



## Effects of natural disasters on livelihood resilience of rural residents in Sichuan

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### ABSTRACT

Measuring livelihood resilience is a difficult task, and practical methods to measure livelihood resilience are needed. We use the structural dynamics to describe the changes in livelihood resilience of Sichuan rural residents from quadruple dimensions: livelihood quality, livelihood promotion, livelihood provision and disaster stress. Results show that (i) the livelihood resilience of rural residents is significantly positively correlated with the livelihood quality, livelihood promotion and livelihood provision, but substantially negatively correlated with the disaster stress. The livelihood resilience is dominated by both livelihood provision and livelihood promotion. (ii) the effect of different natural disasters on the livelihood resilience varies. The contribution rates of earthquake, flood and drought to livelihood resilience are  $-0.5\%$ ,  $-0.3\%$  and  $-0.1\%$ , respectively. The clear understanding of the vulnerable targets such as the poor, agricultural sector, disaster-prone hilly and mountainous areas in Sichuan Province can help limit a disaster's adverse impact on livelihood; (iii) developing incentives to motivate healthcare professionals to retain in rural areas, increasing the scale operations in the education and health sectors, promoting the equitable access to farmland and the economic viability of local farms have to be important part of livelihood resilience improvement.

### 1. Introduction

The concept of resilience has been gaining critical mass in academia since the 1960s (Be'ne', Wood, Newsham, & Davies, 2012). The resilience idea arose from multiple sources and has been examined from multiple disciplinary perspectives (Tanner et al., 2015; Speranza & Rist, 2014; Be'ne' et al., 2012). As different people and disciplines pursue their journey of inquiry about complex systems, understanding of the concept of resilience varies (Woods, 2015; Speranza & Rist, 2014; IPCC, 2007, 2012; Adger, 2003, 2006; Folke, 2006; Berkes, Colding, & Folke, 2003; Carpenter, Walker, Anderies, & Abel, 2001; Berkes & Folke, 1998). However, there is a growing consensus that resilience is not static but keeps changing (Prado, Seixas, & Berkes, 2015; Resilience Alliance, 2007; Saavedra & Budd, 2009; Sallu, Twyman, & Stringer, 2010; Speranza & Rist, 2014; Ulrich et al., 2012; Vaitla, Tesfay, Rounseville, & Maxwell, 2012). And the method of resilience quantification is missing (Ingrisch & Bahn, 2018).

Livelihood resilience is a key component of sustainable livelihoods, primarily reflecting the coping capability to external stresses and shocks, and the ability to return to the original state of livelihood (FAO, 2013a, b; IDS, 1998; Thulstrup, 2015). Existing literature regarding the

livelihood resilience focuses mainly on asset endowment and livelihood resilience (Thulstrup, 2015; Walters, 2015), disaster risk reduction and livelihood resilience (Be'ne' et al., 2012; RFSAN, 2016; FAO, 2010, 2013a; León & March 2014), livelihood function and livelihood resilience (Oparinde & Hodge, 2011; Speranza & Rist, 2014). It is noteworthy that, in their studies of livelihood resilience, Thulstrup (2015), Marschke and Berkes (2006) tend to evaluate livelihood assets, and to estimate the determinants of livelihood strategies, finding links between livelihood asset and livelihoods resilience at different scale through critical indicators analysis. It is demonstrated that the adaptation strategies based on livelihood capital are beneficial for maintaining the diversity of livelihood options and the improvement of livelihoods resilience (Forster, Lake, Watkinson, & Gill, 2014; Prado et al., 2015; Ramanath, 2016; Worku, Pretzsch, Kassa, & Auch, 2014). There remains a broader need to better understand the linkage among livelihood capital, external stresses and livelihood resilience (Marschke & Berkes, 2006; Sallu et al., 2010; Scoones, 2009). In addition, although many international organizations and agencies such as RFSAN (2016), FAO (2013a, 2010), and FIC (2013) stress the importance of enhancing livelihood resilience by disaster risk reduction, the internal correlation between natural disasters and livelihood resilience has not been fully

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**Table 1**  
Major methods of livelihood resilience assessment.

