



# What factors influence the willingness of protected area communities to relocate? China's ecological relocation policy for Dashanbao Protected Area

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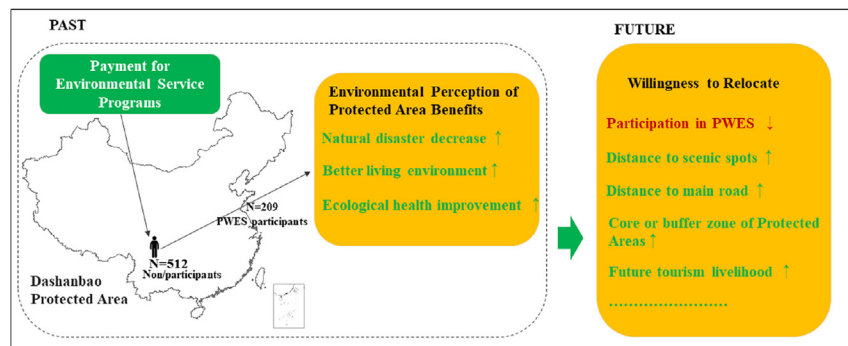
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## HIGHLIGHTS

- PES design significantly influences people's perception of future relocation policy.
- Residence location affects people's willingness to relocate.
- Unwillingness to relocate from PAs stems from concerns about future livelihood.
- Unwillingness to relocate is also associated with attachment to place.
- Relocation packages with land and agriculture schemes should be considered.

## GRAPHICAL ABSTRACT



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## ABSTRACT

Resettlement of local people from protected areas (PAs) has been regarded as a preferred method to alleviate human disturbance and environmental pressure. Lack of knowledge about local communities' perceptions of resettlement, however, can lead to failed relocation projects and negative impacts on environmental sustainability and livelihoods. To better understand local communities' perception of relocation in PAs, we examine factors that affect local communities' willingness to relocate in Dashanbao Protected Area (DPA), an important location for conservation of the rare Black-necked Crane and the subject of a large-scale relocation policy in China. We surveyed 512 households in DPA and used multiple logistic regression to identify which factors predict local communities' willingness to relocate. Then, we examined how local communities' opinions of different payment for environmental services programs (PES) impacted their willingness to relocate. The results indicated that participation in a PES program for wetland conservation significantly decreases willingness, while distance from scenic spots and roads increases willingness. Furthermore, participants in the PES program for wetlands had a greater positive perception of the benefits from the DPA. Concern about a sustainable livelihood and loss of a sense of belonging represent the two main categories or 'clusters' of reasons explaining unwillingness to relocate. Our results suggest that prior experience with PES programs influences attitudes about relocation, and that

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integrating the perception of local communities into policy is important to the success of conservation programs relying on relocation. Managers and decision-makers could usefully consider the coupled relationships between sustainable livelihood strategies such as PES, attitudes toward relocation, and conservation benefits when working with communities in PAs toward enhanced livelihoods and conservation.

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## 1. Introduction

With >70% of the world's Protected Areas (PAs) inhabited by human populations (Wang et al., 2013), increasing anthropogenic pressures have become a pressing concern in achieving the established goals of PAs to safeguard against ecological deterioration and to maintain biodiversity (UNEP-WCMC and IUCN, 2016; UNEP-WCMC and IUCN, 2018). Ecological relocation (ER) programs, relocating residents from ecologically fragile areas or areas with high conservation values, are one of the most prevalent tools used in PAs globally for relieving environmental pressure (Aukema et al., 2017; Lashorchix and Koshari, 2009; Page and Bellotti, 2015). ER programs have been used for moving residents from impoverished and ecologically fragile areas (Jamero et al., 2019; Wang et al., 2018b), for relocating communities exposed to disasters (Bukvic et al., 2015) and climate change (López-Carr and Marter-Kenyon, 2015) and for displacing tribal communities from high conservation values areas of PAs to reduce anthropogenic disturbance (Dash and Behera, 2018). Relocation and displacement of local communities from PAs has a history reaching back to the late nineteenth century with the world national park movements (Rangarajan and Shahabuddin, 2006). However, many relocation projects have failed due to lack of knowledge about local communities' perceptions, including in the USA (Colchester, 1997), southern and eastern Africa (Schmidt-Soltau, 2003), India (Lashorchix and Koshari, 2009), Nepal (Dhakal et al., 2011) and China (Du, 2012; Fan et al., 2015).

Currently, ER remains an important strategy for establishing a new system of national parks in China (Yeh, 2013). In 2017, China released a plan to create a unified park and PAs system for safeguarding China's biodiversity and natural heritage (China State Council and CCCPC, 2017, 2019). To mitigate one of the world's densest human populations residing within these PAs, the overall plan calls for relocation of local communities living in the core protection areas, thus reducing human impact to maintain the least disturbed ecosystems (MAB, 1971; SFA, 2018). Combined with China's recent resettlement program to alleviate poverty (Lo et al., 2016), these two resettlement programs will, in the next decade, lead to the world's largest ecological resettlement from PAs. Understanding the factors and reasons behind people's willingness to participate in an ER program is helpful for improving ER programs and Chinese national park policy design. To some extent, that will affect the successful achievement of this grand plan. Lack of understanding how local people are affected by the resettlement policy may lead to unsustainable outcomes for humans and nature, exacerbating local ecological and social problems (Fan et al., 2015).

