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ORIGINAL PAPER

The impact of severe natural disasters on the livelihoods of farmers in mountainous areas: a case study of Qingping Township, Mianzhu City

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Abstract The '5.12' earthquake in 2008 and the '8.13' debris flow in 2010 brought huge losses of life and property to Qingping Township. Farmers' livelihoods assets were also seriously affected and damaged. These led to a change in farmers' livelihood styles and reduction in their income. A study of the impact of natural disasters on farmers' livelihoods in mountainous areas would have significant importance for policy making. Based on field survey data from sample households, this study comparatively analyzed the assets, livelihood styles and income of farmers over three periods—2007, 2009 after the '5.12' earthquake, and 2 months after '8.13' debris flows. It presents the following findings: (1) livelihood assets suffered heavy losses; (2) livelihood styles were significantly changed; and (3) the sustainability of farmer income was adversely influenced. These results suggest that, during the process of post-disaster reconstruction work, affected farmers' security, the carrying capacity of livelihood assets, and the enhancement of employment and livelihood choice are worthy of much attention from policy makers.

Keywords Disaster · Farmers' livelihoods · Poverty · Sustainable development

1 Introduction

Livelihood is a way to make a living. It is based on the capabilities, assets (including reserve materials, resources, claims, and entitlement), and activities (Chambers and

The data used in this paper originated from the field investigation and interviews of local farmers.

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Conway 1992). The high quality and efficiency of livelihood capital are the basis for farmers to reduce their livelihood vulnerability and enhance their risk resilience ability. The definition in the study emphasizing the diversification of rural livelihoods is that livelihood includes assets (natural, material, human, financial, and social capital), actions, and the means obtaining these assets (subject to the regulation of institutions and social relations), which determines the ability to obtain the living resources required by individuals or households (Ellis 2000). The definition stressing the sustainability of livelihoods is that livelihood consists of the ability to live, assets (including material and social resources), and action (Scoones 1998). Livelihood includes capacities and assets, as well as activities for lifestyle (Carney 1998). These definitions have generally been accepted.

The function of the sustainable livelihoods approach (or sustainable livelihoods framework) is to identify possible contributions from development agencies. In this way, we can hope to enhance and strengthen the livelihoods of the poor populations (Carney 1998). Within modern international development research and practice—especially in the area of poverty reduction—the sustainable livelihoods approach is more widely used. Bilateral and multilateral international aid organizations, such as the World Bank, UK Department for International Development (DFID), and development research institutions, gradually developed the sustainable livelihoods way of studying poverty and development issues within developing countries (Paul 1998). In a variety of sustainable livelihoods frameworks, the sustainable livelihoods framework (SLA) established by the UK Department for International Development (DFID) is more typical (DFID 1999). It has been adopted by many organizations and scholars. By standardizing their work, they are able to make a separate set and shareable development planning approach (Chambers and Conway 1992). This not only reveals a framework for understanding poverty, but it also points out potential opportunities for poverty eradication. Furthermore, it reveals an approach that promotes pursuing a livelihood by using properties, rights, and possible strategies (Ashley and Carney 1999; Goldman 2000; Roberts and Yang 2003). This model can guide the analysis of the livelihood strategies and single-family restrictions, reflecting the interaction and interaction changes between the livelihood capital structure, livelihood process, and livelihood goals of farmers. It can also provide a new perspective for an in-depth observation of farmers.

The theoretical background of SLA is reflected in the definition of poverty and poverty eradication goals. This open guidance can take into account all possible aspects of poverty and all unsustainable way of life associated with this through the participation of the poor in poverty assessment to achieve the purpose of poverty eradication. The core principles supporting this view include human-centered, response and participation, multi-level, and sustainable principles (Ashley and Carney 1999; Goldman 2000; Roberts and Yang 2003). Sustainable livelihoods framework (SLA) is as shown in Fig. 1.

As can be seen from Fig. 1, the sustainable livelihoods framework is composed of a vulnerability context, livelihood capital, the transformation of the structures and systems, sustainable livelihood strategies, and livelihood output. These compositions all interact in complex ways. The arrows indicate that the most important cases are only a component of the others. However, these arrows do not mean to subordinate the relationships or to create causal ones. The manifestations of these relationships are as follows: impact, trends, and seasonality (in the context of vulnerability) can both create capital and destroy it. It is the process of generating capital that causes government agencies to invest in infrastructure construction (materialization capital), technological innovation (human capital), and the construction of the institution (social capital). Both policy and institutions can adjust (to

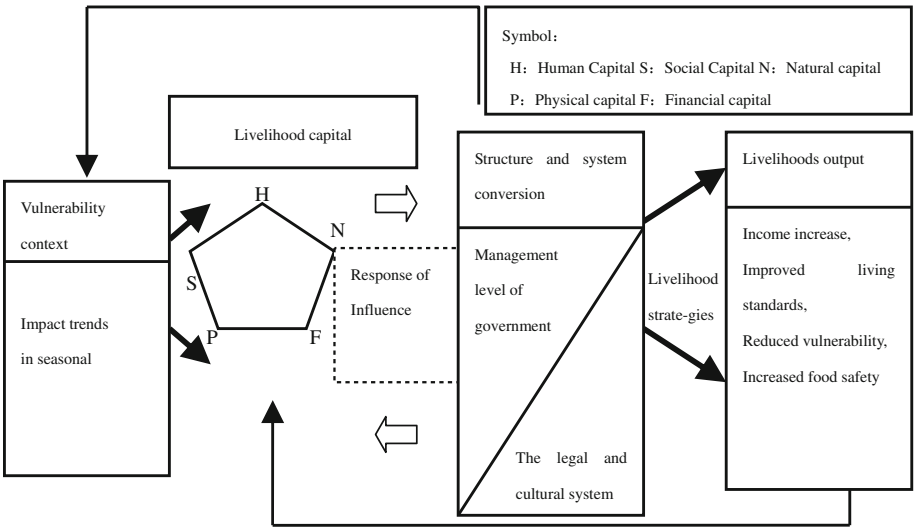

Fig. 1 Sustainable livelihoods framework

some extent) the ownership of the resources, degree of response, and feedback on different livelihood strategies (Kollmair and Gamper 2002).

