



Research article

Relocating disaster-prone villages and improving villager well-being: Evidence from Beijing, China

Jichao Wang¹, Xiaoning Sui², Jie Zhang^{1,3,*}, Wenjie Shi⁴ and Wayne L. Thompson^{5,6}

¹ School of Sociology and Psychology, Central University of Finance and Economics, Beijing, China, 100081

² School of Economics, Central University of Finance and Economics, Beijing, China, 100081

³ Buffalo State University, State University of New York, Buffalo, New York 14222, USA

⁴ School of Foreign Studies, Central University of Finance and Economics, Beijing, China, 100081

⁵ Concordia University, Mequon, Wisconsin, 53097, USA

⁶ Carthage College, Kenosha, Wisconsin, 53140, USA

* **Correspondence:** Email: zhangj@buffalostate.edu.

Abstract: Relocating disaster-prone villages serves both as a strategy and a method for the Beijing Municipal Government to address the life and work challenges faced by these communities. This approach ensures the safety and security of villagers' lives and property, reduces community and resident vulnerability to disaster risks, enhances resilience, and promotes sustainable development. Using a questionnaire research and disaster sociology perspectives, this study explored the perceptions of the well-being of 360 relocated villagers from ten disaster-prone villages in rural Beijing. Findings show that follow-up support projects, CCP branch secretaries, and community services in these relocated villages significantly improved villagers' well-being. Therefore, we suggest that relocation, the role of the CPC branch, and the development of a diversified social security and service network focused on livelihoods and production are effective in enhancing villagers' well-being.

Keywords: disaster-prone villages; Beijing; relocation; well-being

1. Introduction

As the occurrence of natural disasters becomes more frequent, countries are challenged with

floods, hurricanes, and wildfires, which heavily affect human life and property. Relocating villages from locations susceptible to disaster risks to safer settlements with sound infrastructure systems is an accepted approach to disaster avoidance, prevention, and poverty alleviation in China. Disaster-prone villages in Beijing are sparsely populated and located in mountainous regions susceptible to natural disasters, including bushfires, floods, or landslides. In these mountainous areas, Beijing is seeking to improve the quality of the ecological environment and promote farmers' income so that they can live in peace and work in contentment. These areas are being proposed to be included in the current round of relocation, as they are prone to geological disasters such as floods and offer poor living conditions (e.g., drinking water difficulties, dispersed living, and inconvenient transportation); at-risk and low-income villages and households are the key subjects for relocation. In these villages, life and community well-being depend on access to clean drinking water and adequate transport infrastructure. The specific risks faced by disaster-prone villages are divided into four categories. First, heavy rainfall, which may lead to flooding of farmland and rivers, posing a threat to agricultural production and people's lives. Second, flash floods; these disasters have become challenging to defend against due to the increase in extreme weather events. Third, geological disasters, which mainly include landslides, avalanches, and mudslides, all with complex causes and a wide range of impacts. Fourth, strong convective weather, which mainly includes thunderstorms, gusty winds, and hail that damage crops and facility agriculture.

Since 2003, Beijing City government departments have completed four rounds of relocation to improve villagers' living and working conditions and to enhance their well-being and sense of achievement. These projects have relocated approximately 150,000 inhabitants from 64,299 households [1–4]. Relocation is funded by four strategic plans based on national macro-policy for rural development—National Well-off Society Project (2003), Socialist New Rural Community Project (2008), Rural Ecological Upgrading Project (2012), and Beautiful Rural Community Project (2018). Related additional projects include upgrades to reduce rural residential energy use, improving earthquake resistance, sandstorm sources management in Beijing and Tianjin, a clean-energy residential heating project in rural areas, and a grant program for upgrading disabled villagers' homes. These projects have secured financial and social benefits for relocated people, enhanced the safety and security of houses, improved developing businesses and industries, and expanded employment opportunities [1–4].

Still, it is crucial to acknowledge that these relocations have not been without their challenges. For some relocated villagers, their sense of well-being and achievement may have been compromised. Relocation policies and regulations are incomplete; in particular, there is a lack of coherence or even conflicts among relevant policies. This may inadvertently erode social cohesion and heighten tensions within these communities. These challenges have made it challenging to execute industrial projects, resulting in slow progress, meager returns, and the absence of incentivizing mechanisms [5].

The Global Assessment Report on Disaster Risk Reduction (GAR), released by the United Nations Office for Disaster Risk Reduction (UNDRR), categorizes disaster risk assessment into three critical dimensions: hazard, exposure, and vulnerability [6]. This article delves into a myriad of constructive strategies and methodologies aimed at enhancing the defense capabilities of residents in Beijing's disaster-prone villages through relocation initiatives. From a perspective of disaster sociology research, this study casts a spotlight on the vulnerability of residents to disaster risks, providing a valuable case study involving communities and individuals facing significant risks.

2. Literature review and research hypotheses

Well-being refers to the positive psychological experience of individual survival and development affected by internal and external factors [7]. Disaster sociology defines vulnerability as the degree to which different groups of people, communities, and societies are prone to harm when defending against and coping with disaster risks. This is a key concept for understanding the potential impact of disasters. Vulnerability weakens the ability to defend against and cope with disaster risks, being divided into natural and social dimensions. Natural susceptibility relates to the exposure of natural environments, including ecosystems, landforms, and resources, to hazards and disasters, influenced by factors such as geographic location, terrain, and climate. Social susceptibility refers to individual and community susceptibility to harm and disaster, based on factors including socioeconomic status, education, age, gender, and race [8].

2.1. *Impact of villager evaluation of well-being*

Relocating disaster-prone villages may reduce the natural vulnerability to disasters, improving economic resources and perceived well-being. Implemented by local government and CCP departments, relocation projects receive direct grants. Grants, policies, and projects improve the relocation of disaster-prone villages to new settlements and help villagers establish new ways of living and employment, which enhances personal adjustment [4].

Zheng et al. reported that relocation grants helped train and upgrade productive skills and improved skills for obtaining employment, raising household incomes and life satisfaction [9]. In 2015, Zhang and Chen studied integrated relocation for mountain-locked villages in Jiangxi Province. Direct financial grants addressed housing issues, upgraded infrastructure, improved villagers' lives, and reduced employment concerns. Financial aid lowered vulnerabilities following natural disasters and reduced poverty, property loss, and accidental outcomes, promoting happiness and higher work productivity, life satisfaction, and well-being [10,11].

