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Assessing Livelihood Reconstruction in Resettlement Program for Disaster Prevention at Baihe County of China: Extension of the Impoverishment Risks and Reconstruction (IRR) Model

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Abstract: The paper develops a tool for livelihood recovery assessment in disaster-preventive resettlement. A new conceptual framework is built based on the impoverishment risks and reconstruction (IRR) model. This framework leads to a quantitative model that was designed and tested using the disaster resettlement preventive engineering (DRPE) project in Baihe county of China. The new model evaluates the qualities of livelihood recovery in terms of three components: Life reconstruction, development reconstruction, and safety reconstruction, which consider features specific to the Chinese society, and introduce a new insecurity factor. The model showed good reliability, validity, and sensitivity for the evaluation of livelihood reconstruction in disaster-preventive resettlement. Its application will help to target interventions to improve public services in resettlement areas by identifying cases with inadequately sustainable livelihoods.

Keywords: disaster prevention; resettlement; livelihood; evaluation; poverty

1. Introduction

More than 300 million people are displaced and must resettle because of internal disasters, military conflicts, and development projects every year [1]. Population resettlement is an important tactic for disaster reduction throughout the world. An increasing number of disaster displacement projects, including proactive displacements for disaster prevention or passive displacements for catastrophic events, have been initiated in response to climate change (e.g., [2–5]).

China is one of the countries most prone to natural disasters, with about 7900 victims dying each year [6]. Some massive projects for disaster-preventive resettlement have been initiated in China in recent years [7,8]. As displacement and resettlement may destroy people's original livelihoods and expose people to risk of greater poverty, livelihood recovery has been considered a top priority in resettlements [9]. Assessment tools are necessary to evaluate, monitor, or plan the resettlers' livelihood reconstruction in the Chinese context.

The impoverishment risks and reconstruction (IRR) model, developed by Cernea [10–15], has been widely used in the practice of resettlement (e.g., [14–17]). However, the model is a conceptual framework, and cannot be applied quantitatively in assessing livelihood reconstruction. Its application should also be culture-specific and adaptable to trends in urbanization, capitalization,

and specialization. This paper attempts to apply the IRR model in the Chinese social and cultural context by developing a measurement tool to assess livelihood reconstruction in disaster-preventive resettlement. The improved IRR model is expected to be more applicable to assessment of livelihood reconstruction in disaster-preventive resettlement.

2. Literature Review

Resettlement is one of the major solutions to persistent risk of disasters [18]. However, resettlement disrupts the original livelihoods of the resettled people, and may increase their risk of impoverishment, although resettlement projects are expected to restore their livelihoods and create opportunities for development [19].

2.1. The Collapse of Original Livelihoods in Resettlement

It is widely agreed that displacement and resettlement may create new poverty. First, resettlement results in the loss of such natural resources as arable land, forest land, water supplies, or grazing lands [18,20,21]. Second, resettlement can result in the resettlers becoming jobless. Third, the financial situation of resettlers may became worse, because the resettled households can be at a disadvantage in negotiation for compensation, which results in low displacement compensation and bad housing conditions [4,20]. Fourth, resettlers become marginalized due to the disruption of established social networks, cultural and religious activities, or discrimination in their new communities [20,22,23].

Livelihood vulnerabilities related to resettlement have been mentioned in previous studies. Resettlers may suffer from psychological stress, insecurity about drinking water or food, malnutrition, etc. Because of homelessness, joblessness, or marginalization, psychological stress has been found to be prevalent among resettlers, who may develop a sense of fear, alienation, and uncertainty about their future [10,24]. Rebuilding the capacity of regular food production might take several years, so that resettlers have suffered from food insecurity and malnutrition [10,25]. Resettlers were also reported to have increasing morbidity due to lack of good water resources and sanitation facilities [26,27]. Additionally, disorders and even an increase in crime rate were found during resettlement, both of which were far less prevalent in their ancestral villages [20]. These health problems and insecurities related to resettlement might offset improved livelihoods by damaging the sustainability of these livelihoods [5,9].