Classification of evaluation approaches	Study area and scale	Research focus	Major methods used in existing literature	Literature citation
Concept framework	Philippines; Nepal; Bangladesh; Uganda; Papua New Guinea	Strengthening livelihood resilience through disaster risk reduction	RiVAMP; CAPRA; CBDRM framework	FAO (2013b)
	At the global level	Enhancing the resilience of livelihoods against disaster threats	Hyogo framework; DRR/DRM framework	FAO (2013a,b)
	At the global level	A comprehensive analysis framework of livelihood resilience	Conceptual framework based on buffer capacity, self-organization and capacity for learning	Speranza and Rist (2014)
Index-orientated analysis	Kenya	Measuring household livelihood resilience	Livelihood capital and HLRA	Quandt (2018)
	Southeastern Ethiopia	The significance of dry forest income for livelihood resilience	Critical indicators;	Worku et al. (2014)
	India	Modeling the livelihood resilience	Bayesian networks; Indicators measure; Survey of households	Merritt et al. (2016)
	Sub-Saharan Africa	Managing vulnerability to drought and enhancing livelihood resilience	Drought tolerance index; Weather index insurance	Shiferaw et al. (2014)
Questionnaire and interview	Nigeria	Maximising livelihood resilience and minimising vulnerabilities	Multivariate probit mode; An asset-based approach; Survey of households	Oparinde and Hodge (2011)
	India	Women reconstructed their livelihoods in new surroundings	Personal interviews; Participant observation	Ramanath (2016)
	Central Vietnam	Household access to capital and livelihood resilience	A capital-based approach; Semi-structured interviews; Participatory Rural Appraisal	Thulstrup (2015)
	Cambodia	Emphasis on resilience-building strategies at household and community levels	Participatory methods; Qualitative methods	Marschke and Berkes (2006)
	Philippines	Enhancing the role of human and social capital in resilience building at micro-level	Questionnaire surveys; Sustainable livelihoods approach	Uy, Takeuchi, and Shaw (2011)
	Nepal	Migration's role in food security and livelihood resilience	Focus group discussions; Household surveys	Gautam (2017)
	Bangladesh	Building resilience based on people-centred perspective	Participatory assessment; Qualitative method; Semi-structured interviews;	Ayeb-Karlsson et al. (2016)
	Northwest Ethiopia	Addressing expose people to flood disasters and shaping their resilience	Survey of households; Key informant interviews; Principal component analysis; Simple linear regression	Weldegebriel and Amphune (2017)
	Jordan	Strengthening resilience through disaster risk reduction	Secondary data review; Focus group discussions	RFSAN (2016)

examined in practice. Similarly, in Speranza and Rist' (2014) study, they found that livelihood resilience depends on how well a livelihood functions and on the social, institutional and natural conditions. However, important issues, such as how the livelihood function affects livelihood resilience, how to recognize the context-specific nature of livelihood resilience, have not been explained quantitatively.

Three major challenges in livelihood resilience assessment are identified in the existing literature: the first one is the quantitative simulation of livelihood resilience. Despite richness in theory and concept, due to a livelihood and resilience have various dimensions at the individual and structural levels (Speranza & Rist, 2014), the operationalization is difficult and multiple dimensions need to be considered when conceptually and empirically integrating livelihood and resilience (Beichler, Hasibovic, Davidse, & Deppisch, 2014; Quandt, 2018; Speranza & Rist, 2014). A review of many case studies demonstrates that assessments of livelihood resilience usually focus on qualitative description, concept framework, index-oriented analysis and questionnaire surveys (Table 1). To date, the quantitative tendency to focus on resilience has left a gap in our understanding of livelihood resilience and makes it difficult to investigate main variables for livelihood resilience across multiple scales. The second is how to mirror the dynamic nature of livelihood resilience, which implies there is an urgent and continuing need for assessing dynamics and trajectories of livelihood resilience. An equally important aspect in assessing livelihood resilience is analyzing the way in which livelihood resilience change over time, and in response to what stimuli (Vaitla et al., 2012). But the application of qualitative description, conceptual framework,

questionnaire survey, and index-orientated analysis methods in description of dynamic livelihood resilience proves to be difficult (Ingrisch & Bahn, 2018; Merritt, Patch, Reddy, & Syme, 2016). Thirdly, it is extremely difficult to identify the determinants and structural effect that affect livelihood resilience (Quandt, 2018). This means that any successful assessment for livelihood resilience needs to address the issues of interaction among human-caused and natural factors (Frankenberger & Nelson, 2013). In particular, there is still lack of empirical evidence and understanding of the complex causal relationships between livelihood resilience and natural disasters (Marschke & Berkes, 2006; Prado et al., 2015; Sallu et al., 2010; Speranza & Rist, 2014; Thulstrup, 2015). As is in shown in Table 1, the literature to explore quantitatively the livelihood resilience of rural residents based on natural disasters is very scarce (Ayeb-Karlsson, Geest, Ahmed, Huq, & Warner, 2016; