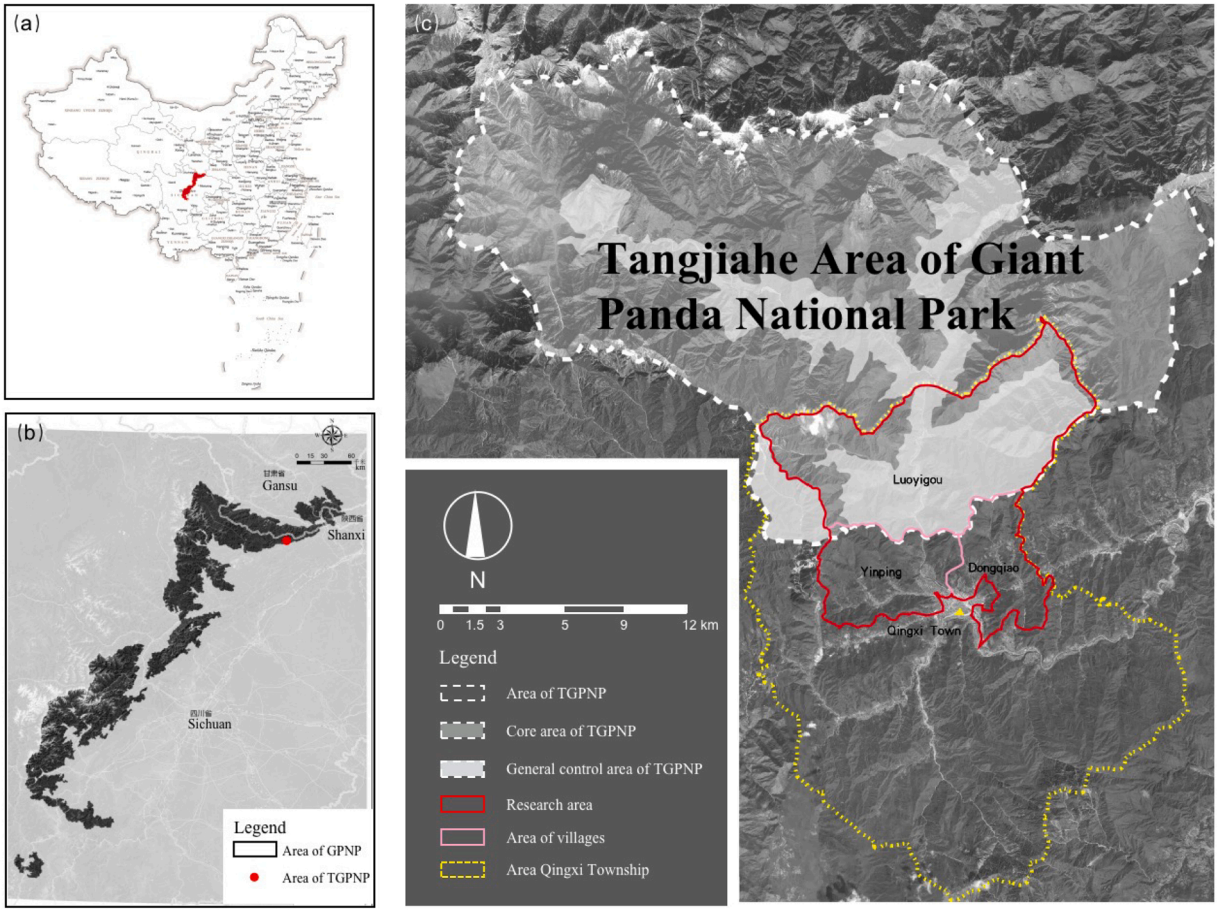

Fig. 2. Map of the Tangjiahe area of the Giant Panda National Park (TGPNP): (a) location of GPNP in China, adapted from http://bzdt.ch.mnr.gov.cn; (b) location of TGPNP, adapted from the Overall Planning of Tangjiahe Area of Giant Panda National Park; (c) location of the TGPNP and surveyed villages.

Luoyigou Village, the sole community residing inside the PA with severe human–wildlife conflicts, was bestowed with the most abundant co-management support by the TAA (Chen et al., 2022).

In contrast, tourism-based businesses in Yinping Village have gained popularity in the last two decades, providing family inns and restaurants with substantial tourism-based benefits.

Dongqiao Village, on the other hand, could be viewed as an ordinary agriculture-based village in proximity to the Tangjiahe area,

Table 1
Surveyed co-management activities in Giant Panda National Park.

Co-management typology	Activities	Survey questions
Instruction	Infrastructure building	I participated in the energy transformation and other facilities renovation projects initiated by ATA.
	Capacity training	I was engaged in the skills training and industry support organized by ATA.
	Nature education	I was involved in environmental educational programs provided by ATA.
	Forest Patrolling	I was engaged in forest patrolling of GPNP.
Consultation	Access to information	I could easily obtain information on co-management policies of GPNP.
	Co-management meetings	I have attended community-based co-management meetings.
	Consultation for policy making	I was involved in consultation of community planning and policy making in GPNP.
Agreement	Fire prevention agreement	I signed fire prevention or human–wildlife compensation agreements with TAA.
	Co-management agreement	I signed a community-basedta co-management agreement with TAA.
	Benefit sharing	I have shared benefits with TAA in bee farming or other cooperatives.
Cooperation	Enacting conservation rules	I was involved in formulating conservation rules with TAA.
	Formal accountability	I have accountabilities for some conservation affairs.

which shared a joint forest ranging system with TAA and, consequently, some agricultural assistance (Chen et al., 2022; Yang, 2022).

All of these villages displayed varied co-management attempts, allowing us to fully explore the potential impact of co-management on perceived performance. Another key consideration is that the overall empowerment level of the Tangjiahe area remains rather limited despite the widespread acknowledgement of co-management, showing the great representativeness of the co-management regime in a centralized PA stewardship (Chen et al., 2022).

2.3. Data collection

This study presents the findings of a quantitative survey in the Tangjiahe area of the GPNP in China, following three steps. First, prior to the survey design, a preliminary survey was conducted from July 26 to July 28, 2017, during which five semi-structured interviews were conducted with TAA staff and village leaders. We also collected co-management plans and annual reports from the TAA to understand the overall community-based strategies in the Tangjiahe area. Through repeated discussions with the TAA staff and consultations with village leaders, we identified 12 co-management activities involving a considerable percentage of local residents, as listed in Table 1.

Second, we developed a questionnaire based on the preliminary survey results, including the following three sections: (1) demographic characteristics, including gender, age, education, village, family size, and income source (Table S1); (2) frequency of involvement in twelve co-management activities, ranging from "never" to "always;" and (3) perceived performances in ecological, economic, and social aspects, measured by a five-point Likert scale: 1, strongly disagree; 2, somewhat disagree; 3, neither agree nor disagree; 4, somewhat agree; and 5, strongly agree. The indices of perceived performance were selected from the framework devised by Plummer and Armitage (2007) and revised based on the studies of Bong et al. (2019), Kovács et al. (2021), Chen et al. (2022), and Yang (2022), as shown in Table 2. The questionnaire was initially developed in Chinese and then translated into English for in this manuscript. Fieldwork was conducted from June 29 to July 6, 2022, and 353 questionnaires were distributed. After eliminating 49 invalid questionnaires, the valid sample reached 304, with an effective return rate of 86.1 %.