2.2. Livelihood Assessment Model Overview

In order to assess, monitor, and avoid negative consequences of livelihood change, researchers have developed livelihood assessment models. There are three major streams of livelihood research: (1) Livelihood assessment from assets, (2) livelihood assessment from vulnerabilities, and (3) livelihood assessment from risk mitigation. The asset stream of research examines the roles of several livelihood capitals that support sustainable livelihoods. The vulnerability stream concentrates on exposure and sensitivity to risk, and adaptive capacities. Finally, the risk mitigation stream focuses on identification of impoverishment risks in resettlement, and follows up with counter-risk assistance. Since our primary interest is livelihood reconstruction in resettlement, we draw heavily from the risk mitigation stream. However, the measurement of capitals in our model is based on the asset stream of research, and indicators of disaster exposure in our model refer to the vulnerability stream of research. Thus, our model integrates aspects of all three streams of research.

The asset stream of research focuses on a broad range of living capitals [28,29]. As livelihood assets are core components of the livelihood system, the assessment model from the asset stream is helpful in showing the livelihood capacity of resettlement. The sustainable livelihoods framework (SLF), developed by the British Department for International Development (DFID), is an outstanding representation of the asset stream and includes five components: Human capital (knowledge and labor), natural capital (natural resources), financial capital (savings and regular money inflows),

physical capital (infrastructure, tools, and equipment), and social capital (social relations and networks) [28,29]. SLF has been widely used to analyze livelihoods of farmers (e.g., [30,31]). A few studies also applied SLF to disaster-preventive resettlements [7,8]. The vulnerability stream of research describes risky situations for resettlers and their incapacity to take risk-reducing actions [32]. Vulnerability is the likelihood of experiencing harm from exposure to a hazard [33]. Vulnerability analysis is always conducted with the livelihood vulnerability index (LVI), which is a function of three elements: Exposure to stresses, sensitivity to the exposure, and the capacity to cope, adapt, or recover [33–35]. LVI is similar to a risk mitigation model, but the risk is broadly defined as exposure, sensitivity, and incapacity. The risk mitigation stream of research aims to recognize the various impoverishment risks, and to mitigate risks by initiating some strategies. The IRR model has been very influential in resettlement research and is at the core of the risk mitigation models [36]. Its advantages and shortcomings will be discussed in detail in the next section.

Although some influential models using the above three streams of research have been widely used, their limitations are also important. Less attention has been paid to the difference between residents' poor livelihoods and resettlers' impoverishment risks in the asset stream of research. For example, the poor were not deemed as victims, but as decision makers for their own livelihoods in SLF [37]. Actually, resettlers are victims, whose original livelihoods are destroyed in the process of resettlement, and they should be compensated for having to adopt a new life. Additionally, there are many problems with health and insecurity during disaster resettlement, which are ignored in the asset stream research. Vulnerability analysis is a technique for strategy promotion, and it is hard to provide feasible solutions based on the vulnerability stream of research. In addition, previous livelihood assessment models, including SLF, LVI, and IRR, have similar limitations. Livelihood factors, such as assets, vulnerabilities, capacities, and strategies, depend strongly on the social, cultural, and economical contexts. However, these models have not evolved in response to changes in the resettlement context in recent years. For example, some resettlements are carried out in capitalist markets through house exchange systems, wage earning reemployment, and communal resource privatization [2]. The idea of urbanization-related displacement is often integrated into disaster prevention, ecological protection, or development project resettlements [38].

2.3. IRR Model Overview

The IRR model is a framework of risks and risk avoidance for resettlement, which describes resettlers' eight primary risks, namely [10,12,13]:

(1) Landlessness,
(2) joblessness,
(3) homelessness,
(4) marginalization,
(5) increased morbidity and mortality,
(6) food insecurity,
(7) loss of access to common property, and
(8) social (community) disarticulation.