Studies of ER programs have, however, focused mainly on assessment of ecological and social consequences (Sina et al., 2019; Torri, 2011). Few have studied factors and reasons that affect individuals or households' willingness to relocate (Dash and Behera, 2018). Some scholars approached this issue from the "push pull paradigm" that developed from Lewis's theory of economic development (Lewis, 1954; Lee, 1966) to explain the forces driving migration as pull factors and push factors (Wang et al., 2018b). Other scholars draw upon behavioral economics theory (maximization of different benefits; Simon, 1959), which holds that individuals or households rationally consider and attempt to maximize gains from migration. Many factors, such as family income (Sina et al., 2019), family assets (Du and Zou, 2018), and house location (Xu et al., 2006) affect expected gains and willingness to participate in ER. Furthermore, prospect theory and expected utility theory have been applied to this inquiry (Spencer et al., 2016),

suggesting that people who tend to take risks were more willing to participate in environmental programs (Wang et al., 2018a, 2018b). Theory of place attachment has helped some scholars understand willingness to relocate from an environmental psychology perspective (Boğaç, 2009). Indigenous peoples and residents of local communities with a long family history in an area and a strong sense of belonging understandably have a lower likelihood of relocating (Seebauer and Winkler, 2020).

Recently, researchers have started to understand individual or household perception of participation in environmental conservation programs in light of experiential knowledge and environmental behavior (McMichael and Katonivualiku, 2019; Fazey et al., 2006). Personal environmental experience tends to change individuals' conservation motivations and shape attitudes for future decision making (Lo and Cheung, 2016; Wandersee et al., 2012). For example, Wang et al., 2018b showed that having previous experience with a payment for environmental services (PES) program significantly influenced households' future environmental participation decision. PES programs, which offer incentive payments to impoverished local communities in exchange for a commitment by residents to manage their land to eliminate disruptive human activities and to improve environmental health (Chen et al., 2009; Wünscher and Engel, 2012), have been shown to influence the perceptions and conservation motivations of local people (Bremer et al., 2014; Dou et al., 2019). Although many PES programs have been undertaken and their environmental and socio-economic effects studied (Chen et al., 2012), research on how PES programs affect the perceptions of local residents and the influence of such programs on attitudes toward future conservation policies, such as ecological resettlement, are limited (Rode et al., 2015). In summary, research on ER has focused mainly on the influence of socio-economic status, expected financial gains, risk taking, and place attachment, with scant documentation of the influence of previous experience with environmental programs on willingness to participate in ER programs. Even though experience with previous environmental programs is known to be an important factor influencing environmental participation and decision-making, studies that consider the influence of previous PES experience on willingness to participate in future ER program are rare.

Toward filling this gap in the literature, we aim to better understand local people's perceptions of resettlement policy and the influence of previous PES programs on future resettlement policy. We present China's Dashanbao Protected Area (DPA) as a case study. DPA was established to protect a rare bird species, Black-necked Crane, which has an estimated world population of 12,000 (Li, 2014a; Pankaj et al., 2014). DPA has a plan for large-scale ER program and a history that includes three implemented PES programs. We aim to: a) identify which factors, including participation in PES programs, influence the willingness of local residents to relocate, b) examine to what extent the design of PES programs influences perceptions of conservation programs by comparing the influence of different PES programs, c) explore reasons local residents are unwilling to relocate and d) offer potential areas to improve policy and management. We hypothesize that PES program design significantly influences the perceptions of local residents and their willingness to relocate, and that perceptions formed from previous involvement in an environmental program can influence willingness to relocate. Gaining this knowledge will assist in the design of environmental programs of both PES and ER programs. It also could shed light on Chinese park policy and other environmental policies. Furthermore, exploring experiential knowledge and perceptions behind future

environmental decisions is vitally important in extending the theory of environmental behavior to understand complexities of coupled human and natural systems (Liu et al., 2007; An and López-Carr, 2012; Lopez-Carr et al., 2012).

## 2. Methods

### 2.1. Study area

DPA covers 192 km<sup>2</sup> in the northeast of Yunnan province, China (103° 14' 55"–103° 23' 49" E, 27° 18' 38"–27° 29' 15" N; Fig. 1). It was established as the Dashanbao Black-necked Crane Nature Reserve in 1990 to protect the rare Black-necked Crane (*Grus nigricollis* Przevalski, 1876) and its wetland habitat. Black-necked Crane is listed as vulnerable on the IUCN Red List of Threatened Species (BirdLife International, 2017), with an estimated global population of 10,000–10,200 (Li, 2014b). DPA supports the largest wintering population on the Yunnan–Guizhou Plateau (Li and Yang, 2003; Yang and Zhang, 2014) and is also one of the most important stopover sites for the eastern Black-necked Crane population, accounting for nearly 30% of the eastern migration population (Kong et al., 2018). The area also supports a fragile subalpine wetland ecosystem which was listed as a Ramsar Wetland of International Importance in 2005 (Ramsar, 2018). Following the principles used in national nature reserves (CEPA, 1994), administrators have divided DPA into core, buffer, and experimental zones, which are afforded the most to the least protection (MAB, 1971) (Fig. 1).

To protect the unique ecosystem and Black-necked Crane habitat, three PES programs and one ecological compensation program have been implemented in DPA (Supplementary Material A, Table A.1). Since 1999, DPA has been a site of the world's largest PES program, the Grain-to-Green Program (GTGP), which converts farmland to grassland to improve environmental quality and reduce water soil erosion.

From 1999 to 2002 the program did not provide compensation, but in 2003, the program added economic incentives (260 Yuan per 0.04 ha) to convert unsuitable farmland to forest. Compensation declined (to 125 Yuan per 0.04 ha) from 2008 to 2018. In 2014, a 4-year payment for wetland ecosystem services (PWES) program, costing 20 million Yuan (about 1,600,000 USD) from government special funds to protect wetland ecosystems and Black-necked Crane habitats, paid local farmers in exchange for halting farming and grazing on PWES areas. Six areas of approximately 350 ha farmland, considered as important habitats for Black-necked Crane, were gradually converted to wetland. This program involved 2669 villagers in 663 households, accounting for 15% of the total Dashanbao population, who received an annual compensation payment calculated by the area of farmland converted for PWES. The average amount of total compensation was 15,680 Yuan (about 2300 USD) for each participating household (Zhao, 2017). In addition to these PES programs, a program was designed to compensate farmers for the loss of crops eaten by Black-necked Cranes, which paid 9 Yuan (about 1.20 USD per year) to all local people living in DPA from 2014 to 2017.

