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Risks of Developing Concentrated Rural Settlement after the Wenchuan Earthquake in China

Yi Peng [1], Xuewen Li [2,*], Li Huang [1], Shuli Jiang [1], Yelin Xu [3] and Yani Lai [4]

[1] School of Public Administration, Zhejiang University of Finance & Economics, Hangzhou 310018, China; pengyihz@zufe.edu.cn (Y.P.); huangli@zufe.edu.cn (L.H.); jiangshuli@zufe.edu.cn (S.J.)
[2] School of Public Affairs, Zhejiang University, Hangzhou 310058, China
[3] Department of Engineering Management, Zhejiang Sci-Tech University, Hangzhou 310018, China; xuyelinhz@163.com
[4] Department of Engineering Management and Real Estate, Shenzhen University, Shenzhen 518060, China; lai.yani@szu.edu.cn
* Correspondence: lixuewen@zju.edu.cn; Tel.: +86-0571-56662162

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Abstract: Concentrated rural settlement (CRS) reconstruction was promoted as a sustainable rural reconstruction way after the Wenchuan earthquake in China. Despite the various benefits of CRS, haphazard CRS reconstruction presents risks to future sustainable development. However, such risks have been rarely investigated. Thus, this study examines the risk factors with eight CRS reconstruction cases after the Wenchuan earthquake. The existence and interactions of economic, social, environmental, and disaster relief risks are observed after reconstruction. A conceptual model is proposed for systematically interpreting the risks. Results obtained can help the local government judiciously consider the risk factors in order to achieve sustainable development when initiating rapid reconstruction.

Keywords: concentrated rural settlement (CRS); Wenchuan earthquake; post-disaster reconstruction; risk; conceptual model; sustainable development

1. Introduction

The Wenchuan earthquake, which occurred on 12 May 2008, resulted in major losses in China. Besides damage to land resources and infrastructure, there were 7.79 million collapsed houses and 24.59 million damaged houses scattered in 14,565 villages during the earthquake. It was estimated that there was about 41.9 billion RMB direct economic losses with more indirect losses [1,2]. Rural areas face more disadvantages than urban areas due to a lack of quality infrastructure and effective disaster education [3]. For example, the number of collapsed houses was estimated to be 826,700 with floor area of 12,403 hectares in the seriously quake-hit rural areas of Sichuan Province during the earthquake. These numbers are 2.2 and 4.2 times of those observed in the severely affected urban areas of Sichuan Province [4]. As housing damage is usually a major loss in rural China, housing reconstruction, therefore, is placed as the topmost priority after disasters.

Rural housing reconstruction is vital for rural recovery and redevelopment [5]. Resettlement and in situ reconstruction are the two common approaches to housing reconstruction after natural disasters. Resettlement is usually initiated due to various concerns, e.g., safety, cost, and redevelopment chances [6–8]. Resettlement provides chances to improve the victims' life with better public infrastructure and services. Yet, it was found that resettlement can result in negative impacts on victims' livelihoods, social networks, and resource utilization [9,10]. In situ reconstruction is building new houses in the pre-disaster venue for rapid recovery. Compared with resettlement, in situ

reconstruction has the advantages of accessing predefined resources, minimal mobilization, and less social tensions [11]. However, the original venue may be constrained by future disasters and preexisting socioeconomic problems.

Concentrated rural settlement (CRS) has been proposed as an alternative form of reconstruction after the Wenchuan earthquake. CRS within a village involves the relocation of scattered victims on a concentration site within the original village [3,12]. Unlike remote resettlement, CRS within villages can provide low-cost public infrastructure and services without compromising existing social networks and resulting social tensions. Compared with in situ reconstruction, existing land and social resources are accessible to CRS while providing a chance to remove from the original site with potential hazards and obtain better development [2]. Before the Wenchuan earthquake, three major policies were adopted to promote CRS in rural areas. They include the coordinated urban–rural development (CURD) strategy, the new socialist countryside construction strategy, and the "increasing versus decreasing balance" policy [13]. The local governments of Sichuan Province also used the "opportunity window" after the Wenchuan earthquake to promote CRS development. A number of news reports on CRS reconstruction claimed that farmers were concentrated for a better future.

However, the risk of CRS reconstruction has been rarely explored. CRS development under normal conditions is controversial because of the resistance of farmers and the potential risks after concentration. Similar to CRS development under normal conditions, CRS reconstruction may also pose potential risks to the long-term sustainability of the farmers. The lack of a systematic investigation on such risks leads to the uncertainty of the sustainability of existing CRS reconstruction projects and presents barriers against future CRS reconstruction. Therefore, this study investigates the risk factors of CRS reconstruction after the Wenchuan earthquake. Section 2 critically reviews the policy context and implementation process of CRS reconstruction as well as the resettlement risk. Section 3 introduces the research method adopted in this study. Case study is used to investigate the risk factors. A semi-structured interview is employed to collect information on the cases. Section 4 presents an in-depth discussion of the findings in the cases. Section 4 also presents a conceptual model developed to systematically understand the risks of CRS reconstruction. Section 5 summarizes the conclusions drawn from this study and specifies possible future research directions.