These risks are associated with impoverishment. As a result, counter-risk strategies must be adopted to alleviate these risks and to reconstruct positive livelihoods for the resettlers [12]. According to the IRR model, the risk-reversal activities of livelihood reconstruction include [10,13,15]:

(1) From landlessness to land-based resettlement,
(2) from joblessness to reemployment,
(3) from homelessness to house reconstruction,
(4) from marginalization to social inclusion,
(5) from increased morbidity to improved health care,

(6) from food insecurity to adequate nutrition,
(7) from loss of access to restoration of community assets and services, and
(8) from social disarticulation to rebuilding networks and communities.

The IRR model provides a conceptual apparatus that helps to explain, predict, and reverse impoverishment risk during displacement and resettlement [12]. It has been widely adopted in research on resettlement and applied to hundreds of resettlement projects by the World Bank [11]. However, the IRR model is only a conceptual framework and does not provide a specific toolkit to resolve practical problems. Therefore, it cannot be applied to assess livelihood reconstruction quantitatively.

Our focus is assessment of reconstructed livelihoods following disaster-preventive resettlement. Livelihood reconstruction is more than capital recovery. Many factors, including resettlement strategies, external environment, community development, and people involved in assessment and decision-making, should also be considered [18,39]. Some parts of the IRR model may not be appropriate for the evaluation of impoverishment risk in some cultures; for example, land-based resettlement is no longer an option in some cases in China [40]. Another shortcoming of the IRR model is that social and natural insecurity caused by displacement and resettlement are not considered. Here, we aim to extend and improve the IRR model according to the specific socio-cultural situation and new dynamics of disaster resettlement. The core of this research develops a new conceptual framework and statistical model for evaluation of livelihood reconstruction in disaster-preventive resettlement.

3. New Conceptual Framework and Its Indicators

3.1. Logical Schematic

A conceptual framework is developed based on Cernea's IRR model. As shown in Figure 1, there were eight impoverishment risks in the IRR model, combined with eight corresponding counter-risk remedies one-to-one, most of which are inherited by the new model. As Figure 1 shows, the new model extends the IRR model, sharing the same structure of risks and risk-reversals but adding or modifying clauses. After new clauses were added to the IRR model, the new model was extended to be a framework that now includes eleven risks and eleven risk-reversal strategies. The first risk-reversal strategy was modified from the IRR model. The conceptual framework is the theoretical part of the new model, which can be used to review qualitatively the livelihood reconstruction of disaster-preventive resettlement.

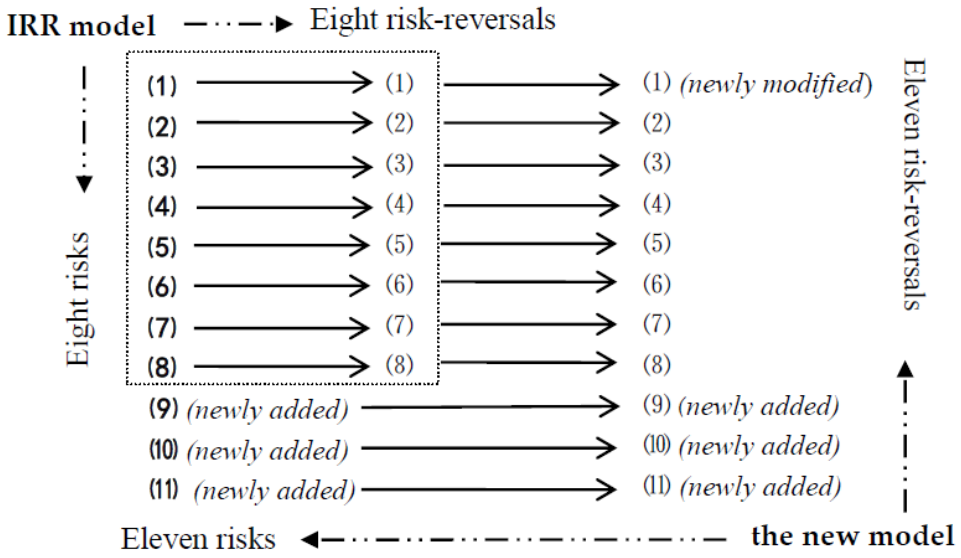

Figure 1. A schematic for the adjustment of Cernea's impoverishment risks and reconstruction (IRR) model.