Grassroots local CCP branches are committed to relocating villagers and building new settlements in an integrated way, creating community service centers and volunteering stations for public benefits, and providing comprehensive services for low-income subsidy applications, health security, and insurance assistance. These efforts strengthened CCP public credibility, provided effective public services, modernized social governance systems, improved grassroots CCP division capacities, and promoted villagers' well-being and employment [12,13]. Li et al. found that CCP leadership facilitated relocation and the creation of new settlements. Establishing grassroot CCP divisions and community management councils improves CCP political and ideological leadership, improving competence and effectiveness and mobilizing villagers and the broader public [14]. Then, how does villagers' positive evaluation of these grassroots organizations determine their perceived well-being after relocation?

Relocation follow-up support projects primarily promote employment and economic activities. Economic development should be planned and implemented in an integrated and balanced manner, nurturing employment skills based on available natural resources and industry. Employment-focused business model components include "Company (Selling) + Production base (Hiring) + Villager (Making)" and "Sole trader + Centralized guidance" [15]. Administration, funds, and policy support are prerequisites for villager relocation, adapting to new communities, and living comfortably. Industry, business organizations, and technology and local industry raise villagers' income and well-being [16].

The core goal of relocating disaster-prone village residents is to improve their economic, anti-risk, and self-development capacities. Grassroots governments and CCP divisions organize and mobilize for relocation projects. Follow-up support projects increase income, benefitting relocated communities. According to relevant studies, direct compulsory financial grants do not significantly contribute to well-being among relocated villagers. Then, what is the impact of villagers' positive evaluation of these well-being support projects on their perceived happiness after relocation?

From the perspective of disaster sociology, social and natural factors interact in affecting the vulnerability and effectiveness of disaster responses. The goal of the relocation of disaster-prone villages is to enhance economic and environmental resilience as well as self-development capabilities. Disaster sociology focuses on social variables and processes affecting the adjustment following relocation.

2.2. The impact of building settlements variables on well-being

Bjarnadottir et al. suggested that building new settlements after the relocation of disaster-prone villages can meet work and life needs by providing childcare, pensions, leisure, healthcare, entertainment, counseling, employment, and legal consultations. Improving community utilities, including water supply, electricity, gas, solid waste treatment, and community property management, raises the well-being of disaster-prone villagers [17,18]. Infrastructure upgrades and ecological and environmental preservation are crucial to building effective new village services. Construction of new villages improves anti-risk resources and resident self-development capacities. Therefore, this study assesses the development and impact of community service systems in relocating and rebuilding disaster-prone villages and residents. Namely, we question: What is the impact of villagers' positive evaluation of the community service systems on their perceived well-being after relocation?

2.3. Disaster, risk, and resilience

Adverse consequences of disasters can be both real and perceived, including their economic, emotional, social, and cultural dimensions [19]. When disasters occur, threats and losses are ubiquitous and felt across classes and other social categories. Institutional responses and community and personal resilience may moderate the negative impacts of disasters with universal impacts.

The awareness that rationality, science, and industrial activities have negative impacts causes uncertainty and heightens the perceived sense of threat. With modernization, the tradition and legitimacy of social norms are challenged by feelings of threat. Characterized by Beck as the risk society, reactions to perceived risk are reflexive, including movements linked to fears about science and technology [20]. Resilience reduces the perception of harm following disasters. When disasters occur, social relationships and institutions also leverage threats to well-being, strengthening social solidarity and personal adjustment. Research should identify disaster responses that reduce harm and improve personal adjustment and equity.

Governance and legitimation are central concerns of risk research [21]. Douglas explored how weakened regulatory institutions amplify identity and solidarity crises for modernized societies [22], eroding trust [23]. Reciprocal relationships between rewards, resources, and institutional responses form the social context of trauma reactions [24]. Following disasters, bonding and attachment are compromised, diminishing hope and desire for life. Institutional responses may increase or lower social cohesion or tensions.

The perceived well-being following disasters expresses resilience and persistence under stress [25]. Lucini studied the responses to three Italian earthquakes, finding that individual and community resilience are affected by institutional responses, potentially improving coping and recovery [26]. Community resilience builds from networks of adaptive capacities, which promote population wellness and equity [27] and enhance hope [28].

Structural-functional perspectives assume that adaptive responses to disaster may reduce or worsen social cohesion, affecting and being moderated by personal and community resilience. Durkheim theorized that modernized societies are highly interdependent, imposing structure on individuals and institutions to improve organic solidarity [29]. Through the functionalist lens, governance and community roles in disaster response affect the sense of belonging and resilience, both resources for recovery.

2.4. Hypotheses

Reducing social and natural vulnerability of disaster-prone village residents requires varied coping strategies. Construction of new community service systems for relocated villages and improving resident capacity in the new location across different demographics affect social vulnerability. The approach of Beijing Municipal Government for disaster-prone villages focus on relocation actions and the construction of post-support projects. Natural vulnerability mediates perceived well-being gains. Combining the above analyses, three hypotheses are proposed.

Hypothesis 1: Controlling for other variables, following relocation, villagers' positive evaluation of grassroots CCP divisions enhances their perceived well-being.

Hypothesis 2: Controlling for other variables, following relocation, villagers' positive evaluation of follow-up support projects reduces their vulnerability and improves their perceived well-being.

Hypothesis 3: Controlling for other variables, following relocation, villagers' positive evaluation of community service systems enhances their perceived well-being.

3. Research methods

3.1. Data source and samples

This study is an integral component of the program Anti-poverty Intervention and Relocation for the Disaster-Prone Village in Beijing, funded in 2017 by the Beijing Social Science Funds. This comprehensive research endeavor focuses on a diverse group of ten villages scattered across five distinct Beijing districts—Shijingshan, Huairou, Mentougou, Miyun, and Yanqing. To capture a truly representative sample of the study population, the research team employed sophisticated multistage and stratified probability and ratio calculation methods for the sampling process. The comprehensive approach can be outlined as follows.

In order to delve deeper into the complexities of disaster-prone villages, the research group thoroughly categorized them into two distinct groups based on the relocation patterns of their inhabitants. The first category encompasses villages where the population has entirely migrated to urban areas and includes seven villages (roughly 10% of the total). The second category is characterized by the establishment of new villages within rural settings, where residents have moved to safer local areas. This category includes 68 villages.

