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The Influence of Poverty Alleviation Resettlement on Rural Household Livelihood Vulnerability in the Western Mountainous Areas, China

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Abstract: Poverty alleviation resettlement (PAR) is China's largest-ever resettlement program and one of China's flagship poverty alleviation initiatives. Resorting to this state-led conversation and development program, the central and provincial governments aim to lift the poor out of the poverty trap and into sustainable livelihoods, by delivering improvements in housing conditions, infrastructure services, public amenities, and living standards. Taking Ankang as an example, this study examines the PAR from the perspective of vulnerability through a household survey conducted in Ankang prefecture of Shaanxi province, China. A total of six townships in Ankang are covered, with 657 valid questionnaires collected. This study shows that there is a difference in exposure, sensitivity, and the adaptive capacity of rural households with different relocation characteristics, hence generating different livelihood vulnerabilities. The PAR generally achieves the target of livelihood vulnerability reduction. Specifically, the project-induced relocation has a significant positive effect on vulnerability, but there is a significant negative correlation between livelihood vulnerability and relocation region, relocation time, and relocation subsidy. Challenges and problems remain to be addressed for the next phases of the PAR, including diminishing the financial burden on those relocated and providing free public transportation services, carrying out community-building programs and updating the household registration institution, balancing the redistribution and sharing of farmland, furnishing assistance measures for employment searches and training in specific skills, and creating an impartial project to safeguard the non-movers from the significant negative impacts on their physical and spiritual dimensions.

Keywords: poverty alleviation resettlement; livelihood vulnerability; rural household; Ankang prefecture

1. Introduction

The challenges that environmental concerns have posed to human society in the 21st century exacerbated vulnerability across global and regional scales. The questions of how to adapt to and respond to environmental changes, and reduce vulnerability, have drawn continuous global attention [1]. Kates et al. (2001) propose that "vulnerability or resilience of natural-social system in special areas" is one of the seven core issues of sustainability science [2]. To date, the examination of vulnerability has become the focus and important analysis tool of scientific research on global environmental change and sustainability science. Due to different research backgrounds and objects, scholars have not reached a consensus yet on the interpretation of definitions and measurements of vulnerability, but generally believe that it is closely related to concepts such as risk, disaster severity,

poverty resilience, and capability. The Intergovernmental Panel on Climate Change (IPCC) defines vulnerability as "exposure components such as well-being, assets, and livelihood activities, and the characteristics and tendencies when experiencing the negative effects of disaster events" [3], which is the function of exposure, sensitivity, and adaptive capacity. Recently, studies on vulnerability gradually have extended from the geoscience field of natural ecosystems to social ecosystems, human earth systems, and human-environment coupling systems.

Environmental issues such as climate change, water shortages, land desertification, soil erosion, and biodiversity loss pose severe challenges to agricultural populations. The impact of environmental problems on the rural household's livelihood is prominent, relatively, especially in ecologically fragile areas and contiguous poor areas in developing countries. Based on the definition of vulnerability, some scholars describe livelihood vulnerability as "the exposure to natural disasters and climate variability, social and economic characteristics of households that affect their adaptive capacity, and current health, food, and water resource characteristics that determine their sensitivity to climate change impacts" [4]. Vulnerability assessment is the logical place to start for most industry leaders or policy-makers working to direct or support efforts to reduce vulnerability and develop plans for adaptation [5,6]. Along with the extension of the livelihood vulnerability definition, scholars have begun to evaluate the livelihood vulnerability of rural households. Most studies focused the assessment criteria on global, national, and regional scales, while little vulnerability assessment research examined the micro perspective, namely the scales of community and rural households. Hahn et al. (2009) examined the livelihood vulnerability index (LVI) for climate change in Mozambique, Africa [4]. Shah et al. (2013) performed the application of LVI for agricultural and natural resource-dependent communities in developing countries [7]. Antwi–Agyei et al. (2013) built and applied LVI at community and household scales to explore the nature of climate vulnerability [8]. Wei et al. (2016) and Chen et al. (2017) analyzed the livelihood vulnerability of rural households in earthquake-stricken areas in China, and the displaced and resettled in the aftermath of the 2008 Wenchuan earthquake, respectively [9,10]. Huang et al. (2017) developed indicators to evaluate the impact of exposure/sensitivity and response capacity on the livelihood vulnerability of land-lost farmers [11]. Zhang et al. (2018) examined the livelihood vulnerability of a variety of rural households by computing the LVI with reference to the IPCC vulnerability framework and the sustainable livelihoods framework (SLF) [6]. Peng et al. (2018) addressed the vulnerability of rural household livelihood to climate variability and adaptive strategies in landslide-threatened regions of the Three Gorges Reservoir Area [12].

To mitigate natural disasters caused by environmental issues, to conserve the ecosystems and their services, and to improve human well-being, China initiated the Poverty Alleviation Resettlement (PAR) nationally in 2001. Meanwhile, as one of China's flagship programs in poverty alleviation [13], PAR provides widespread opportunities and new ideas for addressing environmental and poverty-related concerns in a rapidly changing world [14]. Through this nationwide initiative, the government aims to improve the living standards, incomes, and the access to infrastructure and services by poor rural people living in areas deemed unable to support sustainable livelihoods [15]. A typical PAR project involves relocating the rural poor away from their original home to a centralized resettlement site, with better facilities and a more accessible location [16]. Presently, the implementation of PAR is accelerating. According to the latest official white paper, 2.8 million impoverished people will be resettled in 2018, which means China will resettle approximately 10 million of the poor population between 2016 and 2020. Taken from the literature, poverty alleviation resettlement has had positive impacts on migrants, which can occur through better public services, and improvements in livelihood security and housing quality [16,17]. A recent study, for example, suggests that the PAR generally achieves the goals of ecosystem service increase and livelihood restoration by improving water quality, sediment retention, and carbon sequestration, as well as transforming farmers' livelihood activities from traditional inefficient agricultural and forest production to non-farm activities [14]. Furthermore, the different types of spatial restructuring are an important factor shaping the outcome of poverty alleviation resettlement [15]. Poverty alleviation resettlement is not unique to China [15] in fact,

many developing countries consider resettlement as an effective way of eradicating stubborn poverty. However, several studies have reported significant negative impacts on the livelihoods of migrants, as well as negative health and environmental impacts [18]. Considering Northwestern Ethiopia, for instance, the PAR might create tension and conflicts between migrants and host communities, as well as environmental damage such as forest degradation [19].