3.2. The Conceptual Framework and the Indicators

The IRR model suggests eight risk-reversal activities to advance resettlers' livelihood reconstruction. However, some of these activities are not appropriate for disaster-preventive resettlement in China. Therefore we adjusted and expanded the conceptual framework. Based on this new conceptual framework, practical indicators were also designed to assess the quality and quantity of livelihoods, and each indicator was measured with specific items as in Table 1.

(1) From landless to income-based resettlement (newly modified). Farmland is an essential resource for farmers; therefore, land-based resettlement was highlighted for livelihood reconstruction of resettlers. In China, disaster-preventive resettlement is accompanied by urbanization; that is, most resettlements turn farmers into non-agricultural citizens by reducing their lands and providing alternative compensation in the form of money or houses. Land reduction does not necessarily mean worse living situations for resettlers, as their income is no longer determined by assets provided by natural resources, but mostly by revenues from non-farm activities [39,41]. Alternatively, agricultural activities that are more collective and cost-efficient than before can also increase the average agricultural income [8]. Income, no matter where it is from, is a major concern for resettled people [2], but it has been ignored in the IRR model. In other words, financial capital was not considered in the IRR Model. Thus, we replaced land-based resettlement with income-based resettlement, and two indicators, "savings change" and "income change", were used and reported as X1 and X2, respectively, in Table 1.

(2) From joblessness to reemployment. Two indicators, "employment chance" and "training chance", were used and reported as X7 and X8, respectively.

(3) From homelessness to house reconstruction. The indicator "housing condition" was used and reported as X9.

(4) From marginalization to social inclusion. Two indicators, "relatives contacts" and "making friends", were used and reported as X3 and X4, respectively.

(5) From increased morbidity to improved health care. The indicator "disease incidence" was used and reported as X14.

(6) From food insecurity to adequate nutrition. The indicator "food nutrition" was used and reported as X16.

(7) From loss of access to restoration of community assets and services. Two indicators, "infrastructure condition" and "sanitation condition", were used and reported as X5 and X6, respectively.

(8) From social disarticulation to rebuilding networks and communities. Two indicators, "educational condition" and "community agency", were used and reported as X11 and X12, respectively.

(9) The feeling of disaster reduction (newly added). Disaster resettlement is different from development-forced displacement. Avoiding disaster was the most fundamental reason for disaster preventive displacement and resettlement. Thus, impacts of current and future disasters of the destination areas should be identified and assessed. If relocation sites are expected to experience increased or continued risk, then the effects of resettlement may be largely offset [10]. Thus we added an indicator "disaster reduction", which was reported as X13.

(10) The feeling of resettling performance (newly added). Successful resettlements require good public services, adequate funding, community development, authority responsibility, assessment, and involvement in decision-making [18]. Evaluation of satisfaction is an important way to assess the performance of livelihood reconstruction. The indicator "performance satisfaction" was used and reported as X10.

(11) The feeling of public safety in relocating sites (newly added). Displacement and resettlement tend to bring social insecurity (disorder, conflict, or crime) [20], which may have negative effects on the livelihood reconstruction of resettlers [5,9]. A safe environment is another important guarantee

for livelihood reconstruction. Therefore, we added the indicator "public safety" and report it as X15.

Table 1. Indicators of livelihood reconstruction and their measurement.

Indicators	Measuring Items
X1	Your savings are (will be) increased after the resettlements.
X2	Your annual incomes are (will be) increased after resettlement.
X3	New residence makes it more convenient for me to contact my relatives after resettlement.
X4	New residence makes it easier for me to make new friends after resettlement.
X5	After resettlement, the infrastructure (e.g., traffic conditions) becomes (will become) better.
X6	After resettlement, drinking water and sanitation facilities become (will become) better (e.g., traffic conditions).
X7	Companies in resettling sites are able to provide enough employment.
X8	You can participate in knowledge and skill training provided by the government.
X9	You are satisfied with the current compensation standard for house purchase.
X10	You are satisfied with what the displacing and resettling agencies have done.
X11	Management agencies in the resettling communities are perfect.
X12	Educational conditions for children are (will be) improved after resettlement.
X13	Loss caused by natural disasters (e.g., flood, geologic disaster) is (will be) reduced after the displacement.
X14	Morbidity of resettlers is (will be) decreased after the displacement.
X15	Public safety problems (e.g., theft, robbery) are (will be) reduced after the displacement.
X16	Quality of your diet is (will be) improved after the displacement.