Further to understand the underlying mechanisms of participation levels on perceived performance, we arranged two forums with the Community Office and Conservation Office of the TAA, the responsibilities of which included arranging co-management affairs and recruiting local rangers, respectively. In addition, we undertook 17 in-depth interviews with community leaders, town government cadres, family hotel owners, hotel attendants, co-management committee members, rangers, older adults, and other local residents.

2.4. Data analyses

Demographics and co-management activity frequencies were first calculated to explore the overall status of co-management participation and activities. After checking the reliability (overall Cronbach's alpha coefficient = 0.830) and validity (Kaiser–Meyer–Olkin [KMO] test = 0.781, $p < 0.01$) of the standardized survey data, a principal component analysis (PCA) with varimax rotation was conducted as the first step to reduce the dimensions of the sub-criteria and categorize the participation types and levels of co-management. Second, we tested the correlations between pairs of six co-management types and twelve demographic features (including gender, age, education, village, residency years, household size, household income, and five types of income sources). After excluding ten correlated predictors with a significance of less than 0.05, eight variables (employment, training, support, consultation, agreement, and cooperation co-management as well as gender and residency years) remained as potential influencing factors . These variables include six co-management subtypes, gender and residency years. Four multiple linear regression (MLR) analyses were conducted to investigate the determinants of the ecological, economic, and social factors and comprehensive performance. All MLR analyses passed the multicollinearity diagnostics, with a variance inflation factor less than 2, indicating the suitability of conducting regression analysis. All data analyses were performed using SPSS software.

Table 2
Indicators of co-management performance in GPNP.

Category	Attribute	Survey questions
Ecological performance	Ecosystem conservation (EP1)	The enforcement of co-management policies has achieved positive outcomes in ecosystem conservation.
	Wildlife conservation (EP2)	The wildlife habitat was better conserved after the implementation of co-management.
	Resource protection (EP3)	Success in natural resource (e.g., rivers, air, and geology) conservation have been achieved by enforcing co-management arrangements.
Social performance	Conservation identity (SP1)	Participation in co-management has increased my sense of identity and pride.
	Conservation willingness (SP2)	Participation in co-management has enhanced my willingness to conserve the GPNP.
	Conservation capacity (SP3)	Involvement in co-management has improved my abilities in conservation affairs.
Livelihood performance	Compensation availability (LP1)	I am satisfied with the financial compensation scheme provided by TAA.
	Income enhancement (LP2)	The co-management arrangements assisted me in increasing my income.
	Employment opportunities (LP3)	I have fair access to employment opportunities provided by TAA.

3. Results

3.1. Demographic profile of respondents

A total of 304 responses were analyzed, of which 47 % were from male and 53 % were from female (Table S2). Most respondents were middle-aged or older, with 84 % aged > 40 years. The overall level of education among respondents was low; most (64 %) had not attended school or completed primary school, and only 12 respondents (4 %) had an undergraduate degree. The majority of respondents (88 %) reported that they had lived in their village for more than 20 years, and a considerable proportion (64 %) had a family size of four to six people. Many respondents (41 %) made a living by farming or animal husbandry, and domestic and migratory work were also recognized as main income sources, accounting for 21 % and 32 % of the total, respectively.

3.2. Description of residents' participation and perceived performances

Among respondents, the most frequent co-management activity was infrastructure building, as nearly all respondents (99 %) reported being involved at least once (Fig. 3, Table S3). In contrast, the least universal activity was a co-management agreement, as an estimated 90 % of the respondents stated that they had never signed an agreement with the TAA. In addition, a majority of the respondents declared that they had never accessed co-management meetings (78 %), policymaking consultation committees (79.93 %), or other information sources for the PA (71 %). Notably, formal accountability sharing with locals was not scarce because over 50 % of the respondents indicated that they had participated in enacting conservation rules or formal conservation responsibilities. Comparing participation in co-management activities among the three surveyed villages, it was evident that the participation rate for Luoyigou was substantially, higher than those for Yinping and Dongqiao, as shown in Fig. 4 (Table S4).

Each performance type was calculated using the average scores of the indicators in the study. For example, the ecological performance score was measured using the mean values of ecosystem conservation (EP1), wildlife conservation (EP2), and resource protection (EP3). Comprehensive performance was further determined using the average score of all the measured indices. The scores for perceived performance were then reclassified into four categories: 1–2, very negative; 2–3, somewhat negative; 3–4, somewhat positive; 4–5, very positive, as shown in Table 3. Local residents generally perceived the ecological performance of co-management (mean = 4.27, SD = 0.56) as very positive, followed by their view of social performance (mean = 3.45, SD = 0.76) as somewhat positive. By contrast, the overall perception of economic performance was somewhat negative (mean = 2.66, SD = 0.83). Among all the performance indicators, locals generally reported very positive perceptions of the co-management of wildlife conservation (mean = 4.45, SD = 0.62). However, residents overwhelmingly expressed somewhat negative perceptions of the financial compensation provided by the co-management schemes (mean = 2.44, SD = 1.11). Meanwhile, limited differences in ecological, economic, and social performances were detected across the three surveyed villages, as presented in Fig. 5 (Table S5).

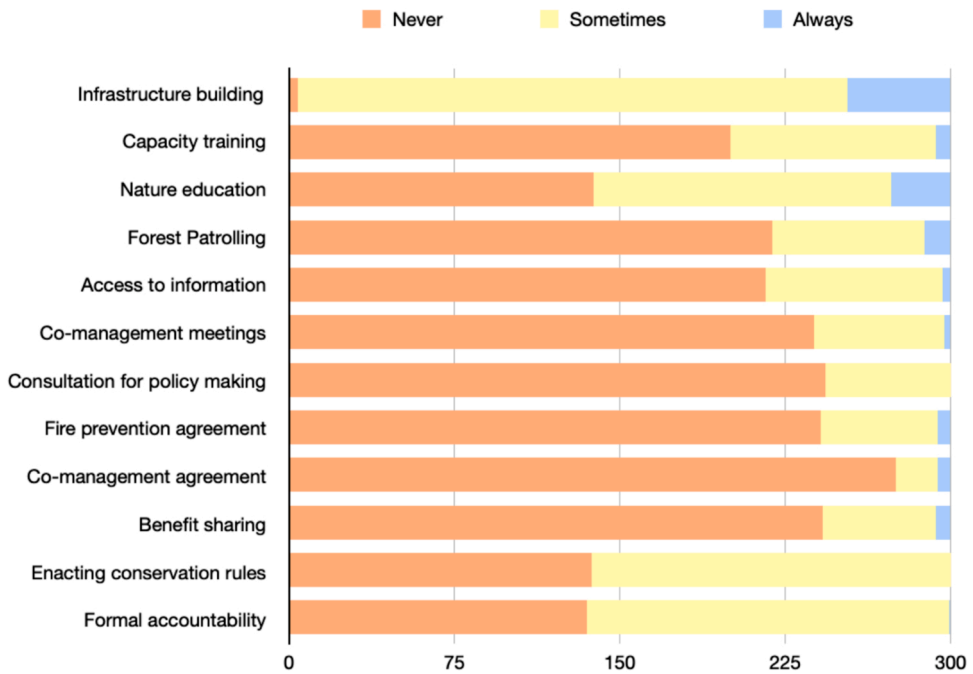

Fig. 3. Frequency of participation in co-management activities.

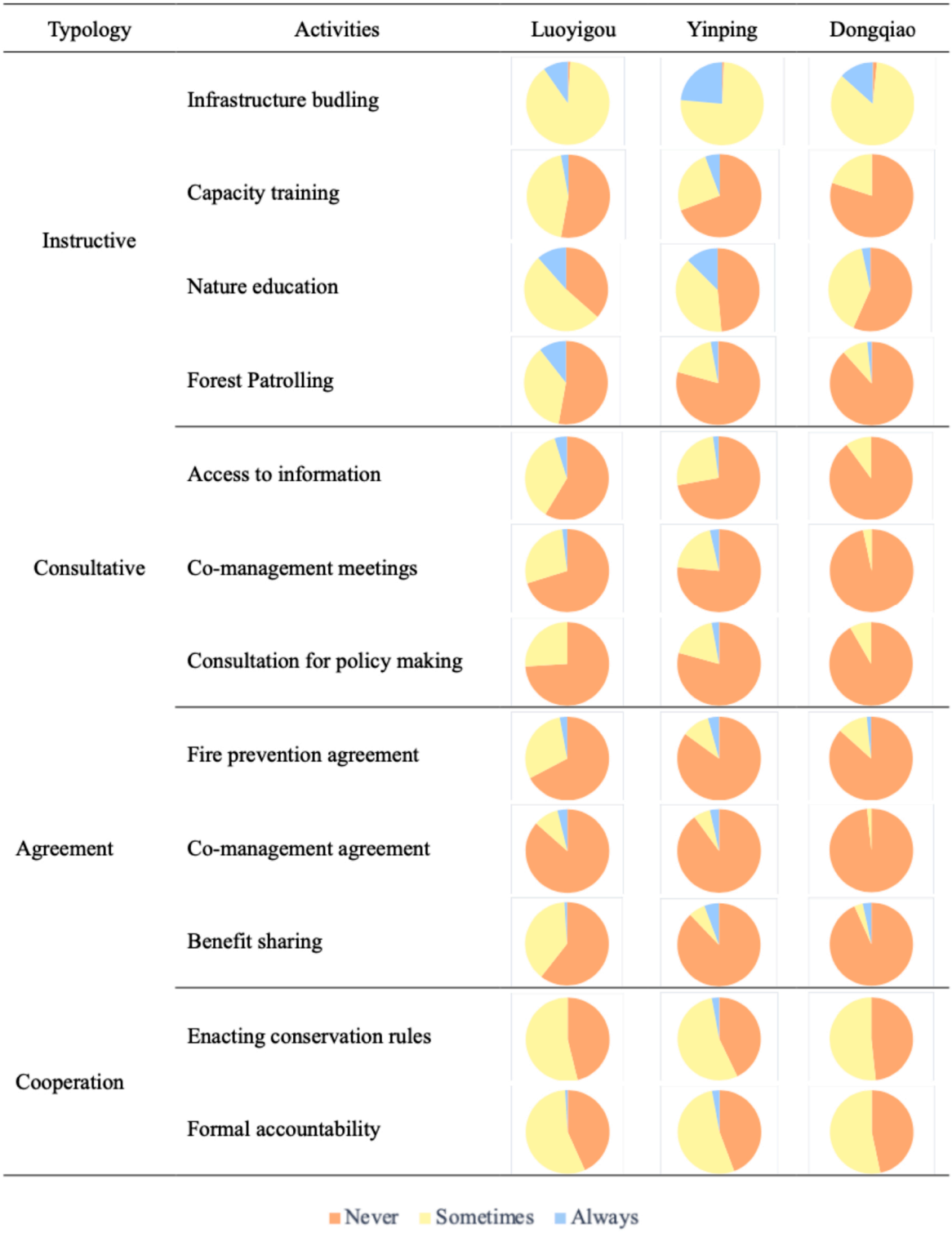

Fig. 4. Frequency of participation in co-management activities among three surveyed villages.

3.3. Evaluation of impact of participation on perceived performances

3.3.1. Identification of participation types and levels

By performing the standard PCA procedure, the value of the KMO statistic was determined to be $0.725 > 0.60$, proving the

Table 3
Local perceptions of ecological, social, and economic performances.

Category	Mean	SD	Indicators	Mean	SD
Ecological performance	4.27	0.56	Ecosystem conservation (EP1)	4.20	0.70
			Wildlife conservation (EP2)	4.45	0.62
			Resource protection (EP3)	4.15	0.65
Social performance	3.45	0.76	Conservation identity (SP1)	3.62	1.01
			Conservation willingness (SP2)	3.80	0.94
			Conservation capacity (SP3)	2.94	1.04
Livelihood performance	2.66	0.83	Compensation availability (LP1)	2.44	1.11
			Income enhancement (LP2)	2.78	0.99
			Employment opportunities (LP3)	2.75	1.07

Note: 1–2, very negative; 2–3, somewhat negative; 3–4, somewhat positive; 4–5, very positive).