China still needs more efforts to achieve its poverty alleviation and sustainable development goals toward an ecological society, particularly in some of the less developed and ecologically fragile areas [20], such as the most remote and marginal areas of western China. Since physical resettlement of the rural poor has become an attractive option for reducing rural poverty, the expanding use of resettlement as a tool for addressing environmental and poverty-related concerns calls for further study into the impact on both the environment and the local populations [14].

Previous studies contributed significantly to understanding the social-ecological impacts of resettlement in China, whereas this study means to approach the topic from the integration of PAR and livelihood vulnerability. Teasing out the relationships, the linkages and interactions between poverty alleviation resettlement and the rural household's livelihood vulnerability, might contribute to the body of knowledge and benefit local policy-making toward a sustainable development.

This study focuses on the prefecture of Ankang, which typifies much of western mountainous China, with serious short-term conflicts between conservation and the livelihood activities of the poor. Therefore, the rural household livelihood vulnerability in Ankang region deserves attention from scholars and policy-makers. However, while several studies paid attention to the observed impacts of PAR in terms of livelihood assets, strategies, outcomes and ecosystem services, few studies explored the phenomenon from the perspective of livelihood vulnerability, and this knowledge gap has prevented a full comprehension of the vulnerable aspect of PAR. Through empirical analysis, this study aims to establish an evaluation index system for rural household livelihood vulnerability in the context of PAR, and to shed light on the integrated impact of PAR on the livelihood vulnerability of the rural households.

2. Study Area

Ankang prefecture is located in the south of Shaanxi Province at the northern base of the Daba Mountains and south of the Qinling Mountains on the upper stream of the Han River, the largest tributary of the Yangtze River. Mountains cover 92% of the region, making Ankang not only an ecologically fragile area, but also a typically impoverished area, which places a heavy burden on ecological conservation and economic development. Specifically, restricted by the limitation of farmland and the eco-conservation policy of "delivering high quality water to arid North China", poverty alleviation is one of the great challenges for the local government. Recently, PAR programs have been designated to restore key ecosystem services and lift local people out of the poverty trap and into sustainable livelihoods. PAR has increased rural household income, contributed to reducing the poverty rate, and improved living conditions and standards, which makes Ankang prefecture a typical site to study how to reduce vulnerability and increase resilience and well-being in the social-ecological system, as well as examine the impact of PAR on rural household livelihood vulnerability [17].

According to the official documents from the government of Ankang prefecture, the region is also an important water resource conservation area for the South-to-North Water Transfer Project (SNWTP)—the largest water transfer project in the world, aimed to send clear water to arid North China by reducing soil erosion and nutrient runoff into the Han River. The 340 km section of the Han River in Ankang prefecture provides an average annual runoff of 1.07×10^{10} m^3. Indeed, Ankang prefecture faces severe challenges in reducing disaster impact and improving human well-being, and, together with its two-neighboring prefectures, historically has been prone to frequent floods, landslides, debris flow, and more that result in severe economic losses every year. Viewing the developmental perspective of the provincial government, resettling people who live in vulnerable mountainous villages, with inconvenient access to basic public services, is the most effective way to improve local rural household livelihoods. Thus, designed to achieve the goals of ecosystem

service increases and human well-being improvement overall, Shaanxi province initiated the "disaster avoidance relocation" program in 2011—now called poverty alleviation resettlement, which is the largest PAR program in the history of modern China. The program involves 226,000 rural households in Ankang prefecture. PAR had relocated more than 713,600 people in Ankang by the end of 2016. According to the Shaanxi provincial government, this target will rise to 2.35 million in the forthcoming "The 13th Five-Year National Plan (2016–2020)".

3. Methods

3.1. Data Source

The study was based on primary cross-sectional survey data collected concerning rural household livelihoods and the eco-environment. Data were collected in the end of 2015 using a convenience sampling design through a questionnaire-based survey, which was conducted by the Institute for Population and Development Studies of Xi'an Jiaotong University. There are 10 county-level administrative areas in Ankang prefecture, considering that the region of Ankang is steeply mountainous and most of the rural households live in scattered locations, it was quite difficult to conduct field survey-based interviews. The survey covered three focal counties in Ankang prefecture according to their Gross Domestic Product (GDP), Hanbin from the top group (1st), Ziyang from the middle (ranked 4th), and Ningshan from the bottom (9th). The authors selected 3 typical communities of centralized resettlement in Ziyang, and another eight administrative villages from four townships in Hanbin and Ningshan for detailed study. A trained team of investigators collected the survey data with face-to-face interviews conducted in respondents' households. The head of the household, or a family member over 18 years old, was asked to complete a questionnaire. A total of 800 questionnaires were issued, of which 670 were returned in the end. Among the 670 returned questionnaires, 657 provided valid responses, including 459 relocation households and 198 non-relocation households.