Note: A simple five-point Likert scale is used for all the items, that is: 5 = strongly agree, 4 = agree, 3 = unknow, 2 = disagree, 1 = strongly disagree.

4. Materials and Methods

4.1. Study Area

The Shaanxi provincial government has initiated a proactive plan for disaster-preventive resettlement engineering (DPRE) in southern Shaanxi to operate from 2011 to 2020 and aims to relocate 811,779 local residents, among whom 60.58% will be resettled because of geological hazards, and 39.44% for flood disasters [42]. In western China, the program covers Ankang City, Shangluo City, and Hanzhong City, which are located in mountainous areas in the Qinling Mountains and Daba Mountains, where local residents are threatened by storms, floods, and geological disasters.

Baihe County, one of the key areas of DPRE, was taken as the case to test our new model for livelihood reconstruction in disaster resettlement. At the population census of 2010 in China, there were 163,395 residents in the county, which is underdeveloped and located in eastern Ankang. According to the Chinese Statistical Yearbook of 2011, the per capita net income of farmers in Baihe county was only 616 USD, far less than the national average of 1080 USD. The poverty of Baihe county may be partly attributable to the frequent disasters there. As the overall DPRE plan reported, there are 12,600 people living in about 107 villages (83.6% of the county) that suffer from landslides, debris flows, and other hazards. Resettlement in Baihe County has been regarded as an important engineering project for disaster prevention and poverty reduction.

4.2. Household Survey

DPRE in Baihe County has been carried out in its inner twelve towns, and three survey sites, Songjia Town, Cangshang Town, and Lengshui Town, shown in Figure 2, were sampled randomly. According to their stage of advancement in resettlement, all the households in these towns can be divided into those that have been resettled, are to be resettled, and not involved in resettlement.

With a stratified random sampling method, we interviewed local residents in the selected towns at the ratio of 5:3:2 for the households that have been resettled, are to be resettled, and are not involved in resettlement. Only one family member above 16 years old in each household was randomly invited to fill out a questionnaire indoors.

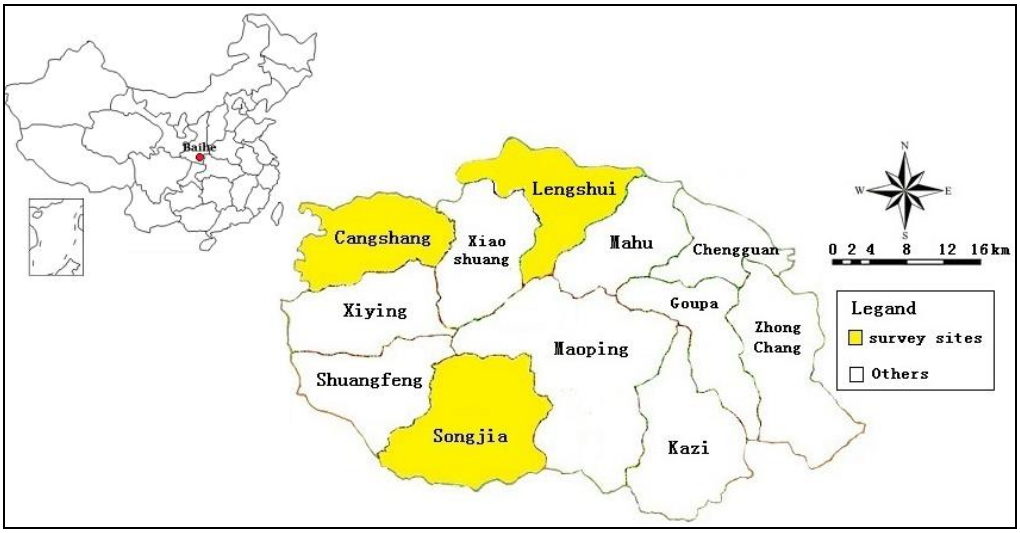

Figure 2. Baihe County (1477 km^2) is located in the most eastern area of Ankang City Shaanxi Province, China. The three yellow areas in this map are the surveyed towns.