Livelihood capitals are divided into natural capital, physical capital, financial capital, social capital, and human capital. Each of these can be transformed into each other under different conditions. Natural capital is the natural resources which are used to maintain people's livelihoods. This can include both renewable and non-renewable resources. Physical capital is created by the human production process. It includes houses, irrigation systems, production tools, and machines, etc. Financial capital usually means the cash which is used for the purchase of consumer goods and production. It can also include available credit and personal loans. Human capital refers to an individuals' living knowledge, skills, ability to work, and health (Li et al. 2004). Social capital involves social resources used in the pursuit of livelihood objectives. It can include things such as social networks and social organizations (religious organizations, friends and family, etc.). These cover the vertical (relationship with superiors or leaders) and level (relationships between people with common interests) social ties.

The sustainable livelihoods framework takes farmers as the objects seeking to survive and make a living within the background of vulnerability. This is their potential to withstand disasters and losses. It involves the ability to withstand, cope with, and resist the disaster, as well as the ability to recover from the disaster's effects. It also involves flexibility which—as well as its opposite—is subject to physical, environmental, social, economic, political, and cultural factors. All of this takes place within an environment in which they can utilize a certain amount of capital. At the same time, this environment also affects the livelihood strategies of rural households, capital allocation, and the way of use, in order to achieve desired results and meet livelihood objectives. In other words, in a fragile environment contributed to by systems, policies, other factors, and under the influence of capital, systems and policies, with the nature and condition of capital as the core of livelihoods, determines the type of livelihood strategies. This results in some type

of livelihood results. It also gives a retroaction on the assets and affects its nature and status.

In China, studies have just begun to analyze livelihood characteristics and approaches to achieving sustainable livelihoods where the sustainable livelihood framework is used as a blueprint. Li et al.(2004). These analyses also combine the concepts, analytical frameworks, and the sustainable livelihood, and made an empirical analysis of the livelihood vulnerability of poorer farmers. Li et al. (2005) suggested that the vulnerability of poor farmers' livelihood capital has led to limited means of risk avoidance when faced with external shocks. This was helpful when seeking to understand the typical characteristics of the livelihood capital of farmers—especially poor farmers.

The '5.12' earthquake and '8.13' debris flows caused heavy losses to both the economy and society in the damaged region. They also had a significant effect on the capital and style of farmers' livelihoods. 27.5 % of all surveyed farmers completely lost their land during the '8.13' debris flows. Until now, research done by Chinese scholars on the sustainable livelihoods of land-lost peasants has mainly concentrated on seven areas: (1) "sustainable livelihoods" as defined by (Social Policy Research Center of Chinese Academy of Social Sciences 2004a, b; Huang 2005; Li 2006; Zhang 2006; Yang 2006; Wang 2006; Wang and Ma 2006; Sun and Zhou 2007; Liu 2007; Zhou et al. 2007; Wang 2008; Liu and Wang 2008; Cheng 2008; Liu and Zhong 2008; Liu 2008; Zhao et al. 2009; Yuan 2008); (2) Its characteristics are summarized by (Wang 2006; Liu et al. 2007); (3) The analytical framework is established by (Cheng 2008); (4) The evaluation system and quantitative criteria as proposed by (Hu et al. 2008); (5) The main problems analyzed by (Zhang 2006; Wang and Ma 2006; Liu 2008); (6) The impact factors of the sustainable livelihoods of land-lost peasants are analyzed by (Wang 2008; Zhao et al. 2009); (7) A variety of solutions to the problems associated with sustainable livelihoods for land-lost peasants were provided. Presently, Chinese academia is focusing on how to achieve the full employment of the land-lost peasants. It has generally arrived at the following conclusions: (1) To put a focus on the personnel difficulties associated with finding employment (Zhang 2006); (2) To encourage and support the employment of multi-channels in order to ensure sustainable careers (Wang and Ma 2006; Liu and Wang 2008); (3) To provide employment protection (Zhou et al. 2007; Liu 2008);(4) to establish a mechanism or system for re-employment (Zhou et al. 2007; Zhao et al. 2009; Zhu and Cui 2005; Liu et al. 2009); (5) To provide employment assistance (Yang 2006); (6) To develop and encourage work in the tertiary sector (Zhou et al. 2007; Feng 2007); (7) To set up a "Farmers Club" (Tang 2007).

In all livelihood studies, theoretical studies are more common, and empirical analyses which integrates farmer' livelihoods and natural disasters are rare. Recently, there have been numerous geological disasters in southwest China. These have had an enormous effect on farmers' livelihoods. The '5.12' earthquake and '8.13' debris flows brought heavy economic and social losses to Qingping Township. They also had a significant effect on farmer livelihood capital and livelihood styles. By taking farmers in Qingping Township as a development unit surviving within a fragile background, this paper will attempt to make a statistical analysis of the livelihoods in Qingping Township. In this way, we hope to be able to provide a basis for policy making decisions on livelihood reconstruction in stricken areas. We also hope to be able to enrich and develop farmer sustainable livelihood studies from the perspective of empirical analysis.