For the purpose of data collection, the research team carefully selected one community from the first category using a rigorous sampling method. Additionally, nine villages from the second category were designated as survey points. To ensure a comprehensive understanding of each village's situation, the team collected samples from 30% of the total population in each village, who were then invited to participate in the questionnaire-filling process. To guarantee the accuracy and reliability of the data collected, the study adopted a formal survey approach, conducting face-to-face interviews. This method not only enhanced the quality of the responses but also fostered a deeper connection between the researchers and the participants, leading to more insightful and authentic data.

In order to improve the reliability and effectiveness of the questionnaire project, this study followed strict scientific norms from questionnaire design to implementation. In the early stages, we collected and studied many relevant regulatory and policy documents, as well as questionnaires and scales, and designed preliminary questionnaires. Afterward, we recruited 15 relocated residents from disaster-prone villages in Shijingshan District for a pre-test pilot study, consulted experts, village leaders, and elderly residents, and revised the questionnaire using these answers and suggestions. Finally, a formal questionnaire survey was conducted using the above method.

3.2. Variables and descriptive statistics

3.2.1. Dependent variables

The dependent variable was the perceived well-being following relocation from disaster-prone Beijing villages, measured from self-reported responses to inventory items. Responding villagers were asked "How satisfied are you now in comparison with the time before the relocation?". This item measures changes in the well-being of relocated villagers. Response attributes were coded as 1 (reduced), 2 (unchanged), or 3 (increased).

Example of an interview:

"I was trading in the city before, and my income was okay. I didn't want to come back at first. We are far away from Beijing city, and we were not famous at that time, so who would come all the way here? And then again, everyone says that there are a lot of cars passing by, but no one parks them, so I didn't want to come back in the first place. Later, because of some urban planning reasons, the business was not doing well in the city. At that time, the village said to set up a cooperative, I think I also have some contacts, can help think of a solution, I also have feelings for this place, so I came back."

3.2.2. Independent variables

Independent variables were chosen to predict well-being related to relocation from disaster-prone villages and the construction of new communities. Two variables measured relocation assistance: The perceived helpfulness of grassroots CCP branches, or "helpfulness", and the perceived utility of follow-up support projects, or "backup utility". Evaluating new settlements referenced components in community service networks.

CCP branch helpfulness was an ordered variable measured by the rating villagers gave to CCP branch secretaries. Ratings were based on a five-point scale, namely: 1 = "very dissatisfied"; 2 = "dissatisfied"; 3 = "no opinion"; 4 = "satisfied"; and 5 = "very satisfied". To aid analysis and

interpretation, responses were re-coded from five to two categories, grouping very dissatisfied, dissatisfied, and no opinion into “below-average satisfaction” and satisfied and very satisfied responses into “satisfied and above”.

Evaluation of follow-up support projects used the same five-point scale, re-coded into three categories for multidimensional data analysis. Specifically, (1) “dissatisfied” responses, which included “very dissatisfied” and “dissatisfied”; (2) “no opinion” responses; and (3) “satisfied” responses, including “satisfied” and “very satisfied”.

Community service was measured by asking villagers to evaluate the community service network using a 0–100 scale. Helpfulness and backup utility measures assessed the perceived effectiveness of local CCP branches in supporting relocation and enhancing villagers’ well-being through the development of follow-up support projects and community service networks. The key variables and measurements for this study are based on relocation policy documents and previous studies.

Example of an interview:

“This public service post, it is two kinds, one bar is you have to go to the examination to go, the government is responsible for the examination, have some professional skills, like computer ah what. The other is not necessary, that is, the village is responsible for, mainly some public service things, anyway, the village to see how to get, arrange for people to do it. There are also subsidies, this is also mainly to consider the poor households have to employment is not, and then the establishment of such a position. Then there is also that service society well, from inside to find people responsible for.”

3.2.3. Controlled variables

Control variables included gender, age, educational attainment, political identity, annual per capita disposable income, and job satisfaction.

Age refers to the 2019 chronological respondent age. Previous research suggests a U-shaped relation between age and well-being [30]. Both age and age-squared were included in models to test for nonlinear age effects on well-being.

Educational attainment was measured by ranked categories for the highest level of formal education obtained. 1 = “junior middle school and below”, 2 = “senior middle school or vocational school”, 3 = “two-year college program”, 4 = “four-year college program”, and 5 = “Master program or above”. For multivariate data analysis, educational attainment was re-coded into 1 = “junior middle school and below”, 2 = “senior middle or vocational school”, and 3 = “two-year college program and above”, which grouped two- and four-year college programs and Master programs or above.

Political identity was coded as 1 = “non-political identity”, 2 = “CCP youth league member”, 3 = “CCP member”, and 4 = “Non-CCP Party member”. Since no respondents reported as being part of category 2, political identity was re-coded into two broad groups: 0 = “Non-political identity” and 1 = “CCP member”. Annual per capita household disposable income related to the year 2019.

Job satisfaction was self-reported using a five-point scale: 1 = “very dissatisfied”, 2 = “dissatisfied”, 3 = “no opinion”, 4 = “satisfied”, and 5 = “very satisfied”. For multivariate modeling, job satisfaction was re-coded to 1 = “below average,” combining “very dissatisfied”, “dissatisfied”, and “no opinion”, 2 = “satisfied”, and 3 = “very satisfied”.

3.3. Research design

The ordered logit model estimated relocation impact on well-being. While testing the feasibility of modeling, we found the data were not sufficiently suitable for the ordered logit model parallel regression assumption. Author's consensus was to use the ordered logit model for a more concise procedure. The basic equations were:

$$\ln\left(\frac{p(Y \leq y)}{1 - p(Y \leq y)}\right) = \theta_j - bx_i \quad (1)$$

$$p(Y \leq y | x_i) = \frac{\exp(\theta_j - bx_i)}{1 + \exp(\theta_j - bx_i)}, j = 1, 2, \dots, J-1 \quad (2)$$

In the above equations, x_i is the independent variable, for which P represents conditional probability; b is the regression coefficient corresponding to the independent variable indexed as i , and θ_j is the gap value. Regression models distinguished dependent and control variables and introduced relocation and settlement variables. Competing models were estimated using Stata (15.0) to identify a preferred model with significant effects while including relevant statistical controls.

4. Findings

4.1. Descriptive statistics

Table 1 presents descriptive statistics for independent, dependent, and explained variables. Relocation significantly improved villagers' self-reported well-being. During relocations and building new settlements, 5.56% claimed overall well-being was reduced, 27.5% claimed it was unchanged, and 66.94% claimed it improved. Overall, the relocation of disaster-prone villages improved villager's well-being.