The questionnaire focused on the household-level and consisted of four parts: (1) Family characteristics, including household size, education years of the household members, cash income per capita, family dependency ratio, per capita cultivated farmland, and relocation time, region, type and subsidy of PAR. (2) Exposure, including whether it suffered from risk shock, such as the agroforestry, property and livestock shock, access to loan and housing structure. (3) Sensitivity, including labor force shock and the dependence on income, food, and energy; and (4) adaptive capacity, including livelihood capitals, such as natural, financial, social, physical and human capital, and livelihood approach, such as the input of household labor force and the source of income.

It is important to identify the best fit adaptation options by understanding different household vulnerabilities, particularly in diverse environments with limited resources [21]. The stratification of households with different socioeconomic traits can contribute to targets and reach the most vulnerable households [6,21], therefore the rural households are often classified into different groups to develop effective protection and adaptation actions for individuals and communities [22]. This approach largely is based on climate, terrain, resource endowments in different regions, poverty and educational experience, livelihood diversification, and nonagricultural employment [6]. This research refers to the existing studies. All samples could be placed into two categories: Relocation households (RHhs), and non-relocation households (NRHhs). According to the diversity of non-agriculturalization and the households' livelihood strategies, the households were categorized into three types: Pure farming households (all human power is engaged in agriculture) (PFHhs); households with combined occupations (the labor force partly worked in agriculture and partly in non-agriculture) (COHhs), and nonfarming households (the labor force worked in only nonagricultural activities) (NFHhs) [20].

For further analysis, the authors stratified the surveyed relocation households since they had distinctive features for resettlement. According to the type of resettlement, the relocation households were categorized into five types: Ecological restoration households (ERHhs); project-induced relocation households (PRHhs); poverty alleviation households (PAHhs); disaster-related relocation households

(DRHhs); and households relocated by other reasons (ORHhs). According to the regions from where households relocated, the relocation samples could be placed into four types: Local community (LCHhs); local township (LTHhs); neighboring township (NTHhs), and other places relocation households (OPHhs). According to the time of resettlement, the relocation households could be placed into three types: Short-term (less than 3 years) (SRHhs); medium-term (3–5 years) (MRHhs), and long-term relocation households (more than 5 years) (LRHhs). According to the subsidy for resettlement, the relocation households were categorized as three types: Highly subsidized (HSHhs); moderately subsidized (MSHhs), and low subsidized relocation households (LSHhs).

Moreover, a livelihood diversification degree of rural households was taken as a livelihood diversification index. Each livelihood activity was assigned a number, 1, for instance, if a family engaged in breeding livestock and rural–urban migration, this family's livelihood diversification index was assigned to 2 [23].

3.2. Comprehensive Evaluation of Rural Households' Livelihood Vulnerability

3.2.1. The Establishment of the Livelihood Vulnerability Index System

The "Exposure-Sensitivity-Adaptive Capacity" research framework proposed by the IPCC [3], and the Sustainable Livelihood Approach (SLA) analysis framework [4], as well as the Vulnerability Scoping Diagram (VSD) evaluation integration model have been widely used to explore livelihood vulnerability at the global, national, regional, and community scales. Previous studies have mostly focused on vulnerability assessment at the national and regional levels, and few existing studies have evaluated vulnerability from the perspective of micro communities and rural households (especially in the context of PAR). Due to the potentially higher vulnerability degree of the susceptible populations, the large-scale household vulnerability assessment at the national level can mask significant local-level susceptibility at the household or community level in terms of access to assets and entitlements, thus, the rural households in contiguous poor areas seem less vulnerable than they fundamentally are [12,24]. Based on the existing related literature and the livelihood characteristics of rural households in the study region, this study intended to consider the response of local farmers to the implementation of the resettlement policy, beginning with the exposure, sensitivity and adaptive capacity of the farmers, respectively, and designed an evaluation index system for rural household livelihood vulnerability (see Table 1) as well as the assessment model. Therein, the authors further evaluated the influence of PAR on rural household livelihood vulnerability so the external shock owing to the intervention of PAR on the farmers' livelihood in poor mountainous areas could be fully reflected.

The rural household livelihood vulnerability evaluation index covers exposure, sensitivity and adaptive capacity [4]. Exposure refers to the farmers' access to loans, housing structure and their risk shock suffering, such as damage to agroforestry, property, and livestock. Sensitivity refers to the labor force disturbance, income, food, and energy dependency degree, as well as access to water. Higher values mean a higher exposure and sensitivity degree. That is to say, if the values of exposure and sensitivity become higher, the farmers' livelihood system might become more vulnerable to the interference and intimidation of external forces. Adaptive capacity is the ability of households in a social-ecological system to recover from external disturbances, to maintain stability, make use of new opportunities, and respond to changes and cope with novel situations without losing options for future development. It is the important process of the redistribution of farmers' livelihood assets and livelihood resources. The stronger the adaptive capability, the much easier the farmers can resist the risk impact from the system and beyond. This study examined the adaptive capacity of farmers from the perspective of livelihood capitals, which included natural capital, financial capital, social capital, physical capital, and human capital, as well as livelihood diversification. Generally, the more livelihood capital that rural households owned, the less likely they suffered from external pressure and shock through having a stronger adaptive capacity. Similarly, higher values meant a higher adaptive capacity, and a higher adaptive capacity made households relatively invulnerable.

Table 1. The evaluation index of rural household livelihood vulnerability.