DPA is also characterized by high crane-human interactions, with five administrative villages containing 110 local villages and a human population of 18,901 in 4547 households living in DPA. This high human population density (99 inhabitants per km<sup>2</sup>) is ten times the mean population density of other Nature Reserves across China (Xu et al., 2016). In recent years, anthropogenic pressures from an increasing population, expansion of human settlements, and construction of buildings have posed a substantial challenge for Black-necked Crane conservation (Harris and Mirande, 2013). To address this issue, the local government is planning an ecological relocation program that will relocate family households outside of DPA, combined with a poverty alleviation resettlement program that would relocate >10,000 local residents outside of DPA by 2020.

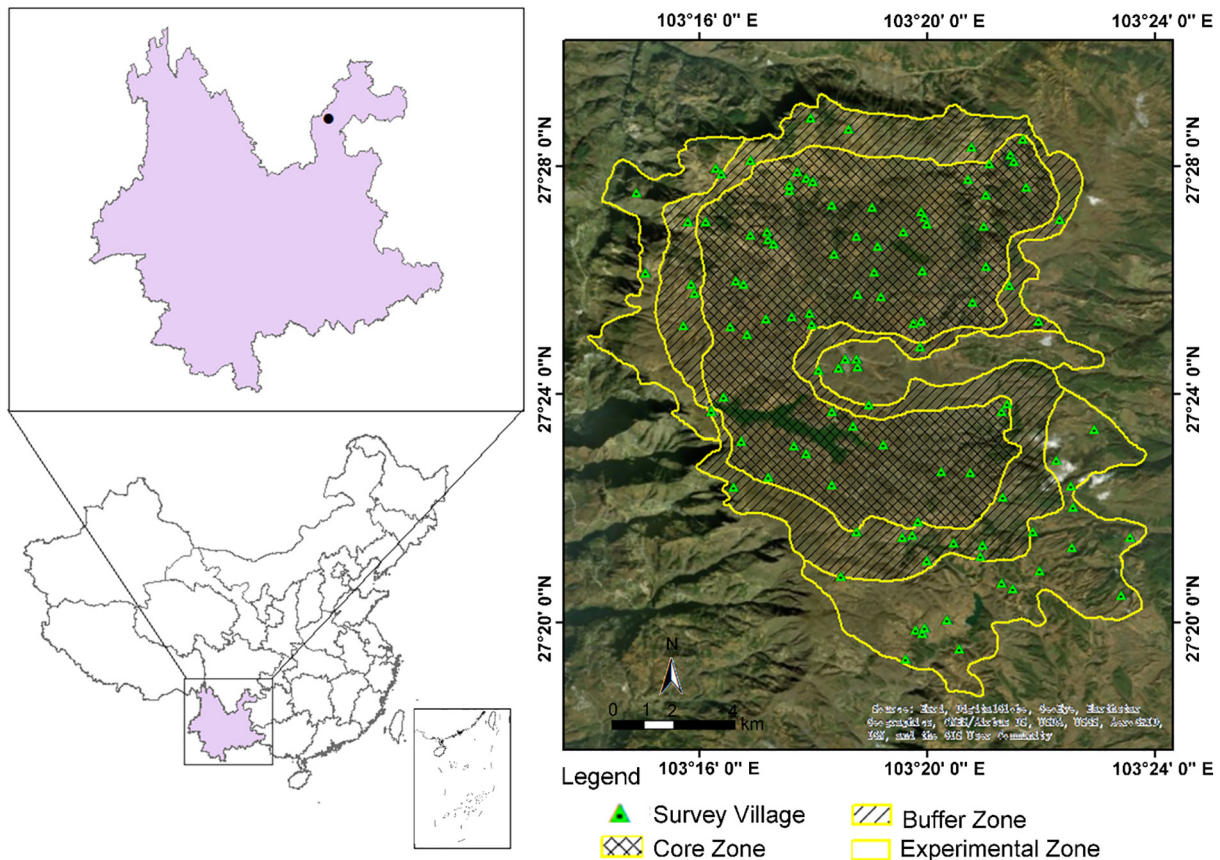


Fig. 1. The study area (right) and its location in Yunnan and China (left).



## 2.2. Data collection and field survey

A household survey, including pre-survey testing, was conducted during June and August of 2017. All local villages in DPA ( $N = 110$ ) were selected for this study. Considering the effect of spatial variation on people's attitudes found in a previous study (Piédallu et al., 2016), we employed a stratified sampling based on the population of each local village to ensure a minimum 30% proportional representation of households across the study regions. Households ( $n = 580$ ) were randomly selected from all local villages in DPA. All respondents were permanent inhabitants. These households randomly included participants and non-participants in different PES programs. To avoid potential bias, it was made clear to the participants that the investigation was for academic research and that the authors have no affiliation with the management authority or any administrative authority (Liu et al., 2010). 512 households from 109 villages provided valid responses to the survey with an overall response rate of 88.2% covering 99.1% of villages across the study regions (Fig. 1).

A pre-survey was conducted, with an open-ended questionnaire. 6 reserve managers and 20 village leaders participated in individual qualitative interviews. Reserve managers who were involved in management of previous PES programs and ecological relocation plans were selected as manager representatives. Representatives of local people consisted of village heads (5) and three volunteers (15) from each of the administrative (larger) villages. Interviews were conducted to understand concerns related to future relocation policy and reasons inhabitants might be willing or unwilling to relocate. From this pre-survey we learned that factors related to household assets, experiences with previous conservation programs, eco-tourism business benefits, expectations for the future, and the communities' location were the most frequently cited concerns associated with future ecological relocation plans.