Females were just over half of the entire sample (52.22%). The mean age was 52.28 years. Junior middle school education or below accounted for 38.89% of respondents, and 36.39% of respondents had completed senior middle school education. One-quarter (24.72%) had completed a college education and above. CCP members comprised 18.06% of respondents. Annual per capita household disposable income was 55,000 RMB Yuan. Following relocation, respondents were satisfied with the new jobs, 43.06% of them reporting "no opinion and below" and 56.94% being "satisfied" or "very satisfied". Overall, relocated villagers were positively supported by the industry, with significantly improved employment and coping.

Almost one-quarter (23.06%) of respondents rated CCP branch secretaries as "no opinion and below", while 76.94% rated as "satisfied and very satisfied," reflecting mostly positive views of CCP branch performance during and following relocations. For follow-up support projects, 27.50% reported "no opinion and below" and 65.28% reported "satisfied and very satisfied"—mostly positive responses. The evaluation of building community service networks in new villages was also mostly positive (76.86%), given the potential conflicts of interest and complexity of the relocation process. New communities established after relocation improved infrastructure and resettled residents to safer areas, reducing hazards and minimizing potential losses. Relocation and institutional responses reduced natural and social vulnerability and enhanced capacity to withstand disasters.

Table 1. Descriptive statistics for key variables.

Variables	Frequency	%	Mean	SD
Gender	188172			
Female		52.22		
Male		47.78		
Age			52.28	11.11
Age squared			2856.36	1164.38
Educational Level				
Junior middle school and below (= 1)	140	38.89		
Senior middle school (= 2)	131	36.39		
College and above (= 3)	89	24.72		
Political identity				
Non-party affiliated (= 0)	295	81.94		
CCP member (= 1)	65	18.06		
Annual per capita disposable income			5.50	2.26
Job satisfaction				
No-opinion and below (= 1)	155	43.06		
Satisfied (= 2)	147	40.83		
Very satisfied (= 3)	58	16.11		
CCP branch secretary performance				
No-opinion and below (= 1)	83	23.06		
Satisfied and very satisfied (= 2)	277	76.94		
Follow-up support projects				
Dissatisfied (= 1)	26	7.22		
No opinion (= 2)	99	27.50		
Satisfied (= 3)	182	50.56		
Very satisfied (= 4)	53	14.72		
Community services			76.86	12.78
Well-being				
Reduced (= 1)	20	5.56		
Unchanged (= 2)	99	27.50		
Increased (= 3)	241	66.94		

Note: (1) Data was recorded for 360 respondents; (2) Frequency and percentages apply to categorized variables, means and standard deviations apply to continuous variables.

4.2. Regression analysis for well-being changes after relocation

Regression models estimated predictor variable effects on well-being. With ordered dependent variable categories, comparative analysis for ratio variables is appropriate, calculating margins due to independent variables with well-being being treated as dependent variable. Then, demographics and variables associated with relocation and settlement were added to the baseline model. Table 2 shows the regression results. All three models achieved statistical significance, confirming predictor variable effects ($p < 0.05$). Specifically, demographic variables as well as CCP branch assistance and subsequent back-up support projects were added to Model 1; indicators on building resettlement communities were added to Model 2; and demographic variables as well as relocation and building resettlement ratings were included in Model 3.

Table 2. Regression analysis of well-being derived from relocation (models 1–3).

	Model 1				Model 2				Model 3			
	β (SE)	OR	z	p	β (SE)	OR	z	p	β (SE)	OR	z	p
Gender (RG: Males)												
Female	-0.263 (0.275)	-0.25 (0.28)	-0.96	0.339	-0.193 (0.275)	-0.15 (0.28)	-0.70	0.483	0.291 (0.287)	-0.26 (0.29)	-1.01	0.312
Age	-0.098 (0.112)	-0.10 (0.11)	-0.88	0.380	0.123 (0.115)	-0.13 (0.11)	-1.08	0.282	-0.125 (0.119)	-0.13 (0.12)	-1.05	0.293
Ages squared	0.001 (0.001)	0.00 (0.00)	0.62	0.535	0.001 (0.001)	0.00 (0.00)	0.83	0.406	0.001 (0.001)	0.00 (0.00)	0.77	0.442
Education (RG: Junior middle school and above)												
Senior middle school	0.414 (0.357)	0.43 (0.36)	1.16	0.274	0.292 (0.369)	0.38 (0.37)	0.79	0.430	0.297 (0.381)	0.36 (0.39)	0.78	0.436
College and above	0.632 (0.457)	0.67 (0.48)	1.38	0.167	0.150 (0.443)	0.37 (0.46)	0.34	0.734	0.518 (0.478)	0.65 (0.50)	1.08	0.279
Political identity (RG: Non-party)												
CCP members	-0.844 (0.383)	-0.86 (0.39)	-2.20	0.027	-0.552 (0.382)	-0.62 (0.39)	-1.44	0.149	-0.677 (0.397)	-0.72 (0.40)	-1.71	0.088
Annual per capita disposable income	0.650 (0.943)	0.65 (0.09)	6.89	< 0.001	0.386 (0.097)	0.37 (0.10)	3.98	< 0.001	0.452 (0.103)	0.44 (0.10)	4.41	< 0.001
Job satisfaction (RG: No-opinion and below)												
Satisfied	-0.018 (0.312)	-0.02 (0.31)	-0.06	0.954	-0.256 (0.310)	-0.25 (0.31)	-0.82	0.410	-0.156 (0.324)	-0.15 (0.32)	-0.48	0.629
Very satisfied	-0.058 (0.312)	-0.08 (0.52)	-0.11	0.910	0.119 (0.511)	-0.02 (0.52)	0.23	0.816	-0.024 (0.537)	-0.10 (0.55)	-0.04	0.965
CCP branch secretary rating (RG: No-opinion and below)												
Satisfied and above	1.282 (0.322)	1.29 (0.32)	3.98	< 0.001					0.883 (0.348)	0.89 (0.35)	2.54	0.011
Follow-up support projects (RG: Dissatisfied)												
No opinion	2.643 (0.567)	2.62 (0.57)	4.66	< 0.001					2.592 (0.587)	2.51 (0.59)	4.41	< 0.001
Satisfied	2.315 (0.529)	2.29 (0.53)	4.38	< 0.001					2.134 (0.541)	2.04 (0.55)	3.94	< 0.001
Very satisfied	2.765 (0.692)	2.74 (0.70)	4.00	< 0.001					2.600 (0.729)	2.50 (0.74)	3.57	< 0.001
Community services												
Outcome 1 (Unchanged)	-0.695 (2.944)				0.084 (0.013)	0.09 (0.01)	6.39	< 0.001	0.073 (0.014)	0.07 (0.01)	5.25	< 0.001
Outcome 2 (Improved)	2.405 (2.949)				0.284 (3.002)				2.161 (3.135)			
LLR	180.82				3.343 (3.009)				5.472 (3.145)			
Pseudo R ²	0.320				181.22				209.98			
Significance level	P < 0.001				< 0.001				< 0.001			

Note: (1) N = 360; (2) significance level $p < 0.05$; (3) options in brackets indicate reference groups. (4) “Reference group” is abbreviated as “RG”.