Dimensions	Evaluation Indices	Definition (Unit)
Exposure	Agroforestry shock	The actual amount of agroforestry devastation in the survey year (yuan)
	Property shock	The actual amount of property damage in the survey year (yuan)
	Livestock shock	The actual amount of livestock loss in the survey year (yuan)
	Access to loans	1 for extremely possible; 2 for possible; 3 for general; 4 for impossible; 5 for extremely impossible
	Housing structure	1.00 for civil structure; 0.67 for brick and wood structure; 0.33 for brick and concrete structure
Sensitivity	Labor force shock	0.33 for the proportion of the medical treatment fee to the family total income<20%; 0.67 for 20%–50%; 1.00 for the proportion>50%
	Income dependence	The proportion of the income from agroforestry and livestock to the family total income
	Food dependence	The proportion of self-sufficient food income to the family's annual total food expenditure
	Energy dependence	The proportion of the firewood collection amount to the family's annual energy consumption expenditure
	Access to water	Whether the household has tap water (1 for no; 0 for yes)
Adaptive Capacity	Farmland area	The cultivated farmland area per capita in the survey year (mu)
	Woodland area	The woodland area per capita in the survey year (mu)
	House value	Current market value of the house (1 for the value<10 wan yuan; 2 for 10–20; 3 for 21–30; 4 for the value>30 wan yuan)
	Housing area	The actual housing area in the survey year (m^2)
	Production and living tools	The total assets owned by family households (pieces)
	Education years of household members	The actual average years of education of the family members in the survey year (years)
	Labor force ability	The number of workers in household to the household size
	Training	Whether the family members were trained (0 for no; 1 for yes)
	Cash income	Annual per capita cash income (yuan)
	Financing channels	Composited by 3 indicators including whether the household borrowed from the bank, whether it had savings in the bank and whether the household borrowed from relatives and friends
	Monetary help	Number of households available to provide assistance (persons)
	Number of village cadres	Number of village cadres in relatives and friends (persons)
	Credibility to others	1 for extremely distrusted; 2 for distrusted; 3 for neutral; 4 for trustworthy; 5 for extremely trustworthy
	New Year's network	Number of people who paid New Year's calls to each other (persons)
	Cooperatives participation	Number of types of cooperatives in which the family participates (types)
	Livelihood diversification	Number of types of rural household livelihood activities (types)

Note: 1 USD = 6.2284 CNY in 2015; 1 mu = 0.0667 hm^2. Source: 2015 survey data from Ankang prefecture, Shaanxi Province.

3.2.2. The Livelihood Vulnerability Evaluation Model

Regarding different scales and dimensions of the indicators, the original value of data was standardized before statistical analysis to avoid problems. This was undertaken by means of dispersion normalization so that the results fell in the range of [0,1]. The equation is as follows:

$$X'_{ij} = \frac{X_{ij} - X_{j\min}}{X_{j\max} - X_{j\min}} \quad (1)$$

where X_{ij} is the initial value of the indicator for the household; $X_{j\max}$ and $X_{j\min}$ is the maximum and minimum value of each indicator, respectively.

Because it was important that the livelihood vulnerability assessment index differed among rural households in Ankang prefecture, this paper used the principal components analysis (PCA) method [25], which ensured that the research process of assessment was scientific and objective in determining the weights of the indicators of different dimensions. The specific results of the PCA method was shown in Table 2.

Table 2. The eigenvalue, variance proportion and cumulative proportion of indicator variables.

Factor	Eigenvalue	Proportion	Cumulative	Factor	Eigenvalue	Proportion	Cumulative
1	2.965	0.114	0.114	14	0.856	0.033	0.708
2	2.223	0.086	0.200	15	0.847	0.033	0.740
3	1.362	0.052	0.252	16	0.829	0.032	0.772
4	1.298	0.050	0.302	17	0.778	0.030	0.802
5	1.263	0.049	0.350	18	0.750	0.029	0.831
6	1.166	0.045	0.395	19	0.702	0.027	0.858
7	1.143	0.044	0.439	20	0.659	0.025	0.883
8	1.097	0.042	0.482	21	0.610	0.024	0.907
9	1.089	0.042	0.523	22	0.540	0.021	0.927
10	1.029	0.040	0.563	23	0.515	0.020	0.947
11	0.992	0.038	0.601	24	0.494	0.019	0.966
12	0.985	0.038	0.639	25	0.470	0.018	0.984
13	0.927	0.036	0.675	26	0.407	0.016	1.000

Source: 2015 survey data from Ankang prefecture, Shaanxi Province.

Livelihood vulnerability is a positive function of the system's exposure and sensitivity, while a negative function of the system's adaptive capacity [26]. Nevertheless, the relationship among all three independent endogenous components was not appointed and regulated by local contexts [6]. The creation of the Livelihood Vulnerability Index (LVI) in this study used the following mathematical equation for vulnerability, by Morzaria–Luna et al. (2014) and Cinner et al. (2012); this equation has been widely applied [27–29]:

$$LVI_i = (E_i + S_i) - A_i \quad (2)$$

where LVI_i is the livelihood vulnerability of the household, and E_i, S_i, and A_i is the exposure, sensitivity, and adaptive capacity of a household's livelihood, respectively. Additionally, the positive LVI value means more vulnerable, while the negative value means less vulnerable, which is the best approach to understanding the estimate of the relative vulnerability of compared households.

3.2.3. The Multiple Linear Regression Analysis Model

To model the impact of PAR on rural household livelihood vulnerability, the multiple linear regression analysis model was applied, which has been developed and conducted in similar evaluation research [6,30]. Rural household livelihoods, relocation features and family characteristics were all fixed into the multiple linear regression model, whose general form is as follows:

$$LVI = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \ldots + \beta_n x_n + \mu \quad (3)$$

where β_0 is a constant term and β_1, β_2,..., β_n are the regression coefficients that represent the contributions made by the various factors (x_i) to LVI, and μ is a random error term. The ordinary least squares (OLS) method was conducted to evaluate the impact of PAR on the livelihood vulnerability of rural households.