2 Study area and method of sample data acquisition

Qingping Township lies in the northwest mountainous area of Mianzhu City. It is about 35 km from Qingping Township to Mianzhu and about 130 km to Chengdu. Its location and distance from the Wenchuan earthquake epicenter can be seen in Fig. 2. Qingping Township territory is made up of mountainous topography, the maximum relative altitude of which reaches 3,621 m. Land areas with slope >25° make up 85.7 % of the total land areas. Due to the location of the fault zone, Qingping Township suffered from heavy economic and social losses during the '5.12' Wenchuan earthquake in 2008. The earthquake led to 279 deaths and economic losses totaling 7.082 billion within the Township. Through 2 years of reconstruction between 2008 and 2009, coal mining and small hydropower received basic rehabilitation. However, Qingping Township was then subjected to another invasion of nature in the form of a rainstorm on the evening of August 12, 2010. Large masses of debris flows occurred in every ditch, resulting in seven dead, seven missing, and direct economic losses totaling an additional 0.728 billion.

The typical household survey data in this paper was obtained by carrying out a random questionnaire and interview in five villages located within Qingping Township on October 21st and 22nd, 2010. Surveyed periods included the 2007 year, 2009 year after the '5.12' earthquake, as well as 2 months after the '8.13' debris flows. According to the economic development level, the population quantity and the damage range of surveyed villages in the study area, we took the stratified sampling method to, respectively, select the upper, middle, and lower income households as the sample households, respectively, in Yanjin, Yuantong, Qianpan, Yuanbao, and Jiangou villages. Ultimately, 80 households were investigated by the way of questionnaire and home interview. Finally, 80 valid questionnaires were completed. The description of the household survey can be seen in Table 1.

The mean, standard error (SE), standard deviation (SD), and unit of the main surveyed indicators are listed in Table 2. Due to the limited number of samples, this paper will adopt the descriptive method to make a comparative analysis on the impact of severe natural

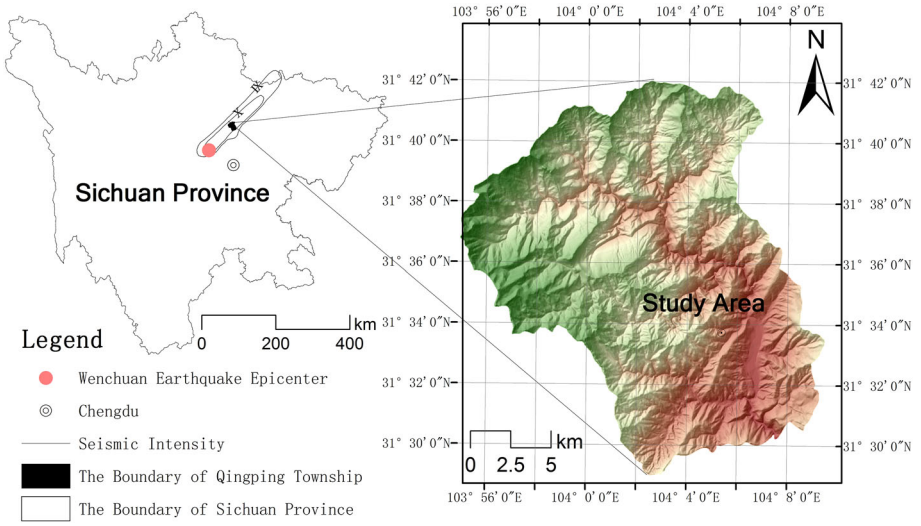

Fig. 2 The location of Qingping Township and the distance to the epicenter of Wenchuan earthquake

Table 1 Description of the household survey

Survey periods	2007 year, 2009 year after '5.12' earthquake, and the 2 months after '8.13' debris flows					
Village name	Yanjin	Yuantong	Qipan	Yuanbao	Jiangou	Total
Sample size	20	12	16	18	14	80
Survey content	The family size, age structure, education level, income composition, as well as household type, basic type of land use and livelihood style					

disasters on farmers' livelihoods. In the sample households, the average family size was 4.38 people, and the average working-age population quantity was 3.4 per household. The average education years of the working-age population was 6.82 years.

3 Results

3.1 Heavy losses in farmers' livelihood assets

3.1.1 Tremendous losses of land resources

The two natural disasters caused serious damage to land resources in Qingping Township. Land resources owned by farmers were limited after these disasters. As shown in Table 3, the land area was significantly reduced by the '5.12' earthquake. 0.1920 ha. of land was lost in per surveyed households. Of this, the arable land area, ecological forest area, and economic and fruit forest area were, respectively, reduced by 0.0327, 0.1160, and 0.0433 ha. The remaining arable land area per household after the disaster was 0.0340 ha. The '8.13' debris flows resulted in a land area reduction in 0.0493 ha. per sample household. Of this, the arable land area, ecological forest area, and economic and fruit forest area were, respectively, reduced by 0.0100, 0.0253, and 0.014 ha. The remaining arable land area per household after the disaster was 0.0240 ha. The enormous damage to land resources caused by the two severe natural disasters will inevitably have considerable adverse effects on sustainable livelihoods in Qingping Township.