4.2.1. CCP branch and support projects effects on well-being

Demographic variables, CCP branch helpfulness, and follow-up support projects were added to Model 1, which was statistically significant ($p < 0.001$). In Model 1, adjusted “pseudo” R^2 was 0.3202, meaning a 32.02% reduction in error for explaining satisfaction by including CCP branch helpfulness and follow-up support projects, thereby improving the fit ratio over Model 1. For CCP branch helpfulness with relocation, the estimated value for “satisfied and above” with CCP branch secretary was 1.282, indicating a positive impact on satisfaction ($p < 0.05$). Positive views of CCP branch secretary efforts improved satisfaction with relocations, supporting Hypothesis 1. Attributes for items rating follow-up support projects were “no opinion”, “satisfied”, and “very satisfied”, with β values of 2.64, 2.32, and 2.78, respectively, all of which raised satisfaction ($p < 0.05$). “No opinion”, “satisfied”, and “very satisfied” evaluations of follow-up projects improved satisfaction compared with “dissatisfied” responses, supporting Hypothesis 2.

Both Hypotheses 1 and 2 received support. Positive reactions to the relocation projects and follow-up support projects enhanced residents’ ability to cope with disaster vulnerability and, consequently, improved villager well-being.

4.2.2. Building settlements’ effect on well-being

Model 2 added indicators about building settlement communities, including base Model 1 predictors. Model 2 was statistically significant ($p < 0.001$) and provided a 32.09% error reduction after adding those variables; it also improved the fit ratio compared with Model 1. Table 2 confirms a positive relationship between community services assessment ($\beta = 0.08$, $p < 0.001$) and marginal utilities related to services (dy/dx : -0.00 , -0.01 , 0.02). Hypothesis 3 was supported. Following relocation, villagers’ well-being is enhanced by new community service networks.

4.2.3. Integrated analysis for relocating and building settlements effect on well-being

As shown in Table 2, Model 3 includes controlled demographic variables and relocation and building settlement ratings. Model 3 was statistically significant ($p < 0.001$) with an adjusted $R^2 = 0.37$, suggesting a 37.19% error reduction by including such variables. Model 3 provides a fair improvement in fit ratio compared with Models 1 and 2 and supports Models 1 and 2. Comparing Model 1 and Model 3, the impact of CCP helpfulness decreased after adding community services assessment to predict well-being. CCP assistance received more positive evaluations for providing services and assistance before the community services networks were planned and available. Hypotheses 1, 2, and 3 received support. Findings are generalizable to relocated villagers. Opinions about relocation and building settlements affected the well-being of relocated villagers. Village relocation and new village construction enhanced the ability to cope with disaster risks, increasing the perceived well-being.

4.3. *Endogeneity and robustness*

4.3.1. Propensity score matching model

The propensity score matching model (PSM) reduces the influence of sample selection bias and

potential confounding factors such as quality of new living environment, social support network, and community cohesion. The PSM model used all control variables, satisfaction with community infrastructure and community environment, opinion about whether elderly or left-behind children are cared for by community organizations, annual frequency of participation in community public affairs, community voluntary activities, and community services system. Also, the PSM treated all independent variables as binary. Follow-up support project responses were combined into “dissatisfied and no opinion” and “satisfied”. “Community service” was divided into two parts based on its mean value, using 1:1 nearest neighbor matching and 1:4 caliper matching. Propensity score matching uses the logit model. Matching reduced bias between variables in the treatment and control groups. The matching result was preferable.

As shown in Table 3, Models 4–6 used 1:1 nearest neighbor matching. Model 4 tested the ratings of CCP branch secretaries; Model 5 tested the ratings of follow-up support projects; Model 6 tested the ratings of community services. Caliper 1:4 matching was used for Models 7–9. Model 7 tested for the ratings of CCP branch secretaries; Model 8 tested the evaluation of follow-up support projects; Model 9 tested the ratings of community services. After reducing selection bias and confounding factors through the PSM model, regression results were consistent with earlier models.

Table 3. Regression analysis of PSM (Models 4–9).

	Model 4 1:1 nearest neighbor matching			Model 5			Model 6		
	β (SE)	z	p	β (SE)	z	p	β (SE)	z	p
Controlled variable	Controlled			Controlled			Controlled		
CCP branch secretary rating (RG: No-opinion and below)									
Satisfied and above	1.278 (0.375)	3.41	0.001						
Follow-up support projects (RG: Dissatisfied)									
No opinion				1.855 (0.706)	2.63	0.009			
Satisfied				1.888 (0.659)	2.87	0.004			
Very satisfied				2.438 (0.795)	3.06	0.002			
Community services							0.232 (0.130)	1.78	0.075
N	308			309			24		
LLR	153.01			131.12			11.12		
Pseudo R ²	0.321			0.2811			0.3204		
Significance level	< 0.001			< 0.001			0.3481		
	Model 7 1:4 caliper matching			Model 8			Model 9		
	β (SE)	z	p	β (SE)	z	p	β (SE)	z	p
Controlled variable	Controlled			Controlled			Controlled		
CCP branch secretary rating (RG: No-opinion and below)									
Satisfied and above	1.109 (0.326)	3.41	0.001						