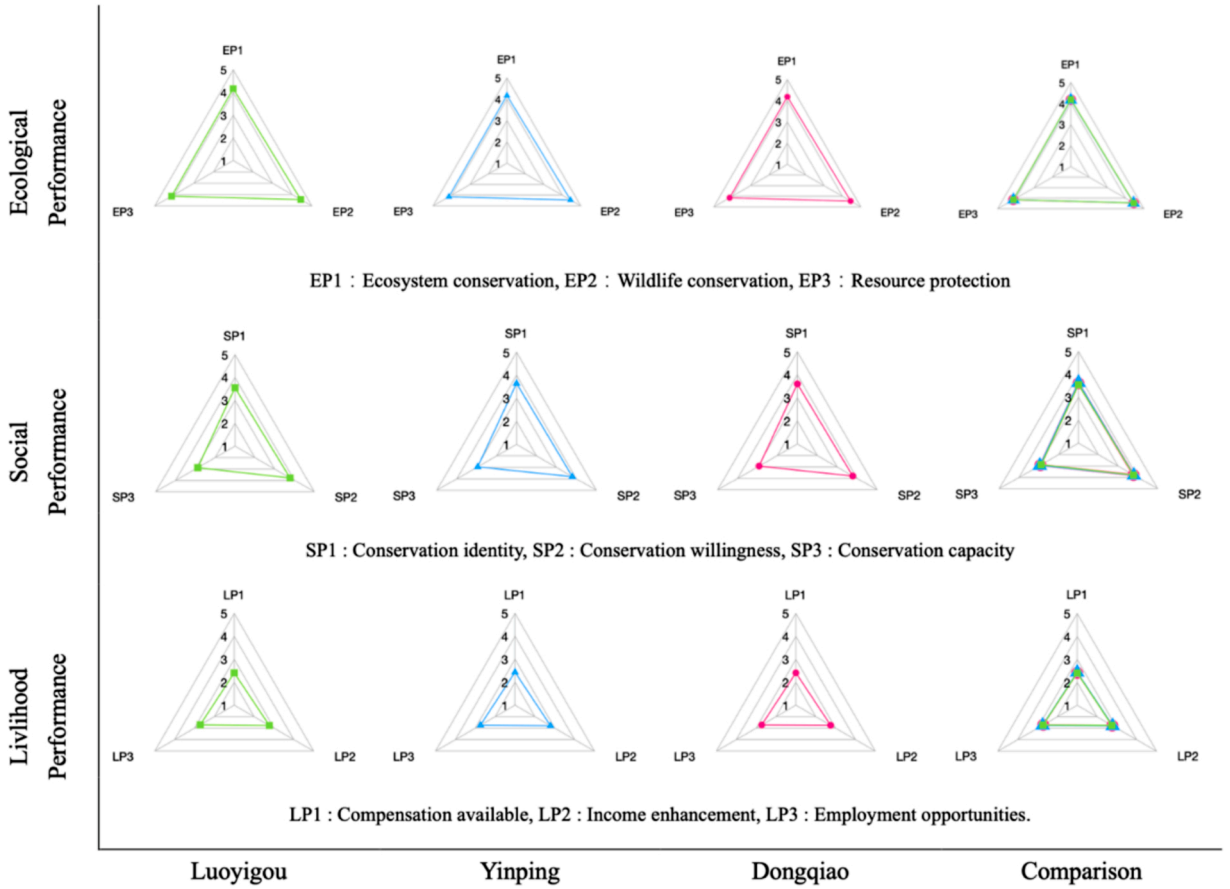

Fig. 5. Comparison of scores of performance indicators among three surveyed villages. Note: The comparison column contains graphics showing differences in the same performance type among the three surveyed villages.

suitability of conducting an exploratory factor analysis. Bartlett's test was highly significant, with a p-value < 0.000, indicating that the variables were interactively related. Table 4 presents the total variance of each component interpretation, and six co-management types were determined as principal components, accounting for 81.9 % of the total variation (Table S6).

As presented in Table 5 and Fig. 6, the six co-management types were further classified into four degrees of empowerment (cooperation, agreement, consultation, and instruction) according to the IUCN co-management classification framework. The first degree, cooperation, comprises two co-management activities, enacting conservation rules (A11) and formal accountability (A12), referring to the collaboration between the TAA and local communities. The second degree, agreement, contains three co-management attempts, fire prevention (A8), co-management agreements (A9), and benefit-sharing (A10), all representing certain forms of a protocol with the TAA. The third degree, consultation, consists of two co-management arrangements, co-management meetings (A6) and consultation for policy making (A7).

The fourth degree, instruction, includes activities classified as employment, training, and support. Although this component

Table 4
Total variance explained through principal component analysis.

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.873	32.273	32.273	3.873	32.273	32.273	1.953	16.275	16.275
2	1.939	16.159	48.432	1.939	16.159	48.432	1.918	15.985	32.260
3	1.404	11.699	60.131	1.404	11.699	60.131	1.801	15.005	47.265
4	1.001	8.341	68.472	1.001	8.341	68.472	1.600	13.330	60.595
5	0.832	6.935	75.408	0.832	6.935	75.408	1.536	12.798	73.394
6	0.781	6.507	81.914	0.781	6.507	81.914	1.022	8.521	81.914
7	0.581	4.845	86.759						
8	0.453	3.778	90.537						
9	0.423	3.523	94.060						
10	0.359	2.995	97.055						
11	0.297	2.473	99.528						
12	0.057	0.472	100.000						

Extraction method: principal component analysis.

Table 5
Rotated component matrix of principal component analysis.

	Cooperation (C1)	Agreement (C2)	Consultation (C3)	Instruction		
				Employment (C4)	Training (C5)	Support (C6)
Infrastructure building	0.002	0.073	0.073	0.056	0.023	0.985
Capacity training	-0.011	0.124	0.137	0.257	0.801	0.019
Nature education	0.095	0.071	0.276	0.092	0.794	0.016
Forest patrolling	-0.049	0.082	0.135	0.835	0.278	0.025
Access to information	0.114	0.099	0.451	0.654	0.187	0.146
Co-management meetings	0.042	0.107	0.883	0.183	0.156	0.092
Consultation for policy making	0.058	0.186	0.806	0.180	0.282	-0.016
Fire prevention agreement	-0.024	0.648	0.142	0.564	-0.045	-0.105
Co-management agreement	0.032	0.853	0.121	0.095	0.034	-0.043
Benefit sharing	0.008	0.825	0.091	0.000	0.198	-0.091
Enacting conservation rules	0.981	-0.013	0.068	-0.039	0.018	0.002
Formal accountability	0.979	0.042	0.035	0.048	0.060	0.003

Extraction method: principal component analysis.
Rotation method: Caesar's normalized maximum variance method.

represents certain features of consultation through access to information, the majority of activity in this category was carried out by forest patrols dominated by the TAA (employment). The training subcategory consists of providing intellectual or material training for locals. The support subcategory refers to the improvement of public facilities.

3.3.2. Detecting predictors of perceived performance

Four MLR models were generated to detect the predictors of local perceptions of ecological, economic, social, and comprehensive performance. Eight variables (employment, training, support, consultation, agreement, and cooperation co-management as well as gender and residency years) were used as potential predictors of perceived co-management outcomes. Collinearity, serial correlation, and residual normality tests were performed for all the regression models to ensure overall feasibility and accuracy. The MLR results demonstrated the positive effects of participation in instruction on perceived outcomes. Local respondents involved in the support subtype of instruction were more likely to report positive perceptions regarding all performance aspects. While participation in the training subtype of instruction was associated with positive social and comprehensive perceptions, the employment subtype was associated with positive ecological, economic, and combined perceptions. In addition, agreement with co-management had an impact on the perception of all performance aspects, although at a much lower rate than those of instruction co-management. Furthermore, engagement in consultation enhanced the positive perceptions of social, economic, and combined dimensions. In contrast, participation in cooperation co-management was not influential in any performance aspect. Despite these valid passing results, the explanatory rates of the predictive variables were rather limited (adjusted $R^2 = 0.163$, 0.288, 0.253, and 0.391, respectively), indicating that participation in those categories was only partially responsible for local perceptions of co-management performance (Table 6; Model S1-S4).