3.1.2 A large number of phosphate wells were buried

Qingping Township is rich in phosphate resources. It contains approximately 15 million tons of total phosphate reserves. In 2007, as the most critical natural capital for sustaining farmer' livelihoods in Qingping Township, phosphate mining and its relevant industries (such as transportation) employed 1,500 local staff and had an annual output of 1.20 million tons. The '5.12' earthquake led to the discontinuation of the Township's phosphate production. The '8.13' debris flows buried all the phosphate wells, even the 23 phosphate wells which had already been recovered after the '5.12' earthquake. It has been predicted that the production scale for phosphate will not recover to 90 % of pre-'5.12' earthquake levels until the end of 2012. For the sample households, there were 44 workers engaged in phosphate mining and transportation in 2007, accounting for 13.92 % of working-age population. The annual working time engaged in phosphate mining and transportation per worker was 7.76 months, and the labor income and transportation service income could reach 16,581 yuan. After the '5.12' earthquake (2009), there were workers engaged in phosphate mining, accounting for 13.01 % of the working-age population. Annual mining

Table 2 Descriptive statistics of investigated indicators

Indicators		In 2007				In 2009			After '8.13'		
		Units	Mean	SE	SD	Mean	SE	SD	Mean	SE	SD
Land	A1	ha.	0.8	0.1	0.8	0.6	0.1	0.8	0.5	0.1	0.8
	A2	ha.	0.4	0.0	0.2	0.3	0.0	0.2	0.2	0.0	0.3
Deposits and loans	B1	yuan	26,540.5	9,049.7	55,047.2	5,561.1	2,225.2	13,351.0	2,681.1	1,413.4	8,597.6
	B2	yuan	8,888.9	3,789.5	22,736.7	29,600.0	5,626.3	33,285.9	25,000.0	5,278.0	31,667.9
Housing	C1	m^2	239.2	29.6	187.5	207.2	24.0	146.0	127.6	22.9	141.2
Crop	D1	ha.	1.4	0.3	1.8	0.4	0.1	0.6	0.0	0.0	0.0
	D2	kg	591.4	207.0	1,259.0	128.9	37.0	221.8	0.0	0.0	0.0
Income	E1	yuan	41,283.7	7,848.5	49,638.4	105,507.1	44,437.9	277,514.4	7,607.5	3,325.9	21,035.1
	E2	yuan	1,244.7	545.3	3,361.7	390.3	140.3	853.3	6.8	4.8	29.3
	E3	yuan	2,623.7	771.1	4,753.1	302.8	94.0	563.9	2.7	2.7	16.4
	E4	yuan	9,017.6	4,671.1	27,237.2	948.5	383.6	2,203.4	142.9	86.1	509.5
	E5	yuan	2,222.2	1,741.7	10,450.2	0.0	0.0	0.0	0.0	0.0	0.0
	E6	yuan	76.8	43.7	266.0	57,228.3	4,874.4	30,440.7	2,480.2	220.2	1,392.5
	E7	yuan	18,017.3	2,354.4	14,890.5	14,892.4	3,083.4	19,255.9	2,553.3	426.8	2,699.4

A1, total area; A2, arable land area; B1, total deposits at the end of year; B2, total debts at the end of year; C1, building area per household (m^2); D1, acreage per household (ha.); D2, yield; E1, total income for family; E2, planting income; E3, aquaculture income; E4, tertiary industry income; E5, secondary industry income; E6, government subsidy; E7, labor income

Table 3 Reduced land areas from the two disasters and the remaining land area after the disasters per sample household (ha.)

Land types	Sample nos.	Reduced land areas				Remaining land areas			
		'5.12'		'8.13'		After '5.12'		After '8.13'	
		Mean	SE	Mean	SE	Mean	SE	Mean	SE
Arable land	80	0.0327	0.0160	0.0100	0.0096	0.034	0.0104	0.024	0.0155
Ecological forest	80	0.116	0.0300	0.0253	0.0254	0.3193	0.1107	0.284	0.1112
Economic and fruit forest	80	0.0433	0.0167	0.0140	0.0116	0.0053	0.0062	0.0053	0.0051
Total	80	0.192	0.0407	0.0493	0.0330	0.3587	0.1235	0.3133	0.1278

time per worker was reduced to 4.58 months, and the labor income was decreased to 9,694 yuan. At the same time, workers engaged in phosphate transportation services were out of work. After the '8.13' debris flows, all of the workers engaged in phosphate mining and transportation were unemployed because phosphate production was completely shut down. Therefore, the future reproduction and recoverable reserves of phosphate have a pivotal position and role to play in the sustainable livelihood of farmers in Qingping Township.

3.1.3 A significant drop in household financial capital

In 2007, the ratio of farmers with deposits and loans was 45.00 and 17.50 %, respectively, for the sample households (the low deposit ratio and high loan ratio was created by the fact that Qingping Township had begun to implement a large scale new rural construction and rural agricultural housing transformation in 2005). As shown in Table 4, the deposits per household, loans per household, and the financial capital per household in the sample, respectively, amounted to 20,975, 7,125, and 13,850 yuan. After the '5.12' earthquake (2009), large scale reconstructions were carried out in Qingping Township. The ratio of farmers with deposits declined to 20.00 % and the ratio of farmers with loans increased to 52.50 % in sample households. The deposits per household, loans per household, and the financial capital per household now, respectively, amounted to 2,505, 21,900, and −19,395 yuan. After the '8.13' debris flows, although large scale reconstructions had not yet started before the investigation, it could be seen that the ratio of farmers with loans had further declined to 15.00 %. According to our investigation, this was done in order to cope with daily life consumption and repayments on previous accumulative loans. The ratio of farmers with loans also declined to 47.50 %, and there was −16,770 yuan of financial capital per household. The survey data and analysis above demonstrate that the '5.12' earthquake and the '8.13' debris flows led to a significant decline in the financial capital of farmers living in Qingping Township. This will undoubtedly have a serious and negative impact on their livelihoods over the next period.