Additionally, household size, dependence ratio, whether the family suffered from risk shock (suffer from the agroforestry, property, and livestock disruption = 1, no = 0) and relocation characteristic variables (whether relocated, relocation type, relocation region, relocation time, and relocation subsidy)

were brought into the analytical model. All statistical analyses were conducted with STATA for Windows version 14.1 (Stata Corp. LLC, College Station, TX, USA).

3.2.4. Evaluation Results of the Livelihood Vulnerability

The PCA method was firstly employed to determine the weights of the measures of all indicators. Specifically, this research took the variance proportion of factors as the weights of the indicators of different dimensions referred to the results of the PCA (see Table 2). After this process of computation, the exposure, sensitivity, adaptive capacity, and vulnerability were combined and obtained by Equation (2).

Exposure is the extent of pressure on a particular area unit [31], which tends to reflect the external shocks encountered by rural households in the Poverty Alleviation Resettlement (PAR) project area. Table 3 shows that the average exposure of household livelihoods was 0.038 in Ankang Prefecture, and the exposure of relocation households (RHhs) (0.036) was relatively lower than non-relocation households (NRHhs) (0.043). Considering relocation type, the exposure of project-induced relocation households (PRHhs) was the highest (0.045), followed by disaster-related relocation households (DRHhs) (0.037), ecological restoration households (ERHhs) (0.034), poverty alleviation households (PAHhs) (0.033), and households relocated by other reasons (ORHhs) (0.028) were the least exposed. Regarding terms of households with different relocation regions, the exposure of neighboring township relocation households (NTHhs) was largest (0.039), other places relocation households (OPHhs) (0.037) and local community relocation households (LCHhs) (0.036) follow, and local township relocation households (LTHhs) (0.035) had the least exposure. Viewing terms of relocation time, the exposure gradually decreased in turns across long–term relocation households (LRHhs), short–term relocation households (SRHhs), and medium–term relocation households (MRHhs). Finally, regarding relocation subsidies, the exposure of low subsidized relocation households (LSHhs) was largest (0.038), followed by moderately subsidized relocation households (MSHhs) (0.034) and highly subsidized relocation households (HSHhs) (0.034).

Table 3. Exposure, sensitivity, adaptive capacity and vulnerability of different types of households.

Type of Household		Exposure	Sensitivity	Adaptive Capacity	Vulnerability
Whether relocated	RHhs	0.036	0.026	0.107	−0.045
	NRHhs	0.043	0.050	0.117	−0.023
Relocation type	ERHhs	0.034	0.016	0.103	−0.053
	PRHhs	0.045	0.039	0.117	−0.033
	DRHhs	0.037	0.022	0.106	−0.047
	PAHhs	0.033	0.026	0.103	−0.044
	ORHhs	0.028	0.032	0.114	−0.054
Relocation region	LCHhs	0.036	0.030	0.109	−0.042
	LTHhs	0.035	0.021	0.105	−0.050
	NTHhs	0.039	0.027	0.113	−0.047
	OPHhs	0.037	0.023	0.106	−0.046
Relocation time	SRHhs	0.035	0.024	0.105	−0.046
	MRHhs	0.034	0.024	0.111	−0.053
	LRHhs	0.039	0.029	0.110	−0.039
Relocation subsidy	LSHhs	0.038	0.030	0.109	−0.040
	MSHhs	0.034	0.022	0.105	−0.049
	HSHhs	0.034	0.022	0.107	−0.051
All households		0.038	0.033	0.110	−0.039

Source: 2015 survey data from Ankang prefecture, Shaanxi Province.

Sensitivity refers to the extent to which exposure units are either adversely or beneficially affected by stress or related stimuli [6,31], which aims to reflect how rural households react to external interference. Table 3 shows the average sensitivity of household livelihoods in Ankang prefecture was 0.033, and the sensitivity of NRHhs (0.050) was much higher than RHhs (0.026). Discussing terms of households to relocation type, the sensitivity gradually increased in file across ERHhs, DRHhs, PAHhs, ORHhs, and PRHhs. Specifically, compared to the other four relocation types of households, the PRHhs' degree of labor force shock and natural resource dependence was stronger. The sensitivity to relocation regions of households was diverse. Compared to the other three relocation regions of households, the sensitivity of LCHhs was the largest (0.030). Considering variation in relocation time and subsidies, the sensitivity of LRHhs and LSHhs were 0.029 and 0.030, respectively.

Adaptive capacity defines the capability of a system to adjust to actual or expected stresses or to cope with the consequences [6,31], which is designed to reflect individual or household livelihood strategies and their abilities to cope with external shocks and environmental risks. Table 3 indicates that the average adaptive capacity of household livelihoods in Ankang prefecture was 0.110, and the adaptive capacity of RHhs (0.107) was relatively lower than NRHhs (0.117). Regarding terms of relocation type, the adaptive capacity of PRHhs was the highest (0.117), followed by ORHhs (0.114) and DRHhs (0.106). Considering relocation region, the adaptive capacity of NTHhs was largest (0.113), LCHhs and OPHhs followed, and LTHhs had the least adaptive capacity. Regarding households with different relocation times, the adaptive capacity of MRHhs was the largest (0.111), and SRHhs had the least adaptive capacity. Regarding variation in relocation subsidies, the adaptive capacity of LSHhs was the highest (0.109), followed by HSHhs (0.107), and the adaptive capacity of MSHhs (0.105) was the lowest.