2. Literature Review

2.1. Policy Context of CRS Development

The CURD strategy is an important policy of promoting CRS. This strategy was introduced by the former President Jiang Zeming in the 16th National Congress of the Communist Party of China in 2002 to cope with the significant imbalance between urban and rural development in China [14]. This national strategy aims to solve problems in agriculture, rural areas, and those of farmers as well as to achieve a coordinated development between urban and rural areas [14]. The CURD is intended to develop a new urban–rural system, which enables the free flow of resources and protects the rights of farmers. In this context, the market mechanism can play a key role in the allocation of resources between urban and rural areas. The farmers therefore can also earn revenues through improving the efficiency of resource allocation, which helps to unify efficiency and fairness. In order to explore effective measures to implement CURD strategy, the State Council selected Chengdu and Chongqing as two experimental reform zones for CURD in 2007 [13]. Chengdu, where the case villages of this study locate in, proposed various measures to establish an urban–rural unified factor market, ensure rural stability, and create a system of sharing outcomes of reform and development between urban and rural areas. Three forms of concentrations were put forward, namely, concentrating industrial development in key development zones, concentrating farmers in towns or cities, and concentrating the land for large-scale operations [15]. CRS development is one of the most important approaches for concentrating farmers and transferring land use rights to other regions with the market price of revenues.

The new socialist countryside construction strategy is another important policy used to promote CRS development. The central government proposed this strategy as an important mission in the Eleventh Five-Year Plan for National Economic and Social Development in 2006 [16]. This policy is considered an inevitable result of implementing the CURD strategy. The new socialist countryside construction strategy was put forward to achieve a high level of agricultural production, high living condition, civilized lifestyle, clean environment, and democratic management [16]. For the implementation of this construction strategy, the government must set aside a huge investment, the secondary industry must sustain the agricultural sector, the urban areas must support the rural areas, and all societal members must be mobilized to participate [17]. Compared to improving civilized lifestyle and democratic management of villages, it is much easier for local officials to improve living conditions and environment through physical construction in order to obtain political performances. Yet, it is costly to provide better physical environment and infrastructure for the scattered villages. CRS development can reduce the cost of providing public services and infrastructure and therefore has been promoted across China when the new socialist countryside construction is implemented.

In addition, CRS is promoted through another policy formulated by the Ministry of Land and Resources of China (MLR). MLR introduced the "increasing versus decreasing balance" regulation to balance the expansion of construction land in urban areas with the reduction of that in rural areas in 2008 [18]. Rural residential land is the most common type of land in the rural setting; thus, "increasing versus decreasing balance" is commonly called "rural residential land exchange." Under this policy, farmers are moved to CRS with less area of residential land, in order to save rural construction land. The saved rural construction land is further reclaimed as cultivated land. After reclamation, the construction use right of the saved size of rural construction land will be transferred to urban areas through the property rights trading center. The farmers will receive certain compensation during the transfer while the buyers can obtain construction use right of the same size of cultivated land in urban areas. Through this way, the total construction land and cultivated land remain unchanged. Relevant costs during residential land exchange are covered by the revenues generated from transferring the land use rights. The outcome of this policy is CRS development as additional rural construction land is needed for transaction. The CRS reconstruction in Chengdu can earn extra revenues from transferring the land use right of the saved construction land, because Chengdu, which is the experimental reform zone for urban–rural coordinated development, established the official market for transaction. However, other municipal cities that took CRS reconstruction cannot enjoy these benefits because they are not included in the experimental reform zone.

Post-disaster reconstruction was immediately implemented with the promotion of such policies. The local governments therefore promoted CRS development through the "window of opportunity" provided by the Wenchuan earthquake. CRS can combine the advantages of resettlement and in situ reconstruction while overcoming their disadvantages as much as possible [2]. When properly managed, the CRS approach can facilitate sustainable development after disasters. China also promotes CRS development under normal conditions. As stated in the mission, such development is expected to bring a better future to the farmers. However, in reality, CRS faces certain challenges in realizing sustainability.

2.2. Implementation of CRS Reconstruction

Although the implementation details vary among villages, a common practice was observed in implementing CRS reconstruction. The village usually disseminated the policies to the farmers before reconstruction. A village committee was established to organize discussions and deliberations with the farmers. CRS reconstruction was initiated when a sufficient number of farmers reached a consensus [19]. CRS delivery has two modes, namely, unified planning self-reconstruction and unified planning unified reconstruction. Unified planning was conducted by a professional consultancy firm to find suitable sites for CRS development, which also concerned scientific layout, proper housing design, and construction. In self-reconstruction, the farmers rebuilt houses by themselves on a smaller residential

land by following the unified planning in the selected sites. In this context, the farmers usually preferred a single house [2]. Compared with self-reconstruction, unified reconstruction involved a collaborative party to construct the houses. In this context, the collaborative party usually developed a multi-story house to minimize reconstruction cost [20]. The village committee usually supervised the reconstruction process to ensure the quality of housing. In both modes, the former rural residential land was consolidated into cultivated land by professional companies, the cost of which was covered by the revenues generated during land use right transfer. Public services and infrastructure were also provided after the farmers moved into CRS.

Existing studies have proved that CRS reconstruction after disasters is easier than CRS development under normal conditions [12]. However, CRS reconstruction has not yet been recognized as a mainstream reconstruction approach. Governmental guidance, economic development conditions, and willingness of victims are three critical factors in implementing CRS reconstruction [3]. Due attention should also be paid to various issues to ensure sustainable development of CRS [13]. In addition, neither unified planning self-reconstruction nor unified planning unified reconstruction was perfect to deliver CRS. Each mode should first satisfy the specific requirements of social–natural basis and planning to ensure the sustainability of CRS [20]. Without proper management, haphazard CRS reconstruction may result in future risks. Therefore, the risk factors of CRS reconstruction should be carefully investigated to improve understanding and management.