4. Discussion

The results of the quantitative analysis revealed the varied but essential role of participation (albeit at different levels) in the formation of positive perceptions regarding co-management performance. However, there was no significant association between

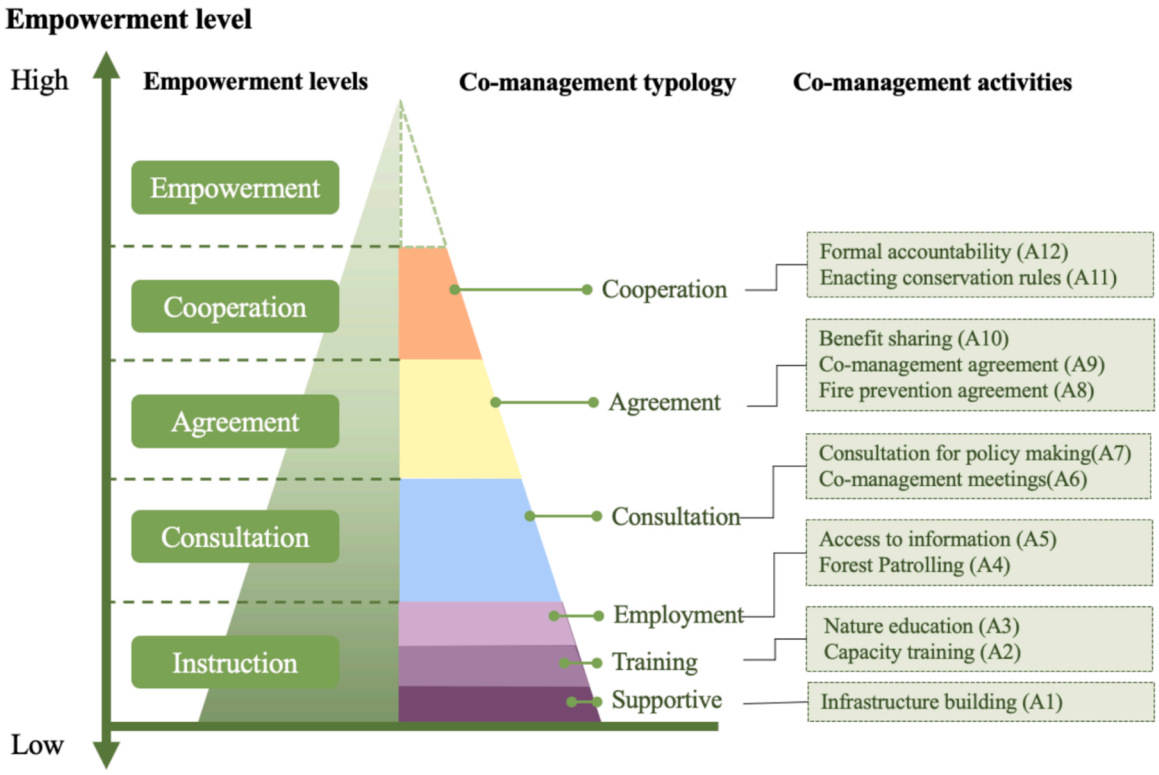

Fig. 6. Six recognized co-management types in the Tangjiahe area of Giant Panda National Park and their relationships with IUCN declared empowerment levels. The dotted line refers to the highest empowerment degree according to the IUCN framework.

Table 6
Multiple linear regression results for predictors of locals' perceived performances.

Model	Dependent variables	Adjusted R^2	F variation	Predictors	Beta		T-value	Sig
1	Ecological Performance	0.163	8.378	Instructive (Supportive)	0.298		5.653	0.000
				Instructive (Employment)	0.129		2.639	0.009
				Agreement	0.211		4.015	0.000
2	Social Performance	0.288	14.882	Instructive (Supportive)		0.347	7.054	0.000
				Instructive (Training)		0.247	5.031	0.000
				Instructive (Employment)		0.186	3.785	0.000
				Consultative		0.222	4.500	0.000
				Agreement		0.138	2.800	0.005
3	Livelihood Performance	0.253	12.517	Instructive (Supportive)	0.164		3.262	0.001
				Instructive (Employment)	0.339		6.724	0.000
				Consultative	0.220		4.361	0.000
				Agreement	0.174		3.467	0.001
4	Comprehensive Performance	0.391	23.699	Instructive (Supportive)	0.357		7.848	0.000
				Instructive (Training)	0.219		4.826	0.000
				Instructive (Employment)	0.318		6.997	0.000
				Consultative	0.242		5.310	0.000
				Agreement	0.232		5.117	0.000

Note: only significant variables with Sig < 0.01 (SSPS) are displayed in this table.

higher participation levels and positive performance judgements. Specifically, the cooperation type/level of co-management did not to facilitate more positive opinions among local residents. In this regard, although it is critical to engage surrounding residents in co-management activities, sololy empowering locals cannot be regarded as a panacea for improving relations. Rather, and to our surprise, the mere inclusion of local communities at the lowest instruction level of co-management can be associated with more favorable opinions toward biodiversity, social, and livelihood outcomes. In particular, the support subtype of instruction co-management was closely linked with more positive perceptions toward each performance aspect (ecological performance, Beta = 0.298; social performance, Beta = 0.347; livelihood performance, Beta = 0.164). The training subtype of instruction co-management was the most influential in affecting perceived social outcomes (Beta = 0.247), and the employment subtype of instruction co-management had the

largest impact on perceptions of livelihood outcomes (Beta = 0.339). (Models S1–S4).

This situation illustrates that the local residents surrounding the Tangjiahe area of the GPNP were more concerned about their enhanced well-being into through co-management regime, such as through infrastructure improvement, job opportunities, and harvesting skill upgrading, rather than conservation accountability or empowerment. It has often been observed that sharing power in conservation efforts makes little difference if livelihood opportunities are reduced because of these arrangements (Brockington et al., 2012).

It is also possible that participation in conservation programs is not the most urgent aspect of people's lives. Many people exert considerable effort toward ensuring that their families and livelihoods prosper. This resonates with findings from southeastern Tanzania, which revealed that oppressive conservation regimes were sometimes viewed as a side show compared with the more important requirements of day-to-day living (Ponte et al., 2022).

Another possibility is that the findings on contemporary responses to conservation empowerment initiatives must be understood in light of the history of local people's interactions with conservation authorities. Past violence or conflict may overshadow plans to make conservation more locally supportive. Similarly, accounts of community conservation efforts in southern and eastern Africa have reported that it took time for the local people and conservation authorities to build mutual trust (Igoe and Brockington, 1999; Hulme and Murphree, 2001).

Caution is necessary therefore when analyzing empowerment, because it may not persist as one of the key concerns of local residents. This finding resonates with that of Kimengsi et al. (2019), which proposed that the top-down co-governance structure, although flawed, might also act as a positive solution to conflicts between park authorities and local residents. However, Sarvestani and Ingram (2020) reported contradictory results in Chehel-Chay, Iran, where delegating authority for local legislation was proposed as a step toward more effective participatory forest governance. In Ugandan villages, the community-based conservation approach has generated positive attitudes toward conservation, whereas the state-led approach has not (Lepp and Holland, 2006). In other African regions, the bottom-up conservation structure has witnesssed a major improvement over the previous top-down model, which failed to be socially and economically sustainable at the grassroots level (Abrams et al., 2009) DeFries et al. (2007) argued that stewardship may simply be effective if alternative economic incentives are also provided with a participatory process. This finding may be consistent with the situation in the Tangjiahe area, where locals reported overwhelming dissatisfaction toward the livelihood impact of co-management.