Continued on next page

	Model 7 1:4 caliper matching			Model 8			Model 9		
	β (SE)	z	p	β (SE)	z	p	β (SE)	z	p
Follow-up support projects (RG: Dissatisfied)									
No opinion				2.842 (0.579)	4.91	< 0.001			
Satisfied				2.631 (0.540)	4.87	< 0.001			
Very satisfied				3.228 (0.694)	4.65	< 0.001			
Community services							0.116 (0.025)	4.67	< 0.001
N	328			349			153		
LLR	147.73			160.72			53.40		
Pseudo R ²	0.2888			0.2901			0.1872		
Significance level	< 0.001			< 0.001			< 0.001		

4.3.2. Replace dependent variable

The independent variable and control variables remained unchanged when the dependent variable was replaced by the question “How satisfied are you now in comparison with the time before relocation?”. Model 10 tested “How satisfied are you with your total income in comparison with the time before relocation?”, being coded as 1 = “reduced”, 2 = “unchanged”, and 3 = “increased”. Model 11 tested “What is your satisfaction with the current community environmental situation”, being rated as 1 = “bad”, 2 = “no opinion”, and 3 = “good”. Model 12 tested “What is your satisfaction with community cultural facilities”, rated as 1 = “dissatisfied”, 2 = “no opinion”, and 3 = “satisfied”. As shown in Table 4, the results are similar to those of earlier models. Conclusions about hypotheses remain robust after replacing the dependent variable.

Table 4. Replacing the dependent variable (Models 10–12).

	Model 10 Total income comparison with before			Model 11 Satisfaction with community environment			Model 12 Satisfaction with community cultural facilities		
	β (SE)	z	p	β (SE)	z	p	β (SE)	z	p
Controlled variable	Controlled			Controlled			Controlled		
CCP branch secretary rating (RG: No-opinion and below)									
Satisfied and above	1.202 (0.393)	3.06	0.002	1.704 (0.363)	4.69	< 0.001	-0.018 (0.263)	-0.07	0.944
Follow-up support projects (RG: Dissatisfied)									
No opinion	1.030 (0.598)	1.72	0.085	2.200 (0.558)	3.94	< 0.001	1.747 (0.483)	3.61	< 0.001
Satisfied	0.785 (0.552)	1.42	0.155	2.954 (0.547)	5.40	< 0.001	1.752 (0.462)	3.79	< 0.001
Very satisfied	0.777 (0.749)	1.04	0.300	3.406 (0.793)	4.30	< 0.001	2.367 (0.551)	4.30	< 0.001
Community services	0.096 (0.015)	6.35	< 0.001	0.044 (0.014)	3.10	0.002	0.232 (0.130)	1.78	0.051
LLR	250.76			207.25			70.31		
Pseudo R ²	0.4735			0.3905			0.0978		
Significance level	< 0.001			< 0.001			< 0.001		

5. Conclusions and discussions

5.1. Conclusion

We explored the well-being of 360 relocated villagers from 10 disaster-prone villages in rural Beijing through a questionnaire survey and a disaster sociology perspective. Specific findings are as follows.

First, the relocation project improved villagers' well-being. The relocation project directly improved villagers' living environment and living conditions by moving them from the geologically disaster-prone mountainous areas with poor infrastructure to new living places with safe and well-developed infrastructure. They gained access to safer housing, easier transportation, cleaner water, and richer public services, all of which are important factors in improving well-being. Relocation projects also provided villagers with new development opportunities. Newly built villages are usually complemented by the development of related industries, which provide villagers with employment opportunities and increase their sources of income. At the same time, the relocated living environment is more conducive to villagers' access to education, healthcare, and other public services, thus improving their quality of life. The relocation project also brought villagers a sense of psychological security. They were no longer worried about the threat of geological disasters and could live and work with peace of mind, which is conducive to their psychological health and social adaptation.

Second, grassroots party branches and subsequent supporting programs played an important organizational and coordinating role in the relocation process. They are responsible for publicizing policies, mobilizing villagers, and coordinating resources from all sides to ensure a smooth relocation process. The active participation of grassroots party branches helps to increase villagers' trust and satisfaction with the relocation project, thereby enhancing their well-being. Subsequent supporting projects provide relocated villagers with support in employment, entrepreneurship, education, and medical care, helping them to adapt to the new living environment as soon as possible and to provide their own development. For example, some relocation projects provide villagers with employment training, entrepreneurship guidance, microfinance, and other services to help them improve their employability and entrepreneurial success. The design and implementation of subsequent supporting projects should focus on sustainable development, avoiding over-reliance on government assistance but rather stimulating the villagers' own endogenous motivation so that they can independently develop their industries and increase their incomes, thus realizing long-term stable development.

Third, the community service system provides villagers with basic livelihood protection, such as water, electricity, gas, garbage disposal, and other public services, as well as social welfare such as pension, medical care, and education. These services safeguard the basic needs of villagers and improve their quality of life and sense of well-being. The community service system also provides villagers with social support, such as community activities, voluntary services, and psychological counseling, among others. These services help to enhance the connection and interaction among villagers and improve their sense of social belonging and well-being. The community service system needs to be continuously improved and developed to meet the growing needs of villagers. For example, cultural and recreational facilities, sports and fitness facilities, and activity centers for the elderly can be added to provide villagers with richer and more varied services and improve their quality of life.

5.2. Discussion

This study analyzes the CCP branch effectiveness in organizing and coordinating relocations and follow-up support projects related to relocation outcomes. CCP activities and follow-up support projects may improve coping ability against natural vulnerability, which affects the well-being of individuals. The rating of follow-up support projects was particularly important. These findings reinforce that grassroots CCP branches actively engage in follow-up support projects by leading and organizing villagers, expanding household incomes, and improving well-being. Only 36.39% of relocated villagers believed that they should be actively involved in the decision-making process regarding relocation because CCP branches were already involved. During relocation and establishment of new settlements, respondents expressed concerns about project standards and quality and the poor fit of some houses for backup industry projects, possibly partially due to lower villager participation.

The follow-up support projects primarily focused on natural resources and landscape tourism. Only 20% of new villages developed other businesses, such as bee farming or fruit planting industries. Consequently, after relocation, industry ventures were narrowly designed, highly overlapped, and were vulnerable to economic cycles and change. Moreover, new businesses had weaker competitiveness, relied on small-scaled sole proprietors or family businesses, and were heavily dependent on short-term-impact government assistance. This shows reduced long-term sustainability in improving the ability to cope with disaster vulnerability.