2.3. Risk of Resettlement

Few studies have been conducted to investigate the risk of CRS reconstruction. However, many studies have been conducted on the risk of resettlement after disasters. Experience shows that resettlement brings negative impacts on livelihoods and social networks, which presents barriers to realizing sustainability in post-disaster reconstruction [9,10]. The key risk factors in the process of resettlement can be summarized as follows: "landlessness, unemployment, homelessness, marginalization, food insecurity, inaccessibility to common property resources, increased morbidity, and community disruption" [21]. In reducing the negative economic effects of resettlement, considerable attention must be paid to improving production efficiency, stimulating economic activities, helping the most vulnerable victims, and balancing the use of natural resources between displaced and host people [11].

The failure factors of resettlement have also been explored. Some scholars have found that the organization of resettlement is a decisive factor in its progress. Young [22] found that bad organization resulting from complex institutional arrangements, unclear responsibility, and fragmented authority can result in completion delays and dissatisfaction among resettled victims. Other scholars have suggested that hotheaded decision-making, lack of victims' participation, and inadequate guidance can result in failures of resettlement [8,23–25]. The economic development after resettlement plays a key role as limited access to finance and information together with low employment skills usually result in difficulty of farmers' income growth and thus their satisfaction towards resettlement would be low [26–28]. Furthermore, some studies have also investigated site selection, layout, and housing design [7]. Site selection is an important consideration due to the increase of seismic hazard in soft-soil sites especially after great earthquakes, such as the Wenchuan earthquake [29]. Linkage to the old village and capability of the community to develop itself are also important considerations [2]. These issues are important for resettlement especially when they are complicated with increasing number of elderly people, low education level, and inconvenient transportation [30–32].

Existing studies on the risk of resettlement provide good references for investigating the risk of CRS reconstruction. However, CRS reconstruction is different from resettlement in terms of social networks and resource allocation. Thus, the risk factors of resettlement cannot be simply and directly applied in analyzing risk factors of CRS, although they face certain common problems. Some environmental issues e.g., water loss and soil erosion, clean energy, and clean water may challenge rural development no matter discussing CRS or resettlement [33–35]. Understanding of

the risk factors of CRS reconstruction as a new reconstruction approach remains limited. Therefore, investigating the risk factors of CRS reconstruction is imperative.

3. Research Method

3.1. Preliminary Risk Factors of CRS Reconstruction

The preliminary risk factors of CRS reconstruction were identified through a literature review of existing studies of resettlement and CRS. Previous studies on the risk of resettlement summarized risks from the perspectives of "landlessness, unemployment, homelessness, marginalization, food insecurity, inaccessibility to common property resources, increased morbidity, and community disruption" [21]. Yet, it cannot be directly and simply applied in analyzing risk factors of CRS due to the difference between remote resettlement and CRS. This study investigated the risk of CRS reconstruction on the basis of the factors affecting sustainable development, which is one of the most important reconstruction objectives emphasized by the government and the academe. Usually, sustainable development is investigated from the economic, social, and environmental perspectives. In addition, disaster relief is one of the key processes in the cycle of disaster management and is especially important after big disasters. Therefore, this study investigated the risk factors of CRS reconstruction from the economic, social, environmental, and disaster relief aspects. The preliminary risk factors identified through literature review were classified into the four aspects by considering its effect on the four aspects of the framework. It should be noticed that some factors can be placed in more than one group as the four aspects actually affect each other. For example, poverty resulting from illness can be placed in either the social aspect or the economic aspect. At such a condition, the main effect of the factor and its classification in existing studies were referenced for classification. A pilot study was conducted in May 2017 to validate the results obtained from literature review. It should be noticed that only few factors come from existing studies on risk of resettlement, most of which were deleted during the pilot study. The key reason is that CRS development within a village is different from remote resettlement. The farmers can still own their former resources and maintain the former social networks in CRS development [3]. Therefore, many factors, e.g., "landlessness, unemployment, homelessness, marginalization, food insecurity, inaccessibility to common property resources, increased morbidity, and community disruption" were suggested to be excluded. Yet, some common risk factors still exist, like difficulty of land adjustment and unclear responsibility of government. In addition, insufficient public budget, disordered community management, land degradation, insufficient capacity of waste disposal, insufficient emergency shelters, and insufficient disaster relief education were found to affect CRS development in terms of the four aspects in the pilot study. Therefore, these factors were included in the preliminary risk factors as demonstrated in Table 1.

3.2. Data Collection

A case study was used to examine the risk factors of CRS reconstruction after the Wenchuan earthquake [36]. Searching online news reports of post-disaster reconstruction was used to select candidate cases in Chengdu, which is one of the experimental reform zones for CURD. Nine villages were reported to take successful rural settlement reconstruction with eight villages developing CRS and one village taking reconstruction in situ in Dujiangyan, Chengdu City [37]. Field study in the nine villages was conducted in June 2017. The village taking reconstruction in situ was also investigated for comparison in the discussion section. The information of the nine villages can be found in Table 2. Considering the ethical issues, the specific name of the investigated villages was replaced with the alphabet. The settlement layout of CRS delivered by unified planning/unified reconstruction, and unified planning/self-reconstruction in the case villages can be found in Figure 1.