Despite the dominant effects of the instruction type of co-management, our study never intends to deny the value of consultative and agreement levels (types) of co-management. First, the inclusion of local communities in consultations was directly linked to more favorable socioeconomic perceptions toward co-management (social performance, Beta = 0.222; livelihood performance, Beta = 0.220). This result highlights the importance of information exchange in consultation meetings, which could provide locals with more opportunities for skill enhancement and alternative livelihoods. However, local residents surrounding the Tangjiahe area reported dissatisfaction with the current consultation procedures. For example, one interviewee complained: "if the TAA asked me to give suggestions or get involved with conservation, I'd love to; but the thing is they never asked me". This finding is consistent with that of Sandström and Widmark (2007) in northern Sweden, where consultations were perceived as an effective tool for co-governing forest resources. Additionally, participants involved in the agreement type of co-management were more likely to develop optimistic opinions in all directions (ecological performance, Beta = 0.211; social performance, Beta = 0.138; livelihood performance, Beta = 0.174). This highlights the irreplaceable effects of the formal protocol between TAA and local communities in promoting positive perceptions. In Mount Elgon National Park, Uganda, conservation agreements that were successfully coordinated between the government and local communities have achieved similar positive effects in providing alternative income for local residents (Oonyu, 2009; Nakakaawa et al., 2015).

Although it is hard to conclude whether co-management has objectively contributed to ecological, social, and livelihood outcomes by merely measuring local opinions, the results of this study provide a reference for understanding how participation can affect co-management perceptions. Practical recommendations can be generalized from the above analyses. First, we recommend strengthening instruction co-management dominated by conservation authorities because of the overwhelming positive effects disclosed in the Tangjiahe area. Practices in this respect may include local employment, infrastructure improvement, technical training, and other conservation-related support (Zhang and Yang, 2021). Furthermore, the current information exchange channels of co-management should be strengthened and expanded to other forms, such as community-based forums and consultation meetings. Simultaneously, human–wildlife compensation agreements should not be limited to Luoyigou Village, and it is imperative to incorporate similar programs in other surrounding communities. Another suggestion we put forward here is to pay more attention to the livelihood impact of co-management in the Tangjiahe area, whose indices were revealed to be the lowest. Relevant countermeasures could include offering more ranger positions, attracting more investments, and enriching industrial activities such as ecotourism, innovative agriculture, and farmland reformation (Chen et al., 2022). Despite the deficiencies recognized in Tangjiahe, we recommend arranging diversified co-management measures across different villages as an effective approach to producing similar performance perceptions. This study further illustrated the feasibility and effectiveness of implementing differentiated co-management in villages with varied conditions, which should be referred to by other PA authorities.

5. Conclusion

As an effective mechanism to coordinate both biological and livelihood targets, co-management in PAs has been advocated and applied for several decades in various contexts, with mixed outcomes (Plummer et al., 2017; Ward et al., 2018). Instead of focusing on the outcomes of co-management, our study aimed to explore the relationships between local participation types and perceived

outcomes to maximize co-management effects. Our findings quantitatively verify the effectiveness of the instruction type of co-management when tailored to the needs of local residents. Herein, we argue that it is premature to enhance locals' perceived outcomes solely by empowering them without taking full account of the local context. Empowerment is a political process that takes place in specific historical contexts and, thus, must acknowledge not only present needs, but also decades of sometimes harmful and damaging interactions with conservation authorities that can take many years to reconcile.

The government's essential role in promoting co-management arrangements and the instruction type of co-management is recognized as an influential force. We call upon local administrations and policymakers to be cautious in ensuring the fulfilment of enabling conditions for co-management, not only in promoting local empowerment, but also in focusing on local well-being by praxis. Further research is required to add more evidence from interviews to reveal the inner mechanisms of participation types, empowerment levels, and co-management performance that the quantitative data cannot explain. Furthermore, as the explanatory rate of predictive variables in MLR models is rather limited, it is important to explore other potential factors influencing perceived performance outcomes. In addition, co-management activities and policies change over time, and long-term observations are necessary to determine the historically evolving trend of co-management. Such attempts can expand the results of this research to a time-series analysis, which might assist scholars and administrators in obtaining novel insights into PA co-management and in formulating comprehensive decision-making instruments to improve conservation relationships in the long term.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data Availability

Data will be made available on request.

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.gecco.2023.e02517.

References

Abrams, R.W., Anwana, E.D., Ormsby, A., Dovie, D.B., Ajagbe, A., Abrams, A., 2009. Integrating top-down with bottom-up conservation policy in Africa. Conserv. Biol. 23 (4), 799–804.

Agarwal, B., 2001. Participatory exclusions, community forestry, and gender: An analysis for South Asia and a conceptual framework. World Dev. 29, 1623–1648. https://doi.org/10.1016/S0305-750X(01)00066-3.

Andrade, G.S., Rhodes, J.R., 2012. Protected areas and local communities: an inevitable partnership toward successful conservation strategies? Ecol. Soc. 17 (4). ⟨http://www.jstor.org/stable/26269207⟩.

Armitage, D., Berkes, F., Doubleday, N., 2010. Adaptive Co-management: Collaboration, Learning, and Multi-level Governance. UBC Press.

Ballet, J., Koffi, K.J.M., Komena, K.B., 2009. Co-management of natural resources in developing countries: the importance of context. Econ. Int. 4, 53–76.

Bennett, N.J., 2016. Using perceptions as evidence to improve conservation and environmental management. Conserv. Biol. 30, 582–592. https://doi.org/10.1111/cobi.12681.

Berkes, F., 2004. Rethinking community based conservation. Conserv. Biol. 18 (3), 621–630. https://doi.org/10.1111/j.1523-1739.2004.00077.x.

Berkes, F., 2009. Evolution of co-management: role of knowledge generation, bridging organizations and social learning. J. Environ. Manag. 90 (5), 1692–1702. https://doi.org/10.1016/j.jenvman.2008.12.001.

Bong, I.W., Moeliono, M., Wong, G.Y., Brockhaus, M., 2019. What is success? Gaps and trade-offs in assessing the performance of traditional social forestry systems in Indonesia. For. Soc. 21, 2549–4724. https://doi.org/10.24259/fs.v3i1.5184.

Borrini-Feyerabend, G., Jaireth, H., Farvar, M.T., Pimbert, M., Renard, Y., Kothari, A., Warren, P., Murphree, M., Pattemore, V. and Ramrez, R. Sharing power: learning-by-doing in co-management of natural resources throughout the world. Earthscan, 2007.

Borrini-Feyerabend G., Dudley N., Jaeger T., Lassen B., Pathak Broom N., Phillips A., Sandwith T., 2012. Governance of protected areas: from understanding to action. IUCN, Gland, Switzerland.

Borrini-Feyerabend, G., Dudley, N., Jaeger, T., et al., 2013. Governance of protected areas: from understanding to action. Best. Pract. Prot. Area Guidel. Ser. (20).