Final questionnaire design was based on earlier ER work (Xu et al., 2006; Spiteri and Nepal, 2008; Shah and Alg-lu, 2010; Shu and Nie, 2013), which verified validity and reliability of scales for tests, with slight modifications based on information gleaned from our pre-survey findings. The survey instrument contained 18 multiple-choice questions and 2 open-ended questions (Supplementary Material A, Table A.2; Supplementary Material B). The questionnaire contained five parts. The first part involved information about household location, demography (4 items) and socio-economic status (8 items), including Ethnic, family size, education level of household head, settle time, family income, number of cattle etc. The second part concentrated on PES programs; the first question is whether respondents participated in any PES program. Subsequently, we asked respondents which PES programs they participated in. Participation of each PES program was coded as binary data. The third part focused on the perception of benefits from PA. Respondents were asked if they perceived any of four possible benefits – increase in income, decrease in natural disaster, improved living environment, and improved ecological health— from establishing the PA. Living environment referred to households' living conditions and surrounding environment, while ecological health referred to broader environmental and human health across the PA. The fourth part of the survey contained questions about opinions of respondents related to ecological relocation, including questions about eco-tourism and expectations for the future. The last section contained questions about willingness to relocate (as a binary variable) and associated reasons for this attitude.

Land cover data were extracted from land use maps produced by the Yunnan Service Center of Chinese National Survey and Planning Administration (interpreted from SPOT imagery). In consideration of the concentrated distribution of households within villages in DPA, location of each survey was coded as the center of each village. Distances to road, township, water area, and scenic locations were generated using the Euclidean Distance function in ArcGIS v. 10.6 (Esri, 2016). Scenic locations were defined from a recreation resource survey reported in the Tourism Planning Report of Dashanbao Nature Reserve (Tourist

Administration, 2012). To summarize livestock ownership, livestock unit (LSU) (Eurostat, 2013) was used to measure the total grazing equivalent of the number of cows, sheep, goats, horses, pigs, and poultry.

## 2.3. Data analysis

All survey data were coded and reviewed to ensure completeness and accuracy. The final sample included 499 households; 13 household questionnaires were removed due to some incomplete answers. In order to assist data interpretation, household descriptive statistics were calculated standard socio-economic characteristics and relocation willingness of respondents' choices percentages with respect to each category.

To examine the influence of many independent variables on a nominal dependent variable (e.g., willingness/unwillingness to relocate), multiple logistic regression has been widely used (Hosmer and Lemeshow, 1980; Li et al., 2014; McDonald, 2014; Wang et al., 2018a), which assesses the influence of several independent variables on a single dichotomous outcome variable. First, we employed binomial logistic regressions to explore the importance of each independent variable in explaining willingness to relocate. 23 significant variables were selected as candidate predictors (Supplementary Material A, Table 2). Though factors of ethnic, settlement year, and education were non-significant predictors, considering the effects of social status influencing people's willingness in previous studies (Dhakal et al., 2011; He et al., 2018a), these three variables were selected as control variables. In the next step, we used multiple logistic regression to examine the relationship between factors influencing dependent (Y) variable of willingness (or not) to resettle with and without the control variables (Wandersee et al., 2012). Data from 436 households were included in multiple logistic regression models, of which 63 households were further excluded from logistic regression because of missing values. Multicollinearity diagnostics included Pearson's  $r$  for continuous data and the variance inflation factor (VIF) (O'Brien, 2007). All VIF values were below 10 and Pearson's  $r$  did not exceed 0.7. Consequently, no subsequent variable was excluded from the multiple regression model (see Supplementary Material A, Table A.3 for details). We analyzed model fits based on model deviance and Akaike Information Criterion (AIC) (Anderson and Burnham, 2004; Wandersee et al., 2012).

To further explore the effect of PES programs on respondents' perception, additional multiple logistic regressions were performed. Four yes/no questions were used as dependent (Y) variable to measure the perception of benefits of PAs: 1) income increase, 2) natural disaster decrease, 3) improved living environment, and 4) improved ecological health, with 1 indicating those households agree that this benefit accrues from the PA and 0 indicating households that never perceive the benefit. Participation in previous PES programs (Grain-to-Green Program<sub>1999</sub>, Grain-to-Green Program<sub>2003</sub>, Payment for Wetland Ecosystem Services, Ecological Compensation) was dummy variables in this regression. Variables were considered significant at  $p < 0.05$ . Interacting effects of participating in several projects simultaneously was also considered. Multiple Correspondence Analysis (MCA) was used to further explore the relationships between reasons for unwillingness to relocate, participation in various PES programs, location, and social background (He et al., 2018a). Data were analyzed using JMP Pro 14 software (JMP®, 1989-2019).

## 3. Results

### 3.1. Household descriptive statistics

All surveyed households lived within the PA; the largest percentage of households was located in the Core Area (56.1%), followed by the Experimental Area (26.9%) and Buffer Area (17.0%) (Table 1). Most households are indigenous peoples who settled in DPA from their ancestors' time (95.0%). Education level of the head of household is low; the

**Table 1**  
Summary socio-economic characteristics and willingness to relocate of the surveyed households in DPR (n = 499).