Six hundred and five respondents provided valid information, including 305 respondents from households that had been resettled (50%), 187 respondents from households to be resettled (31%), and 113 respondents from households not involved in the resettlement (19%). Because the sample from households not involved in resettlement had not faced and will never face livelihood reconstruction, the last 113 cases were excluded, and 492 cases were used for data analyses in this study. Among the final samples shown in Table 2, 61% were male, and 96.6% of the respondents were 18–60 years old. The majority of respondents (84.6%) had education to junior middle school or below, and 91.1% of respondents had annual income less than 8000 RMB (1238 USD). It is obvious that the respondents were mainly from poor families, and were the primary labor force in their families.

Table 2. The sample characteristics.

Variables		Having been Resettled (%) N = 305 (62.0)	To be Resettled (%) N = 187 (38.0)	Involved in Resettlement (%) N = 492 (100)
Gender	Male (men)	173 (56.7)	127 (67.9)	300 (61.0)
Age	Less than 18 years old	6 (2.0)	1 (0.5)	7 (1.4)
	18–45 years old	252 (82.6)	142 (75.9)	394 (80.1)
	46–60 years old	44 (14.4)	37 (19.8)	81 (16.5)
	More than 60 years old	3 (1.0)	7 (3.7)	10 (2.0)
Education	Illiterate	16 (5.2)	21 (11.2)	37 (7.5)
	Elementary school	128 (42.0)	67 (35.8)	195 (39.6)
	Junior middle school	126 (41.3)	58 (31.0)	184 (37.4)
	Senior middle school and above	35 (11.5)	41 (21.9)	76 (15.5)
Annual income	1000 and below (RMB)	84 (27.5)	27 (14.4)	111 (22.6)
	1001–3000	125 (41.0)	69 (36.9)	194 (39.4)
	3001–8000	73 (23.9)	70 (37.5)	143 (29.1)
	8000 above	23 (7.5)	21 (11.2)	44 (8.9)

4.3. Statistical Methods

Using the survey data of resettlement in Baihe County, principal component analysis was conducted on the items of the new index system, to identify the factors of livelihood reconstruction in

resettlement. An index of livelihood reconstruction was then calculated from the total of the common factors. The new index was tested for its internal consistency, structure validity, content validity, and sensitivity. Bartlett's test of sphericity, common factor analysis, and independent *t*-tests were applied. All analyses were conducted using SPSS 19.0 software.

5. Test of the New Model

5.1. Reliability and Validity

The Kaiser-Meyer-Olkin test (KMO = 0.92) and Bartlett's test of sphericity (X^2 = 3177.42, $p < 0.001$) showed that the items were very suitable for factor analysis. A common factor analysis was conducted using principal component analysis, and the factors whose eigenvalues were greater than 1 were extracted. As shown in Table 3, all the items were well divided into three common factors with acceptable total variance explained (60.26%) and standard factor loadings (greater than 0.6). The results show that the scale had good discrimination and construct validity. Reliability analysis was also carried out: Cronbach's alpha value for the total of all items was 0.91, and the values for the three factors were 0.86, 0.86, and 0.79, respectively, indicating that the index system of livelihood reconstructions had good internal consistency.