Brockington, D., Igoe, J., Schmidt-Soltau, K., 2006. Conservation, human rights, and poverty reduction. Conserv. Biol. 20 (1), 250–252 https://www.jstor.org/stable/3591173.

Brockington, D., Duffy, R., Igoe, J., 2012. Nature Unbound: Conservation, Capitalism and the Future of Protected Areas. Routledge.

Brooks, J., Waylen, K.A., Mulder, M.B., 2013. Assessing community-based conservation projects: a systematic review and multilevel analysis of attitudinal, behavioral, ecological, and economic outcomes. Environ. Evid. 2 (1) https://doi.org/10.1186/2047-2382-2-2.
Carlsson, L., Berkes, F., 2005. Co-management: concepts and methodological implications. J. Environ. Manag. 2005 (75), 65–76. https://doi.org/10.1016/j.jenvman.2004.11.008.
Chen, Q., Zhang, Y., Zhang, Y., et al., 2022. Examining Social Equity in the Co-Management of Terrestrial Protected Areas: Perceived Fairness of Local Communities in Giant Panda National Park. China Land 11, 1624. https://doi.org/10.3390/land11101624.
Cinner, J.E., McClanahan, T.R., MacNeil, M.A., Graham, N.A.J., Daw, T.M., Mukminin, A., et al., 2012. Comanagement of coral reef social-ecological systems. Proc. Natl. Acad. Sci. USA 109 (14), 5219–5222. https://doi.org/10.1073/pnas.1121215109.
Cooke, B., Kothari, U., 2001. Participation: The New Tyranny? Zed Books, London, UK.
Cuya, A., Glikman, J.A., Groenendijk, J., et al., 2021. Socio-environmental perceptions and barriers to conservation engagement among artisanal small-scale gold mining communities in Southeastern Peru. Glob. Ecol. Conserv. 31, 2351–9894. https://doi.org/10.1016/j.gecco.2021.e01816.
De Vente, J., Reed, M.S., Stringer, L.C., Valente, S., Newig, J., 2016. How does the context and design of participatory decision making processes affect their outcomes? Evidence from sustainable land management in global drylands. Ecol. Soc. 21 (2) http://ds.doi.org/10.5751/ES-08053-210224.
DeFries, R., Hansen, A., Turner, B., Reid, R., Liu, J., 2007. Land use change around protected areas: management to balance human needs and ecological function. Ecol. Appl. 17 (4), 103–1038. https://doi.org/10.1890/05-1111.
Enengel, B., Penker, M., Muhar, A., 2014. Landscape co-management in Austria: the stakeholder's perspective on efforts, benefits and risks. J. Rural Stud. 34, 223–234. https://doi.org/10.1016/j.jrurstud.2014.02.003.
Evans, L., Cherrett, N., Pemsl, D., 2011. Assessing the impact of fisheries co-management interventions in developing countries: a meta-analysis. J. Environ. Manag. 92 (8), 1938–1949. https://doi.org/10.1016/j.jenvman.2011.03.010.
Franco-Meléndez, M., Tam, J., van Putten, I., Cubillos, L.A., 2021. Integrating human and ecological dimensions: the importance of stakeholders' perceptions and participation on the performance of fisheries co-management in Chile. PLoS One 16 (8), e0254727. https://doi.org/10.1371/journal.pone.0254727.
Gelcich, S., Edwards-Jones, G., Kaiser, M.J., 2005. Importance of attitudinal differences among artisanal fishers toward co-management and conservation of marine resources. Conserv. Biol. 19 (3), 865–875. https://doi.org/10.1111/j.1523-1739.2005.00534.x.
Gelcich, S., Godoy, N., Castilla, J.C., 2009. Artisanal fishers' perceptions regarding coastal co-management policies in Chile and their potentials to scale-up marine biodiversity conservation. Ocean Coast. Manag. 52 (8), 424–432. https://doi.org/10.1016/j.ocecoaman.2009.07.005.
He, J., Zhou, W., 2022. Conservation versus development: Uncovering divergent viewpoints of conservationists on National Parks system by Q methodology in China. Glob. Ecol. Conserv. 40, 2351–9894. https://doi.org/10.1016/j.gecco.2022.e02343.
He, S., Wei, Y., 2022. Measuring the conservation attitudes of local farmers towards conservation easements in the Qianjiangyuan National Park. Glob. Ecol. Conserv. 36, 2351–9894. https://doi.org/10.1016/j.gecco.2022.e02123.
Huang, Q., Fei, Y., Yang, H., Gu, X., Songer, M., 2020. Giant Panda National Park, a step towards streamlining protected areas and cohesive conservation management in China. Glob. Ecol. Conserv. 22, 2351–9894. https://doi.org/10.1016/j.gecco.2020.e00947.
Hulme, D. & Murphree, M., 2001. African Wildlife and Livelihoods. The Promise and Performance of Community Conservation. James Currey, Oxford.
Igoe, J. & Brockington, D. 1999. Pastoral Land Tenure and Community Conservation: a case study from North-East Tanzania. Pastoral Land Tenure Series No 11. IIED, London.in global drylands. Ecology and Society, 21(2):24. https://doi.org/10.5751/ES-080530210224.
Islam, K.N., Rahman, M.M., Jashimuddin, M., Hossain, M.M., Islam, K., Al Faroque, M., 2019. Analyzing multi-temporal satellite imagery and stakeholders' perceptions to have an insight into how forest co-management is changing the protected area landscapes in Bangladesh. For. Policy Econ. 101, 70–80. https://doi.org/10.1016/j.forpol.2019.01.011.
Kimengsi, J.N., Bhusal, P., Aryal, A., Fernandez, M.V.B.C., Owusu, R., Chaudhary, A., Nielsen, W., 2019. What (de) motivates forest users' participation in co-management? Evidence from Nepal. Forests 10 (6), 512. https://doi.org/10.3390/f10060512.
Kovács, E., Mile, O., Fabók, V., et al., 2021. Fostering adaptive co-management with stakeholder participation in the surroundings of soda pans in Kiskunság, Hungary–An assessment. Land Use Policy 100, 104894. https://doi.org/10.1016/j.landusepol.2020.104894.
Lan X., 2020. The research on community participation in giant panda national park– a case study of wolong reserve. Master thesis. Beijign: Beijing Forestry University. ⟨http://doi.org/10.26949/d.cnki.gblyu.2020.000700⟩ (in Chinese with English title and abstract).
Lane, M.B., 2001. Affirming new directions in planning theory: comanagement of protected areas. Soc. Nat. Resour. 14 (8), 657–671.
Laval, M. 2008. People, elephants and forests: collective action to manage an environmental wicked problem in Kodagu, Western Ghats. Thesis. AgroParisTech-ENGREF, CIRAD, Montpellier, France. [online] URL: ⟨http://www.ifpindia.org/ecrire/upload/reports/laval_2008.zip⟩.
Lepp, A., Holland, S., 2006. A comparison of attitudes toward state-led conservation and community-based conservation in the village of Bigodi. Uganda Soc. Nat. Resour. 19 (7), 609–623.
Lund, J.F., Rutt, R.L., Ribot, J., 2018. Trends in research on forestry decentralization policies. Curr. Opin. Environ. Sustain. 32, 17–22. https://doi.org/10.1016/j.cosust.2018.02.003.
Nakakaawa, C., Moll, R., Vedeld, P., Sjaastad, E., Cavanagh, J., 2015. Collaborative resource management and rural livelihoods around protected areas: a case study of Mount Elgon National Park, Uganda. For. Policy Econ. 57, 1–11. https://doi.org/10.1016/j.forpol.2015.04.002.
Nunan, F., Luomba, J., Lwenya, C., Yongo, E., Odongkara, K., Ntambi, B., 2012. Finding space for participation: fisherfolk mobility and co-management of Lake Victoria fisheries. Environ. Manag. 50 (2), 204–216. https://doi.org/10.1007/s00267-012-9881-y.
Oldekop, J.A., Holmes, G., Harris, W.E., Evans, K.L., 2016. A global assessment of the social and conservation outcomes of protected areas. Conserv. Biol. 30, 133–0141. https://doi.org/10.1111/cobi.12568.
Oonyu, J.C., 2009. Conservation education and the attitudes of local communities living adjacent to Mt. Elgon National Park, Uganda. Appl. Environ. Educ. Commun. 8 (3–4), 153–164. https://doi.org/10.1080/15330150903269258.
Pascual, U., Phelps, J., Garmendia, E., et al., 2014. Social equity matters in payments for ecosystem services. Bioscience 64 (11), 1027–1036. https://doi.org/10.1093/biosci/biu146.
Persha, L., Andersson, K., 2014. Elite capture risk and mitigation in decentralized forest governance regimes. Glob. Environ. Change 24, 265–276. https://doi.org/10.1016/j.gloenvcha.2013.12.005.
Plummer, R., Armitage, D., 2007. A resilience-based framework for evaluating adaptive co-management: linking ecology, economics and society in a complex world. Ecol. Econ. 61 (1), 62–74. https://doi.org/10.1016/j.ecolecon.2006.09.025.
Plummer, R., FitzGibbon, J., 2004. Some observations on the terminology in co-operative environmental management. J. Environ. Manag. 70 (1), 63–72. https://doi.org/10.1016/j.jenvman.2003.10.005.
Plummer, R., Baird, J., Dzyundzyak, A., Armitage, D., Bodin, Ö., Schultz, L., 2017. Is adaptive co-management delivering? Examining relationships between collaboration, learning and outcomes in UNESCO biosphere reserves. Ecol. Econ. 140, 79–88. https://doi.org/10.1016/j.ecolecon.2017.04.028.
Ponte, S., Noe, C., & Brockington, D., 2022. Contested Sustainability: The Political Ecology of Conservation and Development in Tanzania. James Currey.
Sandström, C., Widmark, C., 2007. Stakeholders' perceptions of consultations as tools for co-management—A case study of the forestry and reindeer herding sectors in northern Sweden. For. Policy Econ. 10 (1–2), 25–35. https://doi.org/10.1016/j.forpol.2007.02.001.
Sarvestani, A.A., Ingram, V., 2020. Perceptions and practices of rural council participatory forest governance: Closed co-management in Chehel-Chay, Iran. For. Policy Econ. 117, 102202 https://doi.org/10.1016/j.forpol.2020.102202.
Sen, S., Nielsen, J.R., 1996. Fisheries co-management: a comparative analysis. Mar. Policy 20 (5), 405–418. https://doi.org/10.1016/0308-597X(96)00028-0.
Sterling, E.J., Betley, E., Sigouin, A., Gomez, A., Toomey, A., Cullman, G., Malone, C., Pekor, A., Arengo, F., Blair, M., Filardi, C., Landrigan, K., Porzecanski, A.L., 2017. Assessing the evidence for stakeholder engagement in biodiversity conservation. Biol. Conserv. 209, 159–171. https://doi.org/10.1016/j.biocon.2017.02.008.
Stringer, L.C., Dougill, A.J., Fraser, E., Hubacek, K., Prell, C., Reed, M.S., 2006. Unpacking"participation" in the adaptive management of social–ecological systems: a critical review. Ecol. Soc. 11 (2) http://www/eologyandsociety.org/vol1/iss2/art39/.