	%		%
<b>Location of PA zone</b>		<b>Settlement time</b>	
Core area	56.1	From ancestors	95.0
Buffer area	17.0	From father's generation	3.9
Experimental area	26.9	From this generation	0.8
Outside of PA	0	Immigration	0
<b>Education of household head</b>		<b>Income from farming and herding</b>	76.2
Primary school or below	61.1	Occupation: farmer	90.8
Secondary school	37.1	Occupation: pastoralists	40.3
High school	1.8	<b>PES participation</b>	95.1
College and above	0	GTGP_2003 participation	42.8
<b>Ethnicity</b>		PWES participation	41.8
Han	91.4	GTGP_1999 participation	35.3
Yi	4.0	EC participation	37.5
Miao	4.6	<b>Willing to relocate</b>	47.1
		<b>Unwilling to relocate</b>	52.9

highest educational level achieved is high school (1.8%). Three ethnic groups were living in DPA, with Han constituting the largest group by far (91.4%). The majority of households sampled in DPA were farmers (90.8%). Annual household family income was dominated by income from farming and herding (76.2% of income). Approximately 95% of surveyed households had participated in a PES program. The participation rate varied from 35.3% to 42.8% in each program. Surveyed households who are unwilling to relocate are larger in number (52.9%) than willing households (47.1%).

### 3.2. Factors influencing local communities' willingness to relocate in DPA

#### 3.2.1. Model 1 (without control variables)

The multivariate logistic model without control variables showed factors associated with PES program experience; future livelihood expectation, economic status and spatial distribution affect local communities' willingness to relocate (Table 2). Participating in one particular PES program (PWES) resulted in a greater probability of being unwilling to relocate ( $\alpha = -0.616, p < 0.01$ ), while EC had no significant relationship. Respondents envisioning a future livelihood in the tourism business were more likely to be willing to relocate while those envisioning traditional livelihoods complemented by tourism were less likely to be willing to relocate. Interestingly, respondents expecting future work in DPA were more willing to relocate outside of the PA. Farmland size has a significant negative effect on willingness to relocate in the model ( $p < 0.05$ ) while other variables related to family assets did not significantly affect relocation willingness. Location of the respondent is significant in the model. Households in core and buffer zones are more willing to relocate. In addition, those farther from scenic spots ( $p < 0.05$ ) and main roads ( $p < 0.05$ ) were significantly more willing to relocate ( $p < 0.05$ ). Conversely, willingness to relocate slightly decreased with increasing distance from water.

#### 3.2.2. Model 2 (with control variables)

After integrating control variables of ethnicity, education, and settlement time, the full model performance improved and model parameters changed modestly, with the main factors remaining similarly powerful and in the same direction as the model without controls (Model 1; Table 1). Previous involvement in the PWES program remains significant in all models ( $p < 0.01$ ). In addition, spatial variables of distance to main road and scenic spots also significantly predict willingness to relocate across all models ( $p < 0.01$ ), as does location in core and buffer zones ( $p < 0.01$ ). Variables about farmland remain significant as in the first model. Only three variables of cattle units, future livelihood [traditional ways with tourism], and distance to water changed in significance (but not sign) with the addition of control variables. Cattle units became significant with control variables. Households with

**Table 2**  
Multiple logistic regression models of results of respondents' willingness to relocate.

Explanatory variables	Model 1: without control variables	Model 2: with control variables
	Coefficient $\alpha$	Coefficient $\beta$
Family member	0.13	0.177
Farmland	-0.096**	-0.095**
Cattle unit	-0.096	-0.113*
Family income/Yuan	2.03E-05	1.62E-05
Numbers of room	-0.084	-0.078
Newest house/year	-0.016	-0.013
Participation in PWES	-0.616**	-0.636**
Participation in EC	0.181	0.123
Participation in eco-tourists' business	-0.126	-0.390
Future livelihood [traditional farming]	-0.551	-0.413
Future livelihood [traditional ways with tourism]	-0.769*	-0.491
Future livelihood [tourism business]	0.745*	0.796*
willing future work in DPR	1.886**	2.034**
Location of PA: core area	1.061**	1.404**
Location of PA: buffer	1.489**	1.916**
Distance to main road <sup>#</sup>	0.0002*	0.0003*
Distance to water <sup>#</sup>	-0.0004*	-0.0002
Distance to scenic spot <sup>#</sup>	0.0008**	0.0007**
Ethnicity: non-Han	-	12.514
Education of head: primary school	-	-0.003
Education of head: secondary school	-	0.884
Education of head: high school	-	1.590
Settlement time: from ancestor's generation	-	1.533
Settlement time: from father's generation	-	-0.035
Settlement time: from this generation	-	30.493
RSquare (U)	0.3645	0.4134
AICc	422.063	408.232
BIC	497.712	510.818
Number of obs	436	436

- not in the model.

\*  $p < 0.05$ .

\*\*  $p < 0.01$ .

<sup>#</sup> Refers to spatial variable.

increasing head of cattle have a significantly decreased willingness to relocate ( $p < 0.05$ ). On the contrary, variables of future livelihood [traditional ways with tourism] and one spatial variable (distance to water) became non-significant ( $p > 0.05$ ) when control variables were considered.

### 3.3. Influence of current DPA conservation policy on respondents' perceptions

To further understand why some participants are more or less willing to relocate, we identified through multiple logistic regression that participation in different PES programs significantly influenced respondents' perception of the benefits of PAs (Table 3). Participation in PWES positively influenced the respondents' perceptions of the benefits from PAs, while respondents involved in the EC program had significantly negative perceptions of the influence of the PA on income, reduced natural hazards, and improved ecological health. No significant effect of the 1999 or 2003 GTGP programs on respondents' perceptions of PA benefit was found. Participation in multiple conservation programs could affect attitudes. Respondents involved both in 2003 GTGP and PWES felt that DPA improved both the living environment and ecological health.

### 3.4. Reasons for local communities' willingness to relocate

Local residents have different reasons for being unwilling to relocate from within the PA (Fig. 2). Concerns about their future livelihood caused by relocation are the main reason; respondents believed it would be hard to find a job (21.7%) and were concerned about losing farmland (20.5%). A sense of belonging is the other main reason, cited

**Table 3**  
PES programs implemented in DPA influence on respondents' perception of s benefits from DRA identified from multiple logistic regression. GTGP: Grain-to-Green Program, PWES: Payment for Wetland Ecosystem Services, EC: Ecological Compensation.