Table 3. Assessment system for livelihood reconstruction in disaster-preventive resettlement

Conceptual Dimensions	Indicators and Measuring Items	Common Factors and Standard Loadings		
		Life	Development	Safety
(1) (4) (7)	X1	0.724		
	X2	0.647		
	X3	0.745		
	X4	0.773		
	X5	0.722		
	X6	0.678		
(2) (3) (8) (10)	X7		0.719	
	X8		0.741	
	X9		0.637	
	X10		0.717	
	X11		0.731	
	X12		0.673	
(5)	X13			0.768
(6)	X14			0.768
(9)	X15			0.714
(11)	X16			0.616
Cumulative variance explained		22.24%	44.19%	60.26%

For resettlers' livelihood reconstruction, we obtained three common factors: "Life reconstruction", "development reconstruction", and "safety reconstruction". As shown in Tables 1 and 3, the life reconstruction factor includes indicators of savings change, income change, contacts with relatives, making friends, infrastructure conditions, and sanitation conditions; the development reconstruction factor includes indicators of employment chance, training chance, housing conditions, educational conditions, community agency, and performance satisfaction; the safety reconstruction factor includes indicators of disease incidence, food nutrition, disaster reduction, and public safety. Two common factors, life reconstruction and development reconstruction, and their indicators (items), match and are consistent with the original IRR model. Moreover, the new dimension of safety reconstruction is well embedded into the framework, which implies that the livelihood reconstruction assessment system has good content validity.

5.2. Validity of the New Index System for Livelihood Reconstruction Assessment

The new index system was applied to assess the level of DPRE livelihood reconstruction in Baihe County. The level of livelihood reconstruction is shown in Figure 3 after being sorted in ascending

order. Twenty-four resettlers (4.9% of the total) were found to have extremely low values of livelihood reconstruction. In other word, these people were in a bad situation in terms of livelihood reconstruction. When comparing the values of the sixteen indicators and their three factors with averages for the whole sample, we found parts of their livelihoods had been negatively affected by X7, X9, and X11, which suggested that the low values of the 24 resettlers might be attributable to difficulties in seeking new jobs, lower compensation for new house purchases, and less satisfaction with agencies managing the resettling communities.

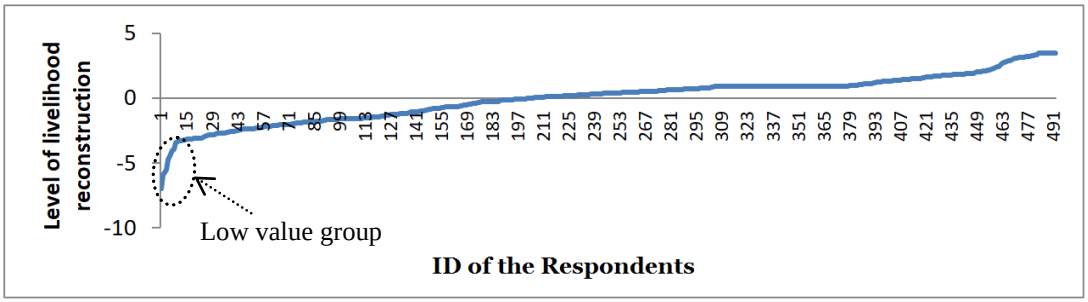

Figure 3. Results from assessment of livelihood reconstruction for disaster-preventive resettlement in Baihe County. Low value group is indicated in the oval.

Additionally, independent sample *t*-tests between the households that have been resettled and are to be resettled show that livelihood reconstruction ($t = -3.89$, $p < 0.001$, Cohen's $d = 0.35$) and the factor of development reconstruction ($t = -4.23$, $p < 0.001$, Cohen's $d = 0.380$ were significantly different. However, differences in the factors of life reconstruction ($t = -1.860$, $p < 0.1$, Cohen's $d = 0.17$), and safety reconstruction ($t = -0.60$, $p > 0.05$, Cohen's $d = 0.05$) were not statistically significant.

It seems that the new index system can distinguish those households that might need some special assistance and whose risk of impoverishment should be monitored. In other words, the evaluation of livelihood reconstruction has distinct policy implications for disaster-preventive resettlement. By identifying specific problems with livelihood reconstruction, improvements in plans for displacement and resettlement can be suggested; both local governments and resettlers can benefit from the application of the new index system.