3.1.4 Houses suffered serious damage

As shown in Fig. 3 and Table 5, the housing building area per sample household was 194.85 m^2 at the end of 2007. The principal types of housing were brick and concrete structure buildings. During the '5.12' earthquake, a large number of rural houses in

Table 4 Deposits and loans per sample household (yuan)

	Sample nos.	Total deposits at the end of the year		Total debts at the end of the year	
		Mean	SE	Mean	SE
In 2007	80	20,975	8,421	7,125	3,515
In 2009	80	2,505	1,063	21,900	5,361
After '8.13'	80	1,230	716	18,000	5,039

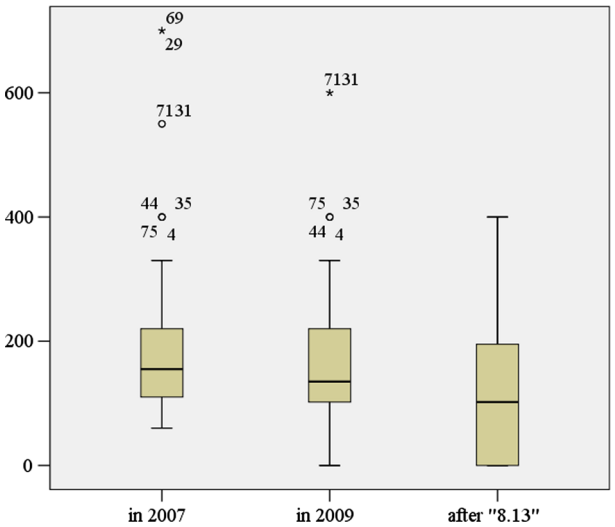

Fig. 3 Building area per household (m^2)

Qingping Township were destroyed. Through reconstruction after disaster, the housing building area per household was 171.48 m^2 at the end of 2009. At this point, the main type of housing was a concrete structure. However, 7.5 % of dangerously damaged houses had not been completely rebuilt. After the '8.13' debris flows, 35 % of houses were destroyed and the housing building area per household declined to 112.73 m^2. After having experienced two severe natural disasters, the residents of Qingping Township are now facing some difficult housing reconstruction work. The housing crisis will continue to have a negative impact on livelihoods for a certain time to come.

3.2 Considerable changes in farmers' livelihood styles

3.2.1 A sharp reduction in planting acreage

As can be seen from the survey data (Table 6), the acreage of food crops, vegetables, fruit trees, and other economic forest crops markedly decreased from 2007 to 2009 (after the '5.12' earthquake). This is a trend which corresponded to that of planting yields. As the mountainous areas are relatively short of arable land, planting acreage per household was a mere 0.1720 ha. For the sample households, the yields of per capita grain, per capita

Table 5 The proportion of different types of houses (%)

	Wooden houses	Brick houses	Concrete houses	Destroyed houses
In 2007	2.5	50	47.5	0.0
In 2009	0.0	10	82.5	7.5
After '8.13'	0.0	5.0	60.0	35.0

Table 6 Cultivation of sample households (ha.)

		Grain	Vegetables	Fruit	Other economic trees	Total
Acreage per household (ha.)	In 2007	0.0580	0.0180	0.0820	0.0140	0.1720
	In 2009	0.0180	0.0093	0.0487	0.0107	0.0867
	After '8.13'	–	–	–	–	–
Per capita yield (kg)	In 2007	123.47	48.41	14.53	–	186.40
	In 2009	26.82	23.14	7.37	–	57.34
	After '8.13'	–	–	–	–	–

Planting activities after the '8.13' debris flows were not investigated because planting requires a certain period of time, and this investigation was carried out only 2 months after the '8.13' debris flows

vegetables, and per capita fruit were 123.47, 48.41, and 14.53 kg, respectively. After the '5.12' earthquake, due to the damage to land resources, planting acreage per household dropped to 0.0867 ha. Furthermore, the yields of per capita grain, per capita vegetables, and per capita fruit were 26.82, 23.14, and 7.37 kg, respectively, in 2009. After the '8.13' debris flows, the arable land area per household and economic and fruit forest area per household were 0.0240 ha. and 0.0053 ha., respectively. Due to this drop, the planting acreage and yields are expected to decrease further in the future.

3.2.2 Diminished breeding stock and the number of livestock slaughtered

Due to the damage to arable land resources, as well as the reduction in feed grain production, household agriculture was unfavorably affected. This was specifically reflected in the noticeably diminished breeding stock and number of livestock slaughtered. As can be seen from Table 7, the breeding stock numbers for pigs and goats were 2.35 and 3.25, respectively, in 2007. The number of slaughtered pigs, goats, and poultry was 3.33, 1.65, and 88.23, respectively. However, in 2009, the breeding stock numbers for pigs, goats, and poultry were 0.78, 0 and 8.88, respectively, and their slaughter numbers were 1.03, 0 and 5.80, respectively. After the '8.13' debris flows, the breeding stocks of pigs and goats sharply declined once more.