Exposures, sensitivities, and adaptive capacities can reflect broader forces, drivers, or determinants that shape or influence local-level vulnerabilities [32]. Generally, exposure and sensitivity are used to describe the potential impact that shock and stress can have on human systems, while the adaptive capacities of the systems affect its vulnerability to shock and stress through modulating exposure and sensitivity. Table 3 indicates that the average vulnerability of household livelihoods was –0.039 in Ankang prefecture. Since different types of households differed in exposure, sensitivity, and adaptive capacity, rural household livelihood vulnerabilities were diverse. Specifically, the vulnerability of NRHhs (–0.023) was relatively higher than RHhs (–0.045). Concerning terms of households with different relocation types, the vulnerability of PRHhs was largest (–0.033) due to strong exposure and high sensitivity. Regarding variation in relocation regions, the vulnerability of LCHhs was highest (–0.042) due to strong sensitivity and low adaptability. Considering differences in relocation times, the vulnerability of LRHhs was largest (–0.039) owing to high exposure and strong sensitivity. Regarding relocation subsidies, the vulnerability of LSHhs was highest (–0.040) due to both strong exposure and sensitivity. Briefly, previous studies have suggested that the impacts of exposure and sensitivity on vulnerability are positive, whereas the impact of adaptive capacity is negative [6,26]. This study also found that the vulnerability of human systems will be aggravated when the exposure and sensitivity increase, while strengthened adaptability can alleviate the vulnerability of the system.

4. Results and Discussion

4.1. The Rural Household Characteristics in Ankang Prefecture

According to the LVI, the K-means cluster analysis method was employed to classify the households into three groups: High vulnerability (HVHhs), moderate vulnerability (MVHhs), and low vulnerability households (LVHhs). The results show that the F-statistics of one-way analysis of variance (ANOVA) was 1297.19, and the significance level was 0.000, which indicates that there were significant differences among the three groups. The average LVI of HVHhs (0.057), which accounted for 13.09%, was dramatically higher than that of the other groups. Meanwhile, the LVI of MVHhs was –0.029, and LVHhs (–0.087) had the least vulnerability. The proportions of MVHhs and LVHhs were 50.53%

and 36.38%, respectively. The rural household characteristics in different livelihood vulnerability levels are shown in Table 4. Specifically, the production and living tools, financing channels, per capita cultivated farmland, number of village cadres, monetary help, credibility to others, and education years of members of HVHhs were lower or less than those of LVHhs and MVHhs. The production and living tools and financing channels for HVHhs were 0.127 less than those of LVHhs; the number of village cadres were 0.574 less than those of LVHhs; the monetary help was 2.112 less than that of LVHhs, and the education years of members were 2.212 lower than those of LVHhs.

Table 4. The rural household characteristics in different livelihood vulnerability levels.

Type of Household	Production and Living Tools	Financing Channels	Per Capita Cultivated Farmland	Number of Village Cadres	Monetary Help	Credibility to Others	Education Years of Members
HVHhs	0.272	0.147	0.912	0.169	2.557	14.674	4.975
MVHhs	0.333	0.189	1.122	0.405	3.837	14.674	5.767
LVHhs	0.399	0.274	0.914	0.743	4.669	15.383	7.187

Source: 2015 survey data from Ankang prefecture, Shaanxi Province.

As was shown in Table 5, the authors used *T*-test to examine the significant difference between relocation households (RHhs) and non-relocation households (NRHhs). The characteristics of the households with different relocation attributes were different; for example, RHhs and NRHhs had an average household size of about 4.512 and 4.460 persons, respectively, and the number in the labor force was 3.205 and 3.227 per household, respectively; however, there was no significant difference between the two groups. RHhs had a cash income per capita of 5855.205 yuan, while the cash income was relatively higher for NRHhs; the average education years for household members of RHhs and NRHhs was about 5.837 and 6.976, respectively, and the possibility of access to loans was 3.552 and 3.147, respectively. In our survey, 10.89% of RHhs reported that all family workforce was engaged in agriculture; 49.24% of them stated that the labor force worked in only nonagricultural activities, and about 39.87% of them partly engaged in agriculture and partly in non-agriculture. Additionally, the percentage of that for NRHhs was 28.28%, 14.14%, 57.58%, respectively. Table 5 shows that education years of members and access to loans have remarkable differences between RHhs and NRHhs. The results indicate that rural households with different relocation attributes owned different amounts and types of livelihood capitals; they had different family livelihood endowments and features.

Table 5. The characteristics of rural households in Ankang prefecture.

Types	Total Sample	RHhs	NRHhs	Significance
Household Size (Persons)	4.496	4.512	4.460	ns
Number in the Labor Force (Persons)	3.212	3.205	3.227	ns
Education Years of Household Members	6.180	5.837	6.976	***
Cash Income Per Capita (yuan)	6204.880	5855.205	7015.489	ns
Access to Loans	3.430	3.552	3.147	***

Source: 2015 survey data from Ankang prefecture, Shaanxi Province; *** indicates that the *T* values are significant at the 1% level.

4.2. The Influence of PAR on Rural Household Livelihood Vulnerability

Taking the rural household livelihood vulnerabilities as response variables, and employing whether relocated, relocation type, relocation region, relocation time, and relocation subsidy as explanatory variables, respectively—while using household size, dependence ratio, education years of household members, production and living tools, financing channels, access to loans, training, credibility to others, monetary help, number of village cadres, New Year's network, whether suffered from risk shock, and livelihood diversification as control variables—the influence of PAR on rural

household livelihood vulnerability was conducted based on the multiple linear regression model (Table 6). Model 1–Model 5 all had an R^2 value of 0.58 and, thus, explain 58% of the total variance in livelihood vulnerability, with F-statistics all at the significant level of 1%. Model 1 demonstrates that a significant negative correlation at the level of 1% between whether relocated and livelihood vulnerability indicates that, with farmers who chose to migrate and resettle, the household vulnerability would be decreased obviously. Since the non-standardized coefficient of whether relocated was between 0 and –1, it means that the variation of vulnerability caused by relocation was relatively slow. Similar to the high vulnerability of project-induced relocation households (PRHhs), the project-induced relocation had a significant positive effect on the vulnerability at the 1% level. This was already revealed by Hwang et al. (2011), who found that, although the displaced have enjoyed a relative gain in housing quality, most of the changes (such as the social, economic, and mental and physical health dimensions) were in the negative direction and many negative changes were statistically significant [33]. Additionally, in this study, it was found that ecological restoration relocation, disaster-related relocation, and poverty alleviation relocation were positively related to livelihood vulnerability, respectively, whereas the positive variations were not statistically significant.