Villager satisfaction with community service networks measures the impact of new settlements. Satisfaction with community service networks improves the relocated residents' perceived well-being. Just over three-quarters (76.86%) were satisfied. As for infrastructure projects, 58.33% were "satisfied and very satisfied", while 41.67% chose "no opinion" or "dissatisfied". Regarding entertainment and cultural activities facilities, 49.17% were "satisfied and above", while 50.83% were classified as "no opinion and below". These findings suggest a desire for improved livelihood and production and cultural and entertainment facilities for leisure and sports activities. Constructing community service systems reduces vulnerability and resource inequity, improving coping resources for disasters.

Overall, this study is significant in reducing disaster risk and improving community resilience in three ways. First, it validates the effectiveness of relocation. Relocation significantly improved villagers' self-reported well-being and reduced disaster risk and potential losses. The relocated new communities have better infrastructure, safer lives, and enhanced disaster resilience. Second, it reveals the key factors in the relocation process. The organizing and coordinating role of grassroots party organizations in the relocation process, as well as the positive evaluation of the follow-up support projects, play an important role in the villagers' well-being. This suggests that relocation is not just a simple transfer of physical space but also requires attention to villagers' psychological adaptation and community building. Third, it provides a reference for other regions to conduct relocation for poverty alleviation, helping local governments to better formulate relocation policies and implementation programs to improve the effectiveness of relocation.

5.3. *Suggestions*

5.3.1. Improvement of village development and villagers' well-being through relocation of vulnerable villages

The potential disaster risks and threats faced by Beijing's disaster-prone villages are deeply intertwined with a complex web of social vulnerability factors. These risks are not just isolated incidents; they involve an intricate mix of human factors and far-reaching social impacts. To effectively reduce the vulnerability of these communities to disasters, it is imperative to narrow the stark gap in the distribution of disaster risks and resources. This necessitates a multifaceted approach aimed at enhancing the risk resistance capacity of these villages and supporting the overall well-being of their residents. Such an approach would involve the strategic relocation of disaster-prone villages, the establishment of robust community service networks, the provision of comprehensive follow-up support projects, and initiatives aimed at raising the income levels of the residents. The findings of this study will form the bedrock of targeted recommendations and interventions, all geared toward fostering better village development and enhancing the quality of life of the villagers.

5.3.2. Fulfilling the key role of local CCP branches in the relocation of vulnerable villages

The success of the relocation efforts hinges significantly on the leadership provided by the local CCP branch leaders and grassroots secretaries. For sustainable local village development to become a reality, it requires their unwavering support and active participation. This implies the need for a well-structured organizational framework that not only involves villagers in the decision-making process but also ensures that their participation is more than just symbolic. It is essential to create meaningful avenues for the villagers to contribute to the development of their communities. Monitoring and evaluating the effectiveness of these participation enhancement efforts would be a collaborative task involving CCP grassroots branches, local governments, villager councils, and community service centers. The success of these endeavors should be evaluated against the descriptors outlined in the initiative's guidelines to ensure that the goals are being met effectively.

5.3.3. Develop diversified social security and service networks focused on livelihood and production in relocated villages

For the relocated villages, it is of utmost importance that they utilize the available funds and resources judiciously to facilitate upgrades in housing, transport infrastructure, water resources, farmland management, and the prevention of natural or geological disasters. Additionally, maintaining the ecological balance of forestry areas should be a priority. To bolster security and social service networks, stakeholders must focus on upgrading critical infrastructure, including power grids, tap water facilities, roads, sewage treatment facilities, and internet access. The agricultural sector should be supported with modern machinery and sustainable ecological farming practices suitable for both croplands and hillsides. The marketing networks for tourism and local agricultural and fruit industries need to be strengthened to provide the necessary technical and logistical support for economic development. Access to market information and sales channels should be improved to enhance the villagers' economic prospects. The funds and resources allocated for village relocation should also be

used to upgrade community services, encompassing a wide range of facilities from hygiene to public transportation, park facilities, public utilities, postal services, security and safety measures, sports and fitness facilities, and care centers for the elderly. In the new villages, volunteer posts should be established to deliver these community services and facilities, thereby not only improving the quality of life but also creating employment opportunities that will further stimulate the local economy.

5.4. Limitations of the study

There are limitations to this study. First, the included variables are incomplete due to limited data when we explored the links between relocation and villagers' well-being. Second, the survey findings may not generalize to all relocated villagers due to the limited sample size and underrepresentation of some villagers, including workers who commute to jobs in other communities. Third, from the perspective of structural functionalism, the obvious function of the relocation of disaster-prone villages is to promote resident coping, reduce disaster vulnerability, and enhance well-being. However, the study did not explore potential harms from disaster responses. The study did not provide an analysis and discussion of power imbalances, competition for interests, and resource limitation effects on coping with disasters. Fourth, this paper did not introduce sustainability indicators, such as environmental sustainability and social equity. Future research could introduce sustainability indicators into relevant studies to assess the long-term success of relocation programs.

Use of AI tools declaration

The authors declare they have not used Artificial Intelligence (AI) tools in the creation of this article.

Conflict of interest

The authors declare no conflict of interest.

Author contributions

1. Jichao Wang: Conceptualization, Data curation, Formal Analysis, Investigation, Methodology, Software, Visualization, Writing—original draft, Writing—review and editing.

2. Xiaoning Sui: Conceptualization, Data curation, Software, Validation, Writing—original draft, Writing—review and editing.

3. Jie Zhang: Conceptualization, Project administration, Supervision, Validation, Writing—original draft, Writing—review and editing.