Semi-structured interviews were conducted with local government officials and farmers to obtain the relevant information about CRS reconstruction as it is a proper method in research relating to disaster victims [38]. The village head was interviewed in the village office via appointment.

The farmers were randomly selected for interview without government officials accompanying in the case village. The interview was stopped if no new information could be added [3]. The first author conducted the interview, which lasted one hour for one interview on average. During the interview, the government officials and farmers were invited to assess the importance of the preliminary risk factors from the perspective of insignificance, significance, and strong significance. These qualitative standards were found more understandable and easier to judge for the interviewees compared to that of numbers in the field study. Besides, their suggestions and views on these risk factors were recorded for analysis during the interview. The Sichuan local dialect was used during the interview for better communication. Efforts have also been made to minimize the information losses in translation [39]. In total, nine village officials and 24 farmers were interviewed. Table 3 presents the key information of the interviews in the nine villages. The following section presents the findings of the case studies.

3.3. Results

The findings of the risk factors of the nine cases are summarized in Table 4. A follow-up interview with the former interviewees was conducted to validate the findings in July 2017. The risk factors demonstrated in Table 4 were presented to the interviewees for verification in the interview. The interviewees agreed that the identified risk factors were convincing. The research assumes the risk factor as critical risk factors, which is significant or strongly significant in more than four cases (half of the total CRS cases). By following this principle, the critical risk factors include difficulty of income growth, low level of employment skills, mismatch of living and production ways, insufficient public budget, difficulty of land adjustment, poverty resulted by illness, disordered community management, difficulty of satisfying the needs of entertainment, unclear responsibility of government, insufficient capacity of waste disposal, and insufficient disaster relief education. The following section discusses these factors based on the eight CRS development cases while comparing them with the I Village, which experienced in situ reconstruction.

Table 1. Preliminary risk factors of CRS development after the Wenchuan earthquake.

Category	Factor	Reference
Economic aspect	F1-Difficulty of income growth	[2,3,26]
	F2-Limited financial access	[19,27]
	F3-Limited information access	[3,27]
	F4-Low level of employment skills	[12,28]
	F5-Mismatch of living and production ways	[2,3,20]
	F6-Insufficient public budget	Pilot study
	F7-Difficulty of land adjustment	[2,21]
Social aspect	F8-Poverty resulted by illness	[19,20]
	F9-Income inequality	[3,12]
	F10-Increasing number of elderly people	[19,30]
	F11-Low education level	[13,31]
	F12-Inconvenient transportation	[20,32]
	F13-Disordered community management	Pilot study
	F14-Difficulty of satisfying the needs of entertainment	[2,20]
	F15-Unclear responsibility of government	[3,22]
Environmental aspect	F16-Water loss and soil erosion	[19,33]
	F17-Land degradation	Pilot study
	F18-Insufficient clean energy	[20,34]
	F19-Insufficient clean tap water	[27,35]
	F20-Insufficient ecological land	[7,19]
	F21-Insufficient capacity of waste disposal	Pilot study
Disaster relief aspect	F22-Insufficient geological safety	[2,13]
	F23-Threatens of secondary disasters	[7,12]
	F24-Insufficient emergency shelters	Pilot study
	F25-Insufficient disaster relief education	Pilot study

Table 2. Background information of the case villages.

Village	Topography	Areas of Land/Cultivated Land (Unit: Hectare)	Population/Households	Collapsed and Severely Damaged Households	Percentage of Households Moving to CRS	CRS Delivery Approach
A	Hilly areas	537/183.2	2354/817	635	90%	Unified planning, unified reconstruction
B	Plain areas	315/115.9	1767/635	433	32%	Unified planning, self reconstruction
C	Hilly areas	8700/100	817/268	257	14%	Unified planning, self reconstruction
D	Plain areas	6300/4000	3400/1030	390	60%	Unified planning, unified reconstruction
E	Plain areas	4875/2280	2740/760	372	43%	Unified planning, self reconstruction
F	Hilly areas	5250/100	580/150	94	29%	Unified planning, unified reconstruction
G	Hilly areas	60,000/1000	1403/536	460	28%	Unified planning, self reconstruction
H	Hilly areas	4920/766	730/285	252	93%	Unified planning, unified reconstruction
I	Plain areas	12,600/10,768	2040/709	68	0% (reconstruction in-situ)	N.A.

(Source: from interview).

(**a**) (**b**)

Figure 1. Layout of CRS in the case villages, (**a**) unified planning and self-reconstruction; (**b**) unified planning and unified reconstruction.

Table 3. The key information of the interviews in the nine villages.