3.2.3 Serious employment shortages

The damage to various resources by the '5.12' earthquake in 2008 and the '8.13' debris flows resulted in a labor force surplus. This was reflected in the reduced number of laborers engaged in planting and aquaculture, non-agricultural employment, and the average annual days of employment (shown in Tables 8, 9). In 2007, there were 316 workers between the ages of 16–64 years old. Laborers engaged in planting/aquaculture and non-agricultural

Table 7 Breeding stock and slaughter numbers for livestock per sample household

	Slaughter number			Breeding stock		
	Pig	Goat	Poultry	Pig	Goat	Poultry
In 2007	3.33	1.65	88.23	2.35	3.25	4.75
In 2009	1.03	0	5.8	0.78	0	8.88
After '8.13'	–	–	–	0.15	0	0.8

Slaughter number after the '8.13' debris flows was not investigated because livestock is usually slaughtered at the end of the year, and this investigation was carried out in October

Table 8 Number of laborers of sample households (persons)

	In 2007	In 2009	After '8.13'
Engaged in planting and aquaculture	46	42	9
Engaged in non-agricultural employment	49	44	74
Engaged in planting and aquaculture and non-agricultural employment	43	33	17
Unemployment	20	27	36
Total	158	146	136

Number of labor forces engaged in non-agricultural employment after '8.13' includes 56 people cleaning debris flow

employment accounted for 29.11 and 31.01 % of the workforce, respectively. Meanwhile, laborers engaged in planting and aquaculture and non-agricultural employment accounted for 27.22 %. The average annual days of employment were 127.05. In 2009, there were 292 laborers. Those engaged in planting/aquaculture and non-agricultural employment accounted for 28.57 and 29.93 %, respectively, while labor forces engaged in the planting and aquaculture and non-agricultural employment accounted for 22.45 %. The average annual days of employment decreased to 105.20. After the '8.13' debris flows, there were 272 laborers. Those engaged in the planting and aquaculture accounted for 6.82 %, and non-agricultural employment accounted for 56.06 %. Meanwhile, laborers engaged in planting/aquaculture and non-agricultural employment accounted for 12.88 %. The average days of employment during the 2 months investigated was 19.96. If we deduct the number of working days for some temporary welfare work arranged by government (such as cleaning up debris flow, etc.), the average days of employment during the 2 months investigated was only 5.83. Due to the shortage in livelihood assets owned by the investigated households, as well as low job skills (mean years of schooling is only 6.82 years), this surplus labor force will be around for quite a long period of time in the future. This will inevitably result in some serious adverse effects on sustainable livelihoods.

3.3 Government relief efforts were great, but the continuity of farmer incomes was adversely affected

The composition of farmer incomes after the '5.12' earthquake and the '8.13' debris flows were different from those in 2007. The continuity of farmer incomes was adversely affected. As can be seen in Table 10, managing farmhouse enjoyment and working

Table 9 Average annual days of labor force employment in different industries of sample households (day)

	In 2007	In 2009	After '8.13'
Planting and aquaculture	70.81	58.17	1.93
Non-planting and aquaculture factory workers	3.43	4.75	0.75
Construction workers	1.49	5.12	0.00
Phosphate mining workers	27.03	13.64	0.00
Service industry workers	6.38	3.11	0.48
Village cadres	3.86	4.38	0.83
Others	14.05	16.01	15.96
Total	127.05	105.20	19.96

"Others" includes military, bank staff, nursing home staff, rangers, and debris flow workers after the '8.13' debris flows

Table 10 Income of the sample households in different periods (yuan)

	In 2007	In 2009	After '8.13'
Planting income	653	373	6
Aquaculture income	2,493	273	3
Secondary industry income	2,000	0	0
Tertiary industry income	7,665	783	125
Interest income	30	0	0
Dividend income of collective economic organizations	553	143	30
Government subsidy	71	57,173	2,480
Labor income	18,017	14,670	326
Short-term public labor income	–	–	2,228
Total income for family	31,481	73,413	5,197

Short-term public labor income refers to the income obtained through participating in cleaning up debris flow by local residents of Qingping Township after the '8.13' debris flows

temporarily outside were the main sources of household income in 2007. Correspondingly, the tertiary industry operating income and labor income was 7,665 and 18,017 yuan, respectively. This accounted for 24.35 and 57.23 % of total household income. Planting and aquaculture income amounted to 3,145 yuan. It made up 9.99 % of total income. In 2009, the post-disaster subsidy per household from all levels of government was 57,173 yuan, accounting for 77.88 % of total income. Meanwhile, the proportion of tertiary industry operating income and labor income were, respectively, decreased to 1.07 and 19.98 %. At this point, planting and aquaculture income only accounted for 0.87 %. After the '8.13' debris flows, the post-disaster subsidy per household from all levels of government was 2,480 yuan, accounting for 47.72 % of total income. Meanwhile, the proportion of tertiary industry operating income and labor income went down to 2.41 and 6.27 %, respectively. Here, the income from cleaning up debris flow accounted for 87.24 % of total labor income. At the same time, planting and aquaculture income only accounted for 0.17 %. After two natural disasters, governmental relief efforts for the farmers have been great. Despite this, the contribution rate of relatively stable income to

total income, such as operating income and labor income of household, has declined sharply and the proportion of short-term instable income increased. This has caused a very negative impact on the sustainable income of farmers.