	Income increase	Natural disaster decrease	Living environment improvement	Ecological health improvement
GTGP <sub>-1999</sub>	-0.164	0.211	0.101	0.015
GTGP <sub>-2003</sub>	-0.163	-0.071	-0.114	-0.148
PWES	0.348**	0.334**	0.413**	0.567**
EC	-0.416**	-0.452**	-0.184	-0.327**
GTGP <sub>-2003</sub> * PWES	0.137	0.064	0.101	0.486**
PWES * GTGP <sub>-1999</sub>	-0.128	0.174	0.244*	0.265*
GTGP <sub>-2003</sub> * GTGP <sub>-1999</sub>	0.099	0.289*	0.202	0.074
GTGP <sub>-2003</sub> * GTGP <sub>-1999</sub> * PWES	-0.212	0.177	0.199	-0.125
Prob>ChiSq	0.0003**	<0.0001**	<0.0001**	<0.0001**

Coefficients are marked with a \* (\*\*) at a significance level of  $p < 0.05$  ( $p < 0.01$ ).

by 19.8% of respondents unwilling to relocate. Concerns about city life were also cited, but at relatively lower frequencies.

The MCA revealed that the reasons for unwillingness to relocate varied with the education of the head of household, zone within the PA, and previous PES program participation (Fig. 3). The first axis of the MCA (86.2% of variance) was correlated with willingness to resettle. Those residents unwilling to relocate from the buffer zone had previously participated in the PWES program and cited a sense of belonging and not wanting to adapt to city life for not wanting to leave. Those in the core zone and unwilling to relocate were involved in the GTGP (2003) program, had low educational attainment, and voiced concerns about finding work if they were relocated.

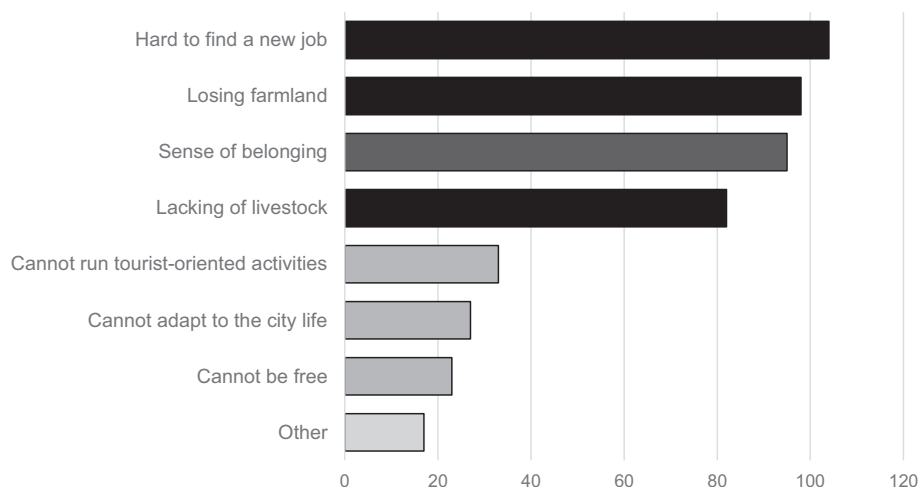
#### 4. Discussion

We explored the factors influencing the willingness of PAs residents to relocate. We found previous PES program experience affects residents' perceptions of future relocation policy. Socio-economic status and spatial heterogeneity are important factors affecting willingness to relocate. Concern about a sustainable livelihood and loss of a sense of belonging characterized the two main clusters of reasons motivating willingness to relocate. This finding represents the early study of factors influencing willingness of local residents to participate in the forthcoming large-scale ER program associated with the new national park and PAs system in China. Our study provides important new information for understanding and refining ER and other environmental policies (e.g., PES in China), and the results may be useful for understanding similar challenges in other countries and regions, especially in developing countries considering ecological relocation as an intervention to alleviate park versus people conflicts and environmental pressure.

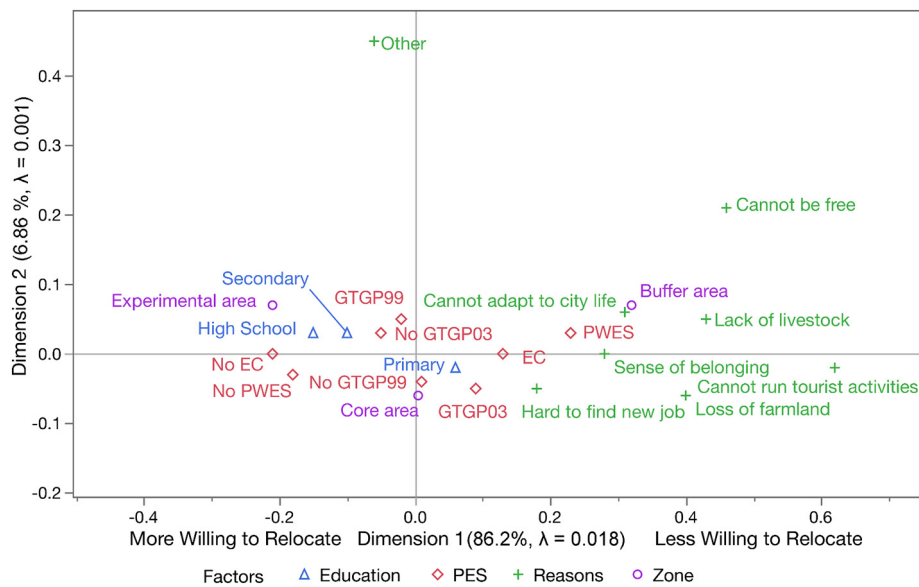
#### 4.1. Previous PES experience influences residents' perceptions

Our results suggest that previous PES participation experience affects residents' perceptions of future relocation policy and PA benefits in DPA. PES schemes provide a mechanism to link conservation actions and incentive payments in a manner that influences economic income (Markova-Nenova and Wätzold, 2017), income structure (Sheng et al., 2019), and even participants' way of earning a livelihood. Finger's study (Finger, 1994) indicated that significant environmental life-experiences could develop experiential knowledge and shape one's behavior, and thus play a critical role in future decision-making (Fazey et al., 2006). In our example, people involved in one particular program (PWES) had a positive perception of PA benefits and were less willing to relocate, while people who participated in an EC program had a negative attitude toward PA benefits. This result is consistent with previous studies in southern Shaanxi, China (Wang et al., 2018b), which found enrollment in the Sloping Land Conversion Program significantly influenced the decision to participate in an ER program. This result can be understood economically, as the PWES program offered sufficiently large payments to sustain local household livelihoods (Kolinjivadi and Sunderland, 2012; Trædal et al., 2016), thereby reducing willingness to resettle. Landholders involved in PWES received on average 15,680 Yuan (about 2300 USD) for each household, accounting for >80% of mean annual family income.

In contrast, poorly designed PES schemes may arouse negative attitudes toward PAs (Petheram and Campbell, 2010), and lead to failure to meet conservation objectives (Du, 2012). The underfunded payment (9 Yuan per year to every local household) of the EC program in DPA does not compensate for economic loss of crops eaten by Black-necked Cranes. The negative effects are compounded by the fact that



**Fig. 2.** Distribution of reasons respondents were unwilling to relocate ( $n = 499$ ).



**Fig. 3.** Multiple correspondence analysis biplot. The biplot shows reasons for being unwilling to relocate from respondents involved in different PES programs and affected by location zones and household educational level.

compensation funds are distributed equally among the population throughout the entire PA, rather than being designed in such a way as to compensate proportionately to losses. The issue of crop loss caused by birds is not unique to DPA, nor is the negative attitude of local people resulting from under-funded compensation for animal damage (Wagner et al., 1997). The success of PES and resulting actions and attitudes of participants depends on the design of the scheme (Chen et al., 2012). Payments that are too low or are not calibrated to economic losses over space have higher possibility to result in negative attitudes toward other conservation programs.

We found that residents participating in the PWES program have a positive perception of the benefits of PAs, a potential explanation for an important underlying motive behind relative willingness to relocate. This result differs from García-Amado's studies (García-Amado et al., 2013), in which local people participating in PES program were relatively more reluctant than non-participants to acknowledge the benefits of PAs. In Dashanbao, participation in PES programs, which provides an opportunity for local people to receive direct payments and get benefits from environmental improvement, tends to significantly raise their environmental awareness and improve recognition of the benefits of PAs (Wandersee et al., 2012). Studies in Guatemala, Cambodia, Tanzania, and elsewhere have provided other evidence that PES schemes can be effective tools for improving environment and supporting rural livelihoods (Ingram et al., 2014).

#### 4.2. Socio-economic status and spatial heterogeneity are important factors

Socio-economic status and future life expectations also influenced willingness to relocate. Family assets also played an important role affecting willingness to relocate. Our findings mirror studies of Shah and Alg-lu (2010) in that those households with more livelihood physical capital (e.g. farmland, cattle) (Du and Zou, 2018), were more reluctant to move outside of PAs. We did not find a significant relationship between family income and household willingness to relocate, unlike the ER program in Similipal Tiger Reserve, India (Dash and Behera, 2018) and in Ningxia, China (Shu and Nie, 2013), where income had a significant impact on willingness to relocate. It could be understood from the income structure in DPA that >90% of households are farmers whose income is mainly from annual grain yield that is greatly affected by weather and natural disasters in reserve. In our study, therefore, fluctuating annual income is less valid predictor compared with family fixed assets (e.g. farmland, cattle).

It is worth noting that residents who expected to engage in tourism and to seek work opportunities in the future national park after relocation were more willing to participate in a relocation program. These results are consistent with the “push pull paradigm” in that residents perceived more opportunities after relocation that had a pulling impact on the decision to participate (Wang et al., 2018b). It also can be explained from prospect theory and expected utility theory that farmers who are risk taking appear to be more willing to change their way of living and to participate in relocation programs (Dustmann et al., 2017). Though eco-tourism in DPA is still in its early stages, it has potential to provide an additional alternative livelihood (Shen et al., 2008; Tao and Wall, 2009).

Spatial heterogeneity of communities is another important determinant of willingness to relocate. Variation of community location will lead to differences in natural and scenic resource use, environmental problems experienced, and ecological compensation opportunities, which in turn will influence people's environmental perception and relocation decisions (Blake, 2001; Dash and Behera, 2018). This possibility was evident in the survey in that willingness to relocate significantly increased with distance from scenic spots. More importantly, management strategies differ within zones of PAs. Restricted activities in core and buffer zones may limit economic development and investment in infrastructure, which contributes to increasing willingness to relocate. It is worth noting that willingness to relocate significantly increases with distance from roads in DPA. A similar result was obtained in Wolong Biosphere Reserve, China, where distance of a household from a main road reduced accessibility while increasing transport and living costs, resulting in higher willingness to relocate (Xu et al., 2006). At present, China's national policy of building paved roads to every rural household to improve wellbeing of rural residents may reduce willingness of those residents to relocate and increase the difficulty of implementing relocation policy in PAs. Transportation planning and especially road building in rural PAs should carefully consider the conservation goals of the PA and the tradeoff of road building for implementation of conservation policies.