Job Title	Gender	Working Experiences	Duration (h)	Place	Village	Date
Branch secretary	Male	22 years of village official	1.5	Village office	H	7 June 2017
Branch secretary	Male	11 years of village official	2	Village office	I	7 June 2017
Branch secretary	Male	16 years of village official	0.8	Village office	A	8 June 2017
Branch secretary	Male	10 years of village official	1.5	Village office	F	9 June 2017
Branch secretary	Male	21 years of village official	1.8	Village office	C	10 June 2017
Village head	Male	20 years of village official	1.6	Personal House	G	8 June 2017
Village head	Male	10 years of village official	2	Village office	E	9 June 2017
Village Head	Male	16 years of village official	1.5	Village office	D	11 June 2017
Woman Director	Female	10 years of village official	0.8	Personal House	B	10 June 2017
Farmer	Female	5 + years working outside	1	Village square	H	7 June 2017
Farmer	Female	3 years working outside	1.2	Village square	I	7 June 2017
Farmer	Female	0 years of working outside	0.6	Personal House	G	8 June 2017
Farmer	Female	5 + years working outside	1.2	Personal House	A	8 June 2017
Farmer	Female	5 + years working outside	0.6	Village square	A	8 June 2017
Farmer	Female	0 years of working outside	0.9	Personal House	A	8 June 2017
Farmer	Female	5 + years working outside	1	Personal House	F	9 June 2017
Farmer	Female	0 years of working outside	0.8	Personal House	F	9 June 2017
Farmer	Female	5 + years working outside	0.8	Personal House	E	9 June 2017
Farmer	Female	4 years of working outside	0.6	Personal House	E	9 June 2017
Farmer	Female	5 + years working outside	0.8	Personal House	C	10 June 2017
Farmer	Female	3 years working outside	0.6	Cropland	B	10 June 2017
Farmer	Female	5 + years working outside	0.8	Personal House	B	10 June 2017
Farmer	Female	0 years of working outside	0.7	Personal House	D	11 June 2017
Farmer	Female	5 + years working outside	0.8	Personal House	D	11 June 2017
Farmer	Male	5 + years working outside	0.75	Village square	H	7 June 2017
Farmer	Male	5 + years working outside	1	Village square	I	7 June 2017
Farmer	Male	0 years of working outside	1	Personal House	G	8 June 2017
Farmer	Male	2 years of working outside	0.5	Personal House	G	8 June 2017
Farmer	Male	5 + years working outside	1	Village square	A	8 June 2017
Farmer	Male	2 years of working outside	0.7	Cropland	E	9 June 2017
Farmer	Male	5 + years working outside	0.6	Personal House	C	10 June 2017
Farmer	Male	4 years working outside	0.7	Personal House	B	10 June 2017
Farmer	Male	5 + years working outside	0.8	Personal House	D	11 June 2017

Table 4. Comparative evaluations of risk factors for CRS reconstruction between case villages.

Category	Factor	A	B	C	D	E	F	G	H	I
Economic aspect	F1-Difficulty of income growth	M	M	M	M	M	M	L	M	L
	F2-Limited financial access	L	L	L	L		L	L	L	L
	F3-Limited information access	M			L	L	L	L	L	M
	F4-Low level of employment skills	M	M	M	M	M	M	L	M	M
	F5-Mismatch of living and production ways	M	M	L	M	M	L	L	M	
	F6-Insufficient public budget	H	M	M	M	M	M	L	M	L
	F7-Difficulty of land adjustment	M	L	M	M	M	L	L	M	
Social aspect	F8-Poverty resulted by illness	M	M	M	M	M	M	M	M	M
	F9-Income inequality	M	L	L	M	L	L	M	L	M
	F10-Increasing number of elderly people	L		L	M	M	M	L	M	M
	F11-Low education level		M	M	L	L	M	L	M	L
	F12-Inconvenient transportation	L	L	L	L	L	L	M	L	M
	F13-Disordered community management	M	M	L	M	M	L	L	M	
	F14-Difficulty of satisfying the needs of entertainment	M	M	L	M	M	L	L	M	
	F15-Unclear responsibility of government	M	M		M	M		L	M	
Environmental aspect	F16-Water loss and soil erosion	M	L	L	L	L	L	M	L	M
	F17-Land degradation	M	M	L	L	M	L	L	L	L
	F18-Insufficient clean energy	L	L	L	L	L	L	L	L	L
	F19-Insufficient clean tap water	L	L	L	L	L	L	L	L	L
	F20-Insufficient ecological land	L	L	L	L	L	L	L	L	L
	F21-Insufficient capacity of waste disposal	M	M	M	M	M	L	L	L	
Disaster relief aspect	F22-Insufficient geological safety	L		L	L	L	L	L	L	L
	F23-Threatens of secondary disasters	L	L	L	L	L	L	L	L	L
	F24-Insufficient emergency shelters	L	L	L	L	L	L	L	L	L
	F25-Insufficient disaster relief education	M	M	M	M	M	M	M	M	M

Note: L: insignificant, M: significant, H: strongly significant, and blank: not mentioned.

4. Case-Based Discussions

4.1. Economic Risk

The economic risk aspect has the most key risk factors among the four aspects. Five key economic risk factors are difficulty of income growth, low level of employment skills, mismatch between living and production ways, insufficient public budget, and difficulty of land adjustment. Without sustainable income growth, farmers in the CRS would face higher risk than those who chose in situ reconstruction because of the high living cost after concentration. The increased living cost mainly comes from gas, newly added household electrical appliances, and extra purchase of eggs, pork, and domestic fowl, which can be provided by the farmers themselves before concentration. It was echoed with the interview as the average annual living cost per capital for farmers in CRS was 9000 RMB while that for farmers in I Village taking in situ reconstruction was 6000 RMB in 2016. Therefore, the significance of difficulty of income growth was identified higher in CRS case villages than that of in situ reconstruction village. This risk is closely related with another risk factor, low level of employment skills, which is a common problem in the case villages. Although the local government provided skills education courses, including cooking and housekeeping, the farmers claimed that the quality of education course was comparatively low and most skills were too common to earn a high salary in the urban areas. Yet, the farmers usually have a comparatively low education level to take higher education and training for a better job.