Uddin, M.S., Mukul, S.A., Khan, M.A.S.A., Asif, C.A.A., Alamgir, Mohammed, 2007. Comparative evaluation of co-management impacts on protected area: a case study from Lawachara National Park. J. For. Environ. 5, 103–110.

Ward, C., Holmes, G., Stringer, L., 2018. Perceived barriers to and drivers of community participation in protected-area governance. Conserv. Biol. 32 (2), 437–446. https://doi.org/10.1111/cobi.13000.

Xu, W., Xiao, Y., Zhang, J., Yang, W., Zhang, L., Hull, V., Wang, Z., Zheng, H., Liu, J., Polasky, S., et al., 2017. Strengthening protected areas for biodiversity and ecosystem services in China. Proc. Natl. Acad. Sci. USA 114, 1601–1606. https://doi.org/10.1073/pnas.1620503114.

Xu, W.H., Pimm, S.L., Du, A., Su, Y., Fan, X., An, L., Liu, J., Ouyang, Z.Y., 2019. Transforming protected area management in China. Trends Ecol. Evol. 34, 762–766. https://doi.org/10.1016/j.tree.2019.05.009.

Yang, B., Qin, S., Xu, W., Busch, J., Yang, X., Gu, X., Yang, Z., Wang, B., Dai, Q., Xu, Y., 2020. Gap Analysis of Giant Panda Conservation as an Example for Planning China's National Park System. Curr. Biol. 30, 1287–1291. https://doi.org/10.1016/j.cub.2020.01.069.

Yang J., 2022. Study on the evaluation index system of community co-management effectiveness of nature reserves from the perspective of farmers– Taking Tangjiahe and Baishuijiang National Nature Reserves as an example.Master thesis. Chengdu: Sichuan Academy of Social Sociences. ⟨http://doi.org/10.27346/d.cnki.gssky.2022.000144⟩ (in Chinese with English title and abstract).

Zhang, Y., Yang, R., 2019. The analysis of the current situation and reform proposals of community-based Co-management in China's Nature Reserves. Chinese Landscape. Chin. Landsc. Architect. 35 (8), 5–9. https://doi.org/10.19775/j.cla.2020.08.0031.

Zhang, Y., Yang, R., 2021. Research on the framework of mechanism building of community-based co-management in China's National Park System. Chin. Landsc. Architect. 37 (11), 98–103. https://doi.org/10.19775/j.cla.2021.11.0098.

Zhang, Y., Xiao, X., Cao, R., Zheng, C., Guo, Y., Gong, W., Wei, Z., 2020. How important is community participation to eco-environmental conservation in protected areas? From the perspective of predicting locals' pro-environmental behaviours. Sci. Total Environ. 739, 139889 https://doi.org/10.1016/j.scitotenv.2020.139889.