Table 6. Estimated results of impact of Poverty Alleviation Resettlement (PAR) on livelihood vulnerability.

Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Relocation Households (RHhs)	−0.028 ***				
Relocation type					
Ecological-Restoration Relocation Households (ERHhs)		0.001			
Project-Induced Relocation Households (PRHhs)		0.020 ***			
Disaster-Related Relocation Households (DRHhs)		0.003			
Poverty Alleviation Relocation Households (PAHhs)		0.005			
Relocation region					
Local Township Relocation Households (LTHhs)			−0.011 ***		
Neighboring Township Relocation Households (NTHhs)			−0.003		
Other Places Relocation Households (OPHhs)			−0.002		
Relocation time					
Short-term Relocation Households (SRHhs)				−0.032 ***	
Medium-term Relocation Households (MRHhs)				−0.029 ***	
Long-term Relocation Households (LRHhs)				−0.022 ***	
Relocation subsidy					
Moderately Subsidized Relocation Households (MSHhs)					−0.011 ***
Highly Subsidized Relocation Households (HSHhs)					−0.011 ***
Household Size	−0.002 *	−0.002 *	−0.002 **	−0.002 **	−0.002 *
Dependency Ratio	0.041 ***	0.038 ***	0.039 ***	0.042 ***	0.041 ***
Education Years of Members	−0.002 ***	−0.002 ***	−0.002 ***	−0.003 ***	−0.002 ***
Production and Living Tools	−0.060 ***	−0.055 ***	−0.052 ***	−0.063 ***	−0.050 ***
Financing Channels	−0.039 ***	−0.038 ***	−0.038 ***	−0.038 ***	−0.038 ***
Access to Loans	0.013 ***	0.010 ***	0.011 ***	0.013 ***	0.011 ***
Training	−0.017 ***	−0.015 ***	−0.011 ***	−0.017 ***	−0.014 ***
Credibility to Others	−0.002 ***	−0.002 ***	−0.002 ***	−0.002 ***	−0.002 ***
Monetary Help	−0.001 **	−0.000 *	−0.000 *	−0.001 **	−0.000
Number of Village Cadres	−0.003 ***	−0.002 *	−0.003 **	−0.003 ***	−0.003 **
New Year's Network	−0.000 *	−0.000 **	−0.000 **	−0.000 *	−0.000 *
Whether Suffered from Risk Shock	0.022 ***	0.038 ***	0.044 ***	0.022 ***	0.041 ***
Livelihood Diversification					
NFHhs	−0.038 ***	−0.032 ***	−0.031 ***	−0.037 ***	−0.031 ***
COHhs	−0.027 ***	−0.022 ***	−0.023 ***	−0.027 ***	−0.023 ***
Constant	0.037 ***	0.010	0.018	0.038 ***	0.007
Number of Observations	610	426	426	607	426
R^2	0.5850	0.5871	0.5801	0.5897	0.5836
F-statistic	55.83 ***	32.15 ***	33.16 ***	49.79 ***	35.83 ***

Note: "whether relocated" and "relocation time" take non-relocation households as the reference group; "relocation type" takes households relocated by other reasons as the reference group; "relocation region" takes local community relocation households as the reference group; "relocation subsidy" takes lower subsidized relocation households as the reference group; "livelihood diversification" takes pure farming households as the reference group; *** indicates that the *T* values are significant at the 1% level, ** indicates that the *T* values are significant at the 5% level, * indicates that the *T* values are significant at the 10% level. Source: 2015 survey data from Ankang prefecture, Shaanxi Province.

Table 6 also indicates that there was a significant negative correlation between livelihood vulnerability and relocation region, relocation time, and relocation subsidy, all at the 1% significance level. Taken from the results of Models 3, 4, and 5, it suggests that the values of the non-standardized

coefficients of relocation region, relocation time, and relocation subsidy were all negative, indicating that local township relocation, short-term relocation, medium-term relocation, long-term relocation, moderately subsidized, and highly subsidized relocation decreased the extent of household livelihood vulnerability; however, the change rate of vulnerability caused by the above relocation traits was also relatively slow.

Considering the impact of control variables on livelihood vulnerability, the results suggest that all these factors had a noticeable influence on livelihood vulnerability, with significance levels at 1%, 5%, and 10%. Among all these indicators, dependence ratio, access to loans, and whether suffered from risk shock had a significant positive effect on livelihood vulnerability, whereas the rest of the factors had an obvious negative impact on livelihood vulnerability. The production and living tools variable had the most remarkable influence on livelihood vulnerability, with a regression coefficients value of –0.063. While exposure was beyond the reach of policy, adaptive capacity can be enhanced by policy measures to reduce sensitivity, and hence vulnerability. Thus, the livelihood capitals and diversification households can access is crucial for farmers adapting to the pressure and shock. However, the LVI is a relative concept based on a considerable number of factors, therefore, it has sensitivity in terms of the indicators' design and data capture.