4. Wenjie Shi: Conceptualization, Validation, Writing—original draft, Writing—review and editing.

5. Wayne L. Thompson: Conceptualization, Validation, Writing—original draft, Writing—review and editing.

References

1. The People's Government of Beijing Municipality (2003) Circular of the general office of the People's Government of Beijing Municipality on transmitting the proposals of the Beijing Municipal Committee of rural affairs of implementing the relocation of the peasant households in the areas liable to mud-rock flow in the mining empty mountain. *Gazette of the People's Government of Beijing Municipality*, 30–32. Available from: <https://www.beijing.gov.cn/zhengce/zfgb/lsgb/201905/W020201228594915819211.pdf>.
2. The People's Government of Beijing Municipality (2008) Circular of the general office of the People's Government of Beijing Municipality on transmitting and issuing the proposals of Beijing Municipal Commission of rural work for relocating farmers from mudslide-prone mountains and hills and the locations with harsh living conditions. *Gazette of the People's Government of Beijing Municipality*, 52–55. Available from: <https://www.beijing.gov.cn/zhengce/zfgb/lsgb/201905/W020191202524224117648.pdf>.
3. The People's Government of Beijing Municipality (2012) Opinions of the People's Government of Beijing Municipality on implementing a new round of rural Residents relocation program in Geological Disasters hotspots and areas with harsh living conditions. *Gazette of the People's Government of Beijing Municipality*, 14–16. Available from: <https://www.beijing.gov.cn/zhengce/zfgb/lsgb/201905/W020191126333690572512.pdf>.
4. The People's Government of Beijing Municipality (2018) Circular of the general office of Beijing leading group for development of the new socialist countryside on printing and issuing the measures for strengthening assistance to low-income rural households. *Gazette of the People's Government of Beijing Municipality*, 26–40. Available from: <https://www.beijing.gov.cn/zhengce/zfgb/lsgb/201905/W020190531528807954007.pdf>.
5. Ye Y, Wang J, Cao Y (2021) Participation, system construction and satisfaction of democratic decision-making—taking the relocation community of Beijing disaster-prone villages as an example. *Open J Polit Sci* 11: 639–654. <https://doi.org/10.4236/ojps.2021.114041>
6. UN Office for Disaster Risk Reduction (UNDRR) (2019) Global assessment report on disaster risk reduction 2019, 82–157. Available from: <https://www.undrr.org/publication/global-assessment-report-disaster-risk-reduction-2019>.
7. Feng L, Zhong H (2021) Interrelationships and methods for improving university students' sense of gain, sense of security, and happiness. *Front Psychol* 12: 729400. <https://doi.org/10.3389/fpsyg.2021.729400>
8. Adger W, Agnew M (2004) New indicators of vulnerability and adaptive capacity, In: *Tyndall Centre for Climate Change Research*, Technical Report 7.
9. Zheng S, Wang X, Peng W (2013) Resettlement in geo-hazard hedging in Chuxiong prefecture. *J Geol Hazard Environ Preserv* 24: 106–110.
10. Zhang Z. Research on the performance evaluation of the funds of for the relocation of the whole immigrants in the five counties of Southern Jiangxi Province in 2015. Master Thesis, Jiangxi University of Finance and Economics, 2018.
11. Chen Y (2015) *Disaster-Related Migration in Mountain Areas of Western China*, Beijing: Social Science Academic Press.
12. Fang L (2020) Exploration on the path of “party building plus” mode in new immigrant villages. *People's Tribune* 98–99.

13. Xu X (2018) Party building leads the way of relocation and concentrates on the dream of Guangsha together. *J Party Branch Constr* 22–23.
14. Li H, He Y (2019) Research on relocation of poverty alleviation in deep poverty areas: A case study of Nujiang prefecture in Yunnan province. *J Yunnan Provincial Committee School CPC* 20: 114–118.
15. Wang Y, Chen Y, Wei F, et al. (2016) Successful practice of relocation for poverty alleviation and its inspiration: Taking Dongxiang County of Gansu province as an example. *Gansu Theory Res* 153–160.
16. Tang Y, Li P, Yu H, et al. (2017) optimization for relocation allowance scheme of avoiding potential geological disaster. *Chin J Geol Hazard Control* 28: 141–145. <https://doi.org/10.16031/j.cnki.issn.1003-8035.2017.01.22>
17. Bjarnadottir S, Li Y, Stewart MG (2011) Social vulnerability index for coastal communities at risk to hurricane hazard and a changing climate. *Nat Hazards* 59: 1055–1075. <https://doi.org/10.1007/s11069-011-9817-5>
18. He L, Qu X (2019) Coordinated development of relocation for poverty alleviation and new urbanization: Based on the practice of deep poverty areas in Guangxi. *Reformation Strategy* 35: 106–116. <https://doi.org/10.16331/j.cnki.issn1002-736x.2019.11.013>
19. Oliver-Smith A (2002) Theorizing disasters: Nature, power, and culture, In: *Catastrophe and Culture: The Anthropology of Disaster*, Santa Fe: School of American Research Press, 23–47.
20. Beck U, Beck-Gernsheim E (2002) A life of one's own in a runaway world: Individualization, globalization and politics, In: *Individualization: Institutionalized Individualism and Its Social and Political Consequences*, London: Sage, 22–29.
21. Lidskog R, Sundqvist G (2012) Sociology of risk, In: *Essentials of Risk Theory*, Dordrecht: Springer, 75–105. https://doi.org/10.1007/978-94-007-5455-3_4
22. Douglas M (2002) *Purity and Danger: An Analysis of the Concepts of Pollution and Taboo*, London: Routledge. <https://doi.org/10.4324/9780203361832>
23. Zinn JO (2008) A comparison of sociological theorizing on risk and uncertainty, In: *Social Theories of Risk and Uncertainty: An Introduction*, Oxford: Blackwell, 168–210. <https://doi.org/10.1002/9781444301489>
24. Shalev A (2005) Interventions for traumatic stress: Theoretical basis, In: *Interventions Following Mass Violence and Disasters: Strategies for Mental Health Practice*, The Guilford Press, 103–120.
25. Endreß, M (2019) The socio-historical constructiveness of resilience, In: *Resilience in Social, Cultural and Political Spheres*, Wiesbaden: Springer VS, 41–58. https://doi.org/10.1007/978-3-658-15329-8_3
26. Lucini B (2014) Conclusion: Final proposal, In: *Disaster Resilience from a Sociological Perspective: Exploring Three Italian Earthquakes as Models for Disaster Resilience Planning*, Cham: Springer, 189–201. https://doi.org/10.1007/978-3-319-04738-6_9
27. Norris F, Stevens SP, Pfefferbaum B, et al. (2008) Community resilience as a metaphor, theory, set of capacities, and strategy for disaster readiness. *Am J Community Psychol* 41: 127–150. <https://doi.org/10.1007/s10464-007-9156-6>
28. VanderPlaat M (2016) Activating the sociological imagination to explore the boundaries of resilience research and practice. *School Psychol Int* 37: 189–203. <https://doi.org/10.1177/0143034315615938>

-
29. Durkheim E (2014) *The Division of Labor in Society*, New York: Simon and Schuster, 158–182.
 30. Wang J, Yan W, Zhang J (2019) Relative income and subjective well-being of urban residents in China. *J Fam Econ Iss* 40: 673–680. <https://doi.org/10.1007/s10834-019-09636-0>



AIMS Press

© 2024 the Author(s), licensee AIMS Press. This is an open access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>)