4 Discussion

This work demonstrated that the assets, livelihood styles, and income of farmers suffered heavy losses which is caused by the '5.12' earthquake and '8.13' debris flows. Also, many farmers lost their land and job. These suggest that, during the process of post-disaster reconstruction work, affected farmers' security, the carrying capacity of livelihood assets, and the enhancement of employment and livelihood choice are worthy of much attention from policy makers. When dealing with the problems associated with sustainable livelihoods of land-lost peasants, Chinese academics have provided a wide range of solutions under the guidance of the "sustainable livelihoods" concept:

To begin the housing reconstruction work immediately. The housing crisis will have a negative impact on livelihoods because many houses suffered serious damage in the natural disasters. Housing and other infrastructure is to maintain and develop the livelihoods of residents, which is the most urgent items to be reconstructed. Currently, residents in the affected areas are still most concerned about the issue of permanent housing reconstruction. Housing is not only as a place of residence, but also a sustenance and protection of the family soul. Lyons et al. (2010) used the term "people-centered housing reconstruction" in Building Back Better: Delivering People-Centered Housing Reconstruction at Scale to analyze the potential for large scale reconstruction to be participatory and developmental for and of ordinary people—"people-centered reconstruction". Therefore, the primary task is to solve the housing problem by actively mobilizing various forces, physical capital to accelerate the speed of recovery in the implementation of the reconstruction work.

To achieve full employment. It means the loss of the most basic jobs for farmers who lose their land (Liu 2007). The achievement of full employment is the current academic consensus on the issue of how to solve the sustainable livelihood question for land-lost peasants. A large number of institutions and scholars agree with using education training to solve the employment problem. They believe this is the most basic way to solve the employment problem (Wang and Ma 2006; Sheng 2007; Huang and Yu 2009).

To encourage private businesses. This is an essential measure for solving the issue of sustainability in the livelihoods of land-lost peasants. They must be encouraged to enter private ventures (Liu and Zhong 2008). Some scholars believe helping the land-lost peasants to become employed will involve helping them to "find their jobs" and to guide them to start their own businesses (Yang 2006). It was suggested that entrepreneurial information and small loans should be provided to help land-lost farmers with various ventures (Chen and Zhu 2006). Guiding the peasants in their ventures can mean taking the initiative to create a means of living. Hopefully, this can also bring more employment opportunities to other land-lost peasants (Zhao et al. 2009).

To convert the role of farmers. Because of the land-lost and a sharp reduction in planting acreage, many peasants who cannot go on with the agricultural production activities have trouble being successfully converted to city resident lifestyles. They have gradually lost their enthusiasm and initiative for life. The backward poverty culture of land-lost peasants is then formed which can shackle thought and imperceptibly influence the next generation. In view of this, "the role of new city residents should be cultivated and strengthened. This will help to create conditions for sustainable livelihoods of land-lost

peasants. It will help in the future of role conversion and achieve the ultimate goal of becoming well-off" (Wang et al. 2008). Chen (2005) believes that "land-lost peasants should be guided to re-socialize and successfully adapt to urban life. They should also be helped to improve their vocational skills and achieve the role changing from farmers to city residents"; Ye (2008) believed that it was necessary for them to take concrete actions in order to realize the changes in employment patterns. They should also strive to achieve a psychological level that allows them to overcome the traditional ideas, to accept the modern urban culture, and integrate into modern urban life.

To improve the compensation mechanism. Chinese scholars have proposed specific ideas geared toward achieving sustainable livelihoods for land-lost peasants by improving the compensation mechanism. This involves enhancing the standards of compensation for land acquisition (Liu 2008; Zhao et al. 2009). It also involves implementing a wide range of placements (compensation) and creating conditions that allow more land-lost peasants to have property income (Liu and Wang 2008). This will mean compensating them through the rules of the market economy.

To implement social security. At present, the social security problems of the land-lost peasants have failed to be resolved (Chen 2008). When exploring the implementation of social security problems for land-lost peasants, academic circles have discussed the pension insurance and medical insurance policies found in social insurance. Due to the fact that most land-lost farmers all over China receive land compensation that is too small, and therefore their basic living cannot be guaranteed, some scholars have proposed a "land for social security" mode (Sheng 2007; Wei 2006). In order to achieve the goal of sustainable livelihoods for land-lost peasants, most scholars advocate that a social security system and social security mechanisms should be established to enforce the resilience which was first defined by Holling as the time required for an ecosystem to return to an equilibrium or steady-state following a perturbation (Holling 1973; Gunderson 2000). In this way, the "old" land-lost peasants (excluded in the existing system) could be given priority and included within this new coverage (Zhang 2006). Of course, appropriate institutional arrangements, as well as supporting policies, are both necessary for the implementation of such social security for the land-lost peasants (Li 2007).

To protect legitimate rights. One of the key ways to solve the problem of sustainable livelihoods for land-lost peasants is to protect their legitimate rights. Several ideas surrounding this theory have been put forward to by Chinese academic circles, including: to protect their land rights (Sun and Zhou 2007); to protect their labor rights (Wang and Ma 2006); and to protect their children's education rights. Some scholars have suggested that the land-lost peasants themselves should raise their own consciousness and ability to maintain their rights (Li et al. 2008).

To transform traditional ideas. This includes two meanings. The first is to change the traditional concept of government; another is to change the traditional concept of the land-lost peasant. The traditional concept of land-lost peasant has implications for the conservative ideals of employment awareness and career-selection attitude. Therefore, some scholars have advocated that a shift in the mindset of land-lost peasants should be pursued from the outset (Zhao et al. 2009).