5. Conclusions

China's largest-ever resettlement program is underway. This ecological conservation and human development initiative aims to alleviate natural disasters caused by ecosystem degradation, to restore crucial ecosystem services, and to lift poor households out of the poverty trap and into sustainable livelihoods. Though it meets the strong desire of rural households who lived in the impoverished mountainous regions and under extremely severe conditions, the interventional risks proposed by Cernea (2000) and vulnerable livelihoods still might exist if unpredictable problems hinder migration/resettlement, deprive opportunities and entitlements to successful livelihood development [34], owing to land scarcity, high liability, and shortage of employment offers. This study suggests that there is a difference in exposure, sensitivity, and adaptive capacity of rural households with different relocation characteristics, hence generating remarkably different livelihood vulnerabilities. Generally, the PAR achieves the target of livelihood vulnerability reduction. Through the improvement of relocation households' living conditions and standards, such as the convenience of access to public infrastructure and service facilities, the changes in housing structure after relocation, and the greater possibility to capture non-farm employment opportunities, thereby accomplishing and shifting livelihood strategies from traditional inefficient agricultural and forestry production to non-farm employment, the high exposure and sensitivity have been mitigated. Meanwhile, the local government dramatically funds public facilities and large-scale industrial parks, leading to many rural–urban cyclic migration households to transform from out-migration activities to local migration activities. This shift not only decreases livelihood costs and family expenditures, but also improves the rural household's income and wellbeing, which can facilitate relocation household absorption of the variation in livelihood approach and reestablish their livelihood resilience. This, therefore, promotes the adaptive capacity to reduce both current and future livelihood vulnerabilities and achieves sustainable livelihood development.

Additionally, one of the important findings contrasted with households relocated by other reasons (ORHhs), was the livelihood vulnerabilities of project-induced relocation households (PRHhs) were relatively high and the project-induced relocation brought more risk and pressure, hence, vulnerability as described by Hwang et al. (2011) [33]. The categorization of four types of spatial forms indicates that local township relocation had a particularly significant positive effect on vulnerability reduction. An interesting finding is that neither short-term relocation, medium-term relocation, nor long-term relocation benefitted the migrants' livelihood. Again, high relocation costs can present a major barrier to migration and resettlement, particularly for the aged and infirm, which are the very poor households that the PAR intends to help. Therefore, the result indicates that increasing the

size of subsidies can minimize the relocation costs, thereby reducing the livelihood vulnerability of relocation households.

However, challenges and problems also appear subsequent to resettlement, such as rising expenditures, the pressure of financial burdens, increasing urban lifestyle costs, social isolation, social capital reconnection, deficiency of garden plot regions and space to collect productive tools, lack of job-search and training assistance, and diminished farming income. Previous studies proved that the PAR will not only result in positive net benefits to the government and beneficiaries over the long run, associated with environment improvement, but also will result in a high level of satisfaction among the migrants, as it has delivered improvements in housing conditions, infrastructure, amenities, ecosystem services increase, and livelihood restoration, whereas this research indicates that the PAR can diminish the migrants' livelihood vulnerability.

Based on this insight, there are policy implications to better pursue the conservation and development goals and meet the needs of the households of whom the PAR aims to serve and bestow. Firstly, according to the distribution of the financial burden of resettlement and high resettlement costs, it is important to diminish the financial burden on the relocated and to provide free public transportation services, especially for long-distance resettlement. Secondly, it is proven that economic and social security assistance projects could overcome vexing dilemmas to the migrants' social integration in the forced resettlement, while post-resettlement support and social capital rebuilding both are essential to the long-term goals of the PAR, equally. Therefore, policymakers should not regard that the programs are complete once the resettled have moved into their new communities. On the contrary, it is vital to carry out community-building programs and updating of the household registration institution. Thirdly, the PAR did not change substantially the farmland plot sizes of the resettled, but it might be difficult to engage in agricultural activities by commuting to the farmlands for long-distance relocation households, thus the innovative incentive policy scheme probably needs to balance the redistribution and sharing dilemma of farmland between the original residents and the relocation households. Moreover, the government officials should provide assistance in employment searches and training in specific skills. Finally, the authors also note that the most vulnerable and disadvantaged households have stayed behind regardless of how much the relocation subsidies are. Nevertheless, based on the principle of voluntary nature and equity, non-movers cannot be forced or requested to move into the new surroundings; on the contrary, local governments need to create an impartial project to safeguard them from the significant physical and spiritual negative impacts.

This study has some key limitations. Firstly, the authors conducted the cross-sectional household survey four years after the PAR was implemented in Ankang in the end of 2015. Using such non-ideal data, the variation of relocation and non-relocation households could not be better revealed. Conversely, the variation among households can have significant effects on those who decide to participate. This might bring endogeneity and selection bias to the estimate results. Secondly, the authors selected the sub-components subjectively and indicated the direction of the relationship between the indicators and vulnerability, and also suppressed the extreme values by employing standardized means to compute the indices and weights. Thirdly, the livelihood vulnerability was influenced by different characteristics and contexts of households, hence this study's approach can be refined by incorporating multiple socioeconomic variables and more indicators. The authors are planning to conduct a follow-up household survey to monitor the dynamics of the farmers' livelihood vulnerability in a future study, and are considering including exposure and living conditions, as well as access values, and modifying the multiple linear regression analysis model. Additionally, the livelihood vulnerability evaluation framework against impoverished communities at different scales should be developed, and more socioeconomic levels should be included to target and identify the type of vulnerable rural households. Meanwhile, the authors do not deny that the survey samples were small, and there could be enormous variation and unobservable characteristics among those households surveyed in different communities and counties which can influence rural household participation and generate selection bias in assessing

livelihood vulnerability. Considering these possible biases, the authors tried to consider those who had a high similarity in resettlement traits and livelihood approaches for the surveyed households.

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