Mismatch between living and production ways is another key risk factor. Although farmers can enjoy improved living conditions, infrastructure, and public services in the concentration site, they experienced mismatch between living and production methods. There is no space for the farmers to store the grains and farm tools in their house in villages A, D, and H. The three villages took unified planning and unified reconstruction to deliver CRS, which is similar to urban apartments. Although farmers in villages B and E have space to store grains and farm tools in their single house, some farmers face the challenge of living far away from their contracted land after concentration. This risk is closely related with difficulty of land adjustment. In order to concentrate sufficient farmers to provide public infrastructure while avoiding potential hazards, the sites for concentration are usually limited and cannot satisfy the needs of all farmers. Therefore, it is common that some farmers live far away from the contracted land. Land adjustment is a potential approach to solve this problem. Yet, the village committee cannot adjust the contracted farmland at the village level as the state maintains the term of farmland contraction for unchanged. Therefore, the farmers have to negotiate at the individual level if they want to adjust farmland for reducing commute cost. However, it is usually unsuccessful due to higher cost of co-ordination. Therefore, farmers in most CRS have to give up farm work because of such mismatch. In addition, they have to work as migrant workers to earn additional money to cover the increasing living cost caused by the mismatch. However, the employment opportunities of these farmers are low given their low education level, lack of professional skills, and limited information access.

In addition, seven case villages except for G Village lack sufficient budget to implement public management of CRS. After concentration, there is extra cost for public maintenance and services. Yet, the farmers are reluctant to pay property management fees due to low income and unconsciousness of necessity of public management. Therefore, public budgeting is needed to cover these extra costs. However, the seven villages have no collective assets and have to rely on financial allocation from upper level government. The financial allocation is limited and is not specialized for CRS management. This is evident with the fact that I Village with in situ reconstruction regarded the risk of insufficient public budget as insignificant, while the seven CRS villages considered it as significant. Without sustainable income growth, a concentration site will not improve, and instead, will face high risk of poverty and instability.

The sole exception for the economic risk is the G Village, which is located in the tourism destination of Qingchengshan. The farmers have comparatively stable income from tourism and therefore have

less worries of income growth and employment. In addition, the village committee has certain collective assets to cover extra cost while the farmers are conscious of paying for the public cost to maintain a good environment for attracting tourism, which reflects the usefulness of combining risk with rewards [40]. This case provides implications for reducing such economic risk in existing CRS. Local governments must develop suitable industries to attract employees and increase income based on local conditions. Organic farming, farming tourism, and characteristic planting and breeding can be encouraged. Rational guidance must be introduced into industry development to avoid the negative market effects of rapid development. In addition, future CRS reconstruction must be planned rationally by reflecting on the aforementioned risks because CRS reconstruction is only suitable for certain villages with good economic locations [20].

4.2. Social Risk

There are four key social risk factors, namely poverty resulting from illnesses, difficulty of satisfying the needs of entertainment, disordered community management, and unclear responsibility of government. These social risks are closely related to economic risk. The central government is promoting social security insurance and medical insurance in rural areas. Yet, the farmers are reluctant to buy these insurances as the premium is increasing rapidly year by year. Moreover, some farmers do not purchase these products, not because they have insufficient funds, but because they are unaware of the clear functions of these insurance products. Therefore, poverty resulting from illness may occur if no insurance is purchased while the savings are limited. In addition, without sufficient public expenditure, the community management is not so good and it is also difficult to satisfy the needs of entertainment. It was easy to find broken external walls, unclear environment, unused sports facilities, and people gathering to play mah-jong, as shown in Figure 2. During the interview, it was found that all CRS were beautiful in the first several years after construction, but deteriorated after several years without sufficient maintenance. Compared with the seven CRS villages, I Village did not identify the significance of disordered community management and difficulty of satisfying the needs of entertainment as there is no such an urgent need for scattered farmers.

(**a**) (**b**)

Figure 2. Disordered community management. (**a**) broken external walls; (**b**) unused sports facilities.

Unclear responsibility of government is another key social risk factor. During the interview, it was found that the farmers usually take the village committee as the representative of literal "government" and continuously seek out village officials no matter what kind of problems they have. Without collective assets and sufficient financial sources, the village committee actually has few or even no resources to solve problems in CRS and has to merely report the problems to the upper level government. The gap between the farmers' expectations and the efficiency of solving the problems usually results in tensions between the village officials and farmers [41–43]. On the other hand, the village officials also have difficulty working with upper level government. All kinds of work

would be passed to the village officials through various departments (it is also called "Shang Mian Qian Tiao Xian, Xia Mian Yi Gen Zhen" in Chinese). However, the village committee usually has much fewer officials to deal with the passed work. Therefore, the daily work usually occupies much time of the village officials and leaves much less time for them to really solve the problems of farmers and seek development opportunities.

It is evident that villages with good economic development may have less social risks in the case of G Village. Therefore, promoting economic development is necessary and useful to mitigate these social risks. With regard to the difficulty in satisfying entertainment needs, additional suitable public spaces and facilities, besides fitness facilities, must be provided according to local needs. Different villages may have various cultural or ritual requirements that must be satisfied. Public discussions can be conducted to reach a consensus on providing such additional facilities. Only relying on increasing public expenditure and enhanced social harmony can solve the problems of disordered community management. For unclear responsibility of government, proper policy dissemination is necessary to reduce farmers' misunderstandings and unreasonably high expectations. Meanwhile, the work relationship between village committees and upper level government should be changed to leave more time for the village officials to solve real problems.