#### 4.3. Reasons for unwillingness to relocate

Our study revealed clusters of factors associated with unwillingness to relocate. This suggests that decision-makers of PAs can identify the reasons that residents with different characteristics are reluctant to relocate and then adapt relocation strategies accordingly when relocation



is indeed necessary. For example, for the cluster of residents who worried about finding a new job with a low education background, a relocation program could provide job skills training to improve their confidence and ability to adapt to a new job. In addition, we found concerns about a loss of sense of attachment and park-related place identity are main reasons motivating unwillingness to relocate for a certain group. Local communities in DPA have formed a strong sense of attachment and park-related place identity (Carrus et al., 2005), which generates a people-park bond (Buta et al., 2014). Relocating outside of the park disrupts this attachment, and it is difficult for park-based communities to be integrated into a new community outside the park. Furthermore, resettling the resident population from the park will lead to loss of opportunities to run tourist-oriented activities within the park. If a relocation program must be implemented for this group, the program could focus on building a sense of community after relocation.

Many PAs in developing countries experience similar circumstances as DPA: locals usually have low educational attainment and traditional agriculture and animal husbandry have been their way of life for generations. This traditional livelihood provides stable income from subsistence agriculture and livestock. Relocation will force them to shift away from their traditional lifestyles and occupations, learn new skills, and adjust to a new occupation, which is relatively difficult for people with lower educational backgrounds (Xu et al., 2006). Furthermore, loss of pastures, farmland and other natural resources caused by relocation can cause a host of negative impacts on residents who heavily depend on traditional resource-oriental livelihoods, and for whom loss of resources directly reduces family income (Du, 2012). A similar situation occurred with a relocation program at Kuno Wildlife Sanctuary in India (Rangarajan and Shahabuddin, 2006), where relocated villagers who lost their traditional forest products for both nutrition and incomes, led to severe impoverishment and became an economically marginal community in resettlement sites.

#### 4.4. Implications

The world's largest ecological resettlement program, China's establishment of a national park system, is on the horizon. Our results suggest that relocating park-based communities to urban areas should proceed with caution. Relocation packages with land and agriculture development schemes should be considered (Lashorchix and Koshari, 2009). They appear to have higher probability of maintaining original livelihoods and the land-people bond. If relocation policy is to be planned, spatial variation should be considered, and an adaptive ecosystem-based management with regard to community needs and conservation requirements should be applied in future national parks.

More importantly, our research suggests that a well-designed PES scheme has the potential to provide alternative livelihoods and increase positive attitudes toward the environmental quality and ecological health improvement in PAs (Cimon-Morin et al., 2013). Instead of expensive, large-scale relocation of indigenous peoples, and because of increasing social and ecological uncertainty, we encourage better designed PES programs based on a land easement system that incorporates conservation needs with local people's perceptions into conservation easement agreements (He et al., 2018b). In this case study, unwillingness to relocate paradoxically may be beneficial to Black-necked Crane conservation if managed appropriately. Agricultural fields near roosting sites are key foraging habitats for Black-necked Crane and the probability of occupancy for cranes declines with distance from agricultural villages (Kong et al., 2011; Peng et al., 2020). Well-designed PES schemes that consider effects on conservation needs and social results rather than focus only on landowners' profits can achieve conservation objectives by managing private and collective land ownership of PAs while maintaining sustainable livelihoods (Ingram et al., 2014; Wang et al., 2019). If carefully planned and managed, potentially harmful activities in PAs can be managed through easement agreements (Su, 2019), and eco-tourism appears to be an alternative sustainable

livelihood strategy for local communities and could be encouraged (Tao and Wall, 2009; Wandersee et al., 2012). Local people with deep land attachment participating in eco-tourism have the potential to create "win-win" scenarios for conservation and sustainable livelihoods. The pilot national park of Sanjiangyuan is a good example. Hiring local residents to do eco-tourism related jobs leads to higher income while staying and working on their land and benefiting conservation (Yangguang, 2018). Our research examines driving forces behind attitudes toward conservation policies in a rural, subsistence landscape. The results demonstrate an influence of environmental programs on attitudes toward subsequent programs. Our modeling approach could be developed and applied to future national park policies in China and to other environmental programs globally.

## 5. Conclusions

Exploring the impact of experiences with previous environmental programs on human perception and future environmental decisions is an important extension of coupled human and natural systems theory and environmental policy practice. Moreover, integrating those experiences with the spatial characteristics of communities into models to understand attitudes arising synergistically across social and spatial dimensions provides crucial insights for the upcoming Chinese national park policy and other community-based conservation programs globally. PES design significantly influences participants' perceptions of environmental programs. Perceptions formed from previous involvement in a program can influence willingness to relocate. Besides major concerns about future sustainable livelihood, multifactor analysis identified that losing a sense of belonging is also an important contributor to unwillingness to relocate. In planning relocation policy, relocation packages with land and agriculture development schemes to maintain original livelihoods and the land-people bond are encouraged. Rather than implementing large-scale relocation, integrating local people's perception into PES schemes have potential to minimize harmful human activities on private and collective land ownership while facilitating environmental and livelihood sustainability. Future work will further explore how to integrate perception into PES program design and relocation program planning. Integrating local people's perception into PES schemes and ecological relocation policy can ultimately increase the sustainability of the environment and subsistence livelihoods in PAs globally.

### CRedit authorship contribution statement

**Wanting Peng:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Software, Validation, Visualization, Writing - original draft, Writing - review & editing. **David López-Carr:** Formal analysis, Methodology, Validation, Writing - review & editing. **Chengzhao Wu:** Conceptualization, Funding acquisition, Project administration, Resources, Supervision, Writing - review & editing. **Xin Wang:** Conceptualization, Data curation, Formal analysis, Investigation. **Travis Longcore:** Conceptualization, Formal analysis, Methodology, Software, Supervision, Validation, Visualization, Writing - review & editing.

### 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.

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## Appendix A. Supplementary data

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