5.3. Sensitivity Analysis

To test the sensitivity of the new model, two opposing variables were used. One is a supportive attitude variable measured by the question, "Is disaster preventive displacement and the resettling project beneficial for the people involved?", while the other is an opposing attitude variable measured by the question, "Will you refuse displacement or move back when you have difficulties and problems?" A simple five-point Likert scale was used for the answers.

For the first question, 70.5% of the respondents agreed (strongly agree, agree) that the project was beneficial for the people involved, 20.7% disagreed (strongly disagree, disagree), and 8.7% said it was hard to tell. For the second question, 52.0% of the respondents answered they would refuse displacement or move back when having difficulties and problems, 38.2% answered they would not do that, and 9.8% said it was uncertain.

First, the correlations between the livelihood reconstruction index and the resettlers' attitudes assessed by the above two questions were analyzed. A higher value of the index indicates that the project is more beneficial for people involved and fewer will refuse displacement or move back. As a result, the index of livelihood reconstruction was positively correlated with the supportive attitude ($R = 0.547$, $p < 0.001$), and negatively correlated with the negative attitude ($R = -0.218$, $p < 0.001$), which indicates that the quality of livelihood reconstruction could be sensitive to the resettlers' attitudes to disaster-preventive resettlement.

Then, taking the two questions above as grouping variables, an independent *t*-test of the livelihood reconstruction index was conducted to evaluate the sensitivity of the new tool. Results [t(388) = −12.85, $p < 0.001$, Cohen's d = 0.65; t(442) = 4.70, $p < 0.001$, Cohen's d = 0.46] confirmed that the differences between the two groups were significant, which suggests that the livelihood reconstruction index was acceptably sensitive in assessing resettlers' livelihood reconstruction.

6. Conclusions and Discussion

The well-known IRR model, which was developed two decades ago, has been widely applied in assessing livelihood reconstruction. However, its applications are limited, especially for quantitatively assessing livelihood reconstruction in disaster-preventive resettlement, because it lacks a specific measuring tool and doesn't take account of trends in urbanization, capitalization, and specialization. Based on the IRR model and in the context of disaster adaptive resettlements in China, we developed a new index system to assess livelihood reconstruction and tested it with data from Baihe county.

Results showed our new model with satisfactory reliability, validity, and sensitivity. A new dimension of safety reconstruction was added to the standard IRR model. This is necessary for the livelihood reconstruction of resettlers, especially for disaster resettlements. Living in a new site that is safer than the original place is the goal of disaster-preventive resettlement, so safety reconstruction deserves the utmost attention. In addition, the term "land-based resettlement" was replaced by "income-based resettlement" to increase the relevance to livelihood reconstruction, because the former was not applicable in some cultural contexts.

By applying the new model to assessing resettlers' livelihood reconstruction in Baihe county, several resettlers with low values of livelihood reconstruction could be identified. Comparative analyses also found that livelihood reconstruction in Baihe county still had some problems, especially in the factor of development, which implies that more attention should be paid to the resettlers' development ability by providing more work opportunities and better housing conditions. Moreover, differences in livelihood reconstruction between the groups that were resettled and are to be resettled also suggests improvement in managing the resettling communities in Baihe county is needed. The high consistency with the resettlers' acceptance of disaster-preventive resettlement confirms that the new index system can be used as a tool to assess performance of resettlement. By incorporating the needs and feelings of the resettlers into the index, their interests are expected to be better served. Moreover, information about livelihood reconstruction in resettlement may help to improve the quality of public services, and avoid resettlers' protesting against displacement or returning to their original homes.

7. Limitation

There are several limitations in our study. Sixteen indicators of livelihood reconstruction were selected from the IRR conceptual framework and previous literature. More studies are needed to test whether these specific indicators are feasible for disaster-preventive resettlements in other areas or countries, or whether more indicators and larger samples should be included. In this study, the livelihood reconstruction index was developed on behalf of the resettlers, and the concerns of displacement project managers were not considered. This has been a contentious issue in some situations. In addition, we could not conduct comparisons with other models based on the data of Baihe due to the data limitation.

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