4.3. Environmental Risk

The key environmental risk is insufficient capacity for waste disposal, which is closely related to economic risk. After concentration, much more domestic waste would be accumulated, which needs collective disposal rather than individual disposal. Therefore, I Village does not consider it as a significant risk factor compared with other CRS villages. The capacity of waste disposal is determined by both the labors and physical facilities [44,45]. Usually, the physical facilities are sufficient. However, there is insufficient labor to collect domestic waste in houses or public places in the case villages. In addition, domestic waste sometimes was not transferred in a timely manner from the concentration site to the disposal factory, which results in environmental pollution or dispersion of viruses and bacteria, as shown in Figure 3. Measures should be taken to promote self-collection and drop-off in the fixed domestic garbage. In addition, the transfer of domestic waste from villages to the disposal factory should also be optimized to reduce long term accumulation of domestic waste in the fixed domestic garbage.

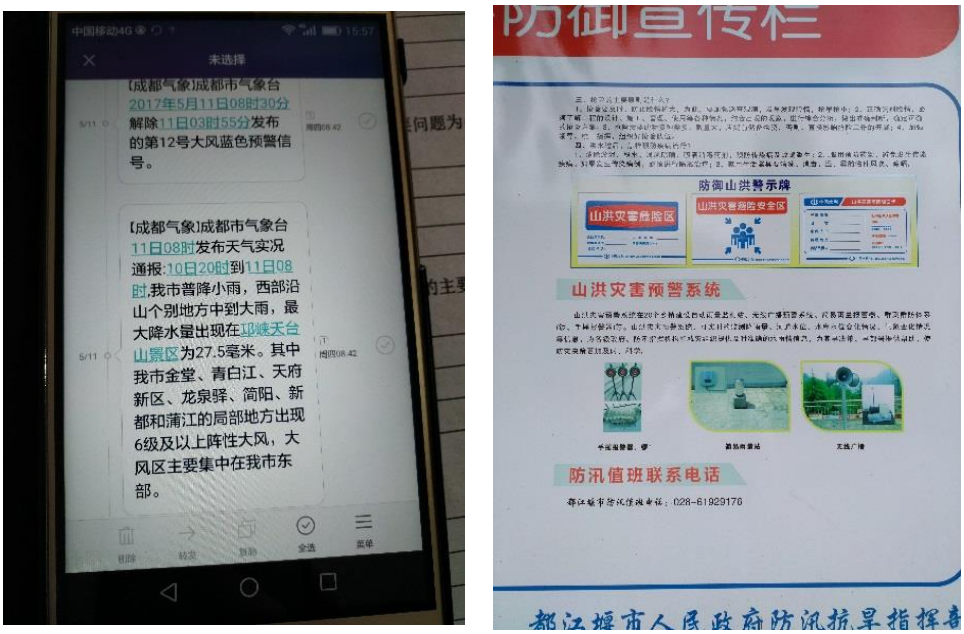
Figure 3. Inappropriate domestic waste disposal.

Attention should also be paid to land degradation, especially in plain areas, although it is not identified as a key environmental risk factor. The farmers have to increase the productivity through using chemical fertilizers and pesticides, which usually results in land degradation. This was evident with the interview in villages of A, B, and E. Organic farming and farming tourism must be developed to increase income while simultaneously compelling farmers to be concerned with environmental quality. Appropriate education must be provided to make farmers realize the negative effects of misusing chemical fertilizers and pesticides. Government departments and NGOs can provide suitable guidance to farmers to engage in organic farming and farming tourism in the long term. Such change cannot be achieved overnight; hence, persistent efforts must be exerted on this issue. To address insufficient waste disposal capacity, a post-evaluation of the amount of waste disposed must be conducted. Additional facilities must be built to satisfy current and future waste disposal demands.

4.4. Disaster Relief Risk

The key disaster relief risk is insufficient disaster relief education. Disaster relief is a critical issue, especially when there were many secondary disasters and aftershocks after the Wenchuan earthquake. Due to unified planning and quality supervision during reconstruction, CRS has much better performance through mitigating seismic hazards of the reconstruction site and reducing the seismic vulnerability of the reconstructed houses compared with those of in situ reconstruction. In addition, farmers in CRS were more easily gathered for disaster relief education and rehearsal. This evident from the interviews, reporting that the farmers in CRS performed better than those from in situ reconstruction sites in response to the Lushan earthquake, which struck Sichuan Province in 2013. However, education is insufficient and non-persistent. This problem is interconnected with the low education level and difficulty of income growth at the individual level, and insufficient public budgeting at the village level. During the interview, it was found that education for preventing fires, floods, and safety utilization of household appliances and gas is usually conducted in all case villages. Some materials were delivered or posted for education or prevention, as shown in Figure 4. However, the way to deliver such education is usually boring and farmers are usually reluctant to participate in such education programs unless the village committee provides a certain incentive for them. There are also some rehearsals for farmers nearby the geological hazard areas. The farmers who live away from this area usually do not participate in such rehearsals. Therefore, it was found during the interview that the farmers usually are uneducated on how to face potential hazards.