To innovate the existing system. As a very complex social problem, the solution to sustainable livelihoods for land-lost peasants depends largely on system innovations. Some scholars believe that a prerequisite and basis for success is to speed up institutional innovation and build a scientific and rational system for solving the problem of sustainable livelihoods. These innovative ideas and measures are as follows: to further improve the people's congress system, to ensure the farmer's right to speak (particularly those still engaged in farming), to reform the land expropriation system, to safeguard the basic rights of farmers on the land, to

establish an education system and social security system, to enhance survival competitiveness in land-lost peasants, to reform the Appraisal System and fiscal system (Sun and Zhou 2007). Some academics have suggested that a people-oriented policy idea should be realistically established, the primary responsibility of government should be cleared in the resettlement of land-lost peasants, and the performance evaluation system of the party and government should be improved (Yu 2008). As can be seen from above ideas, a range of systems should be innovated in order to solve the problem of sustainable livelihoods of land-lost peasants. Some scholars have also put forward that success will depend on the four aspects of mechanism innovation, including power, operation, error correction, and relief to ensure the realization of institutional innovation (Wang 2007).

5 Conclusions

This paper comparatively analyzed the changes in farmer livelihood assets and livelihood styles caused by the '5.12' earthquake and '8.13' debris flows by using typical household survey data. Several pieces of empirical results have been drawn. The severe natural disasters brought serious damage to livelihood assets relied upon by farmers in Qingping Township (i.e., land resources, phosphate and houses, etc.). They have also resulted in a shortage of household financial capital. Both of these effects have resulted in major changes to traditional livelihood styles (i.e., household planting and aquaculture, phosphate mining and related services, etc.) and a serious shortage of employment. While government at all levels has made great relief efforts to help the affected farmers, the contribution rate of a relatively stable income was reduced sharply. This included such things as operating income and household labor income. Furthermore, the proportion of short-term instable income increased, leading to an extremely negative influence on sustainable income for farmers.

To alleviate the adverse effects of severe natural disasters on the sustainable livelihoods of farmers in Qingping Township, some issues worthy of policy maker attention in terms of the process in post-disaster reconstruction are as follows:

First, after suffering through two severe natural disasters, farmer livelihood assets (such as land resources and phosphate), have been insufficient to support their future sustainable livelihoods. Under the premise of considering the wishes of those affected, positive guidance should be provided to help relocate farmers through post-disaster reconstruction funds and policy support. It is necessary for local post-disaster recovery plans to elicit positive recovery outcomes and that these plans include a sound participatory process. They should establish a nexus between local needs and policy objectives (Schwab et al. 1998). The characteristics of geography show that this discipline has special advantages for this kind of plan. For example: geographers in China played a vital role in the State Overall Planning for the Post-Earthquake Restoration and Reconstruction of Wenchuan (12 May 2008, M8.0) and Yushu (14 April 2010, M7.1). Resources and environmental carrying capacity evaluations issued by the Chinese Academy of Sciences have played a significant part in the State Planning for Post-Wenchuan Earthquake Restoration and Reconstruction, as well as the one for the Post-Yushu Earthquake (Fan 2009; Fan 2010). In addition, the Atlas of Regional Eco-environment in the Yushu Earthquake Affected Area issued by the Chinese Academy of Sciences also played an important role in the post-Yushu earthquake restoration and reconstruction (Institute of Geographic Sciences and Natural Resources Research of CAS 2010).

Second, in view of the serious damage caused by the two natural disasters to the ecological environment in Qingping Township, ecological recovery and disaster prevention should be strengthened in order to supply a security guarantee for residents. This will help to avoid the re-

invasion of new disasters. Developing a Disaster Monitoring and Simulation System is important (Long 2011). The role of GIS technologies in detecting, modeling, and monitoring natural hazards is also important (Pradhan 2010). By using simulation systems and technology, simulation systems for major natural disasters and their emergency plans can be constructed according to the possibility of their occurrence and based on the principles of historical recurrence (Pradhan 2010). Advantage should be taken of 3S technology and network information management systems, major natural disaster monitoring, and situations assessment systems, as well, regional disaster reduction capacity assessment systems can be established in order to prevent and manage diversified disasters (Shi et al. 2009; Wang et al. 2008).

Third, tourism should be restored and developed according to the national post-disaster reconstruction policy in Qingping Township. '5.12' earthquake and '8.13' debris flow disaster brought heavy blows to Qingping Township where the tourism industry was one of the important pillars before these two natural disaster. The post-earthquake restoration and reconstruction should focus the tourism as one of the key items. Compared to other industries, the tourism industry restoration is characterized by small input and effective output, and could encourage the development of a number of related industries and increase employment. In the aspects of its total income, employment, value-added, investment, and tax, the tourism development in Qingping Township benefits greatly. So, how to restore the tourism industry as soon as possible has become one of the important works in post-disaster reconstruction in Qingping Township.

Furthermore, phosphate mining and related services are the most important sources of livelihood for rural farmers living in Qingping Township. They should be restored to production as soon as possible to help solve the employment challenges and livelihood issues confronted by Qingping Township's residents. However, this should be accomplished under the pretext of safety. Farmers in Qingping Township—accustomed to being involved with planting and aquaculture, phosphate mining, and related services—are confronted with a severe shortage of employment skills. This is especially true within the context of momentous changes to traditional livelihood styles after a severe natural disaster. Therefore, it is essential to increase the funding and policy support for re-employment skills training in order to improve the quality and number of livelihood options for affected farmers.

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