Suitable public education on disaster relief must be provided to farmers. Education and information dissemination must consider potential hazards and the comprehension capacity of farmers with low education levels. Before the local government provides sufficient public expenditure and education, NGOs can be invited to contribute to this critical issue.



(**a**) (**b**)

Figure 4. Materials and information of disaster relief in the case villages. (**a**) Information dissemination of hazard forecast through SMS; (**b**) poster of disaster relief education.

4.5. Summary

The eight cases present various risks in the economic, social, environmental, and disaster relief aspects of CRS. Based on the case studies, this research develops a conceptual model that characterizes the key risk factors of CRS reconstruction, as shown in Figure 5. These risk factors are inter-played and affected by the pressures exerted by place, population, and policy. The place of CRS development would bring relevant economic and environmental risks. A mismatch between living and production methods occurs more readily when CRS has to be built far from the contracted land to improve living conditions and safety, as demonstrated in Villages A, B, D, E, and H. This condition thereby makes it difficult for farmers to continue their former farm work. Therefore, the farmers have to rely on the secondary and tertiary industries to cover increasing living cost. Unlike Village G with good economic location, farmers in other villages have to migrate to urban areas comparatively far for more employment opportunities and thus bear the risk of income growth. In addition, the unreasonable location of waste disposal sites poses the risks of insufficient waste disposal capacity in Villages A, B, C, D, and E. The pressure exerted by the population also poses certain social risks and environmental risks. With the increasing number of elderly people, the burdens of social security and medical service are considerable in CRS. Constrained by the limited income growth, the risk of poverty resulting from illness was therefore identified as significant in the eight CRS case villages. In addition, chemical fertilizers and pesticides were misused to improve the productivity of farmlands because most skilled laborers have moved to urban areas in search of higher income. Thus, the pressure of insufficient population also poses environmental risks, such as land degradation as demonstrated in Villages A, B, and E. Whether there is a good policy also affects disaster relief education risk and social risks. The construction safety policy ensured by unified planning and quality supervision made CRS much more resilient to secondary disasters and aftershocks following the Wenchuan earthquake. However, all the case villages face risk of disaster relief because only a few policies that promote disaster relief education were implemented. Although SMS and public posters were available, only a few deliver effective knowledge on disaster relief to farmers. In addition, without policy and budget support, public management of CRS cannot be implemented effectively, which may result in disordered

community management, as demonstrated in Villages A, B, D, E, and H. Yet, as a conceptual model, the complicated relationship between the key risk factors and external pressures needs further analysis.

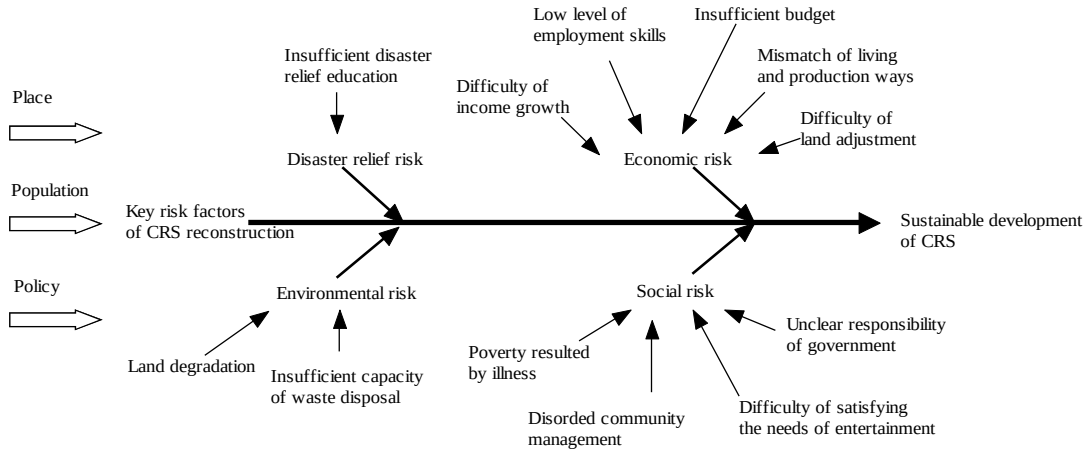


Figure 5. The conceptual risk model of CRS reconstruction.

5. Conclusions

Rural housing reconstruction is critical for realizing a better future after disasters. CRS reconstruction has been promoted after the Wenchuan earthquake. This study investigates the risk posed by CRS reconstruction after six years of reconstruction completion. The risks are examined from the economic, social, environmental, and disaster relief perspectives based on eight CRS case villages and one case village with in situ reconstruction. The risk factors are inter-played and affected by the pressures exerted by place, population, and policy. A conceptual model is developed based on the case studies to better understand the risks posed by CRS reconstruction.

A total of eleven key risk factors are summarized from the case studies, while appropriate measures are also proposed to reduce these risks. The findings of this study can help local governments examine existing CRS development and take necessary measures to ensure the sustainability of CRS. The results also provide reference for future CRS reconstruction because the identified risks must be carefully considered and mitigated before CRS reconstruction is initiated. However, this study has certain limitations caused by applying a qualitative examination approach. Future studies can quantify the importance of the identified risk factors to establish suitable mitigation policies. In addition, it is necessary to investigate the complicated relationship between the eleven risk factors and external pressures with quantitative methods in order to deepen the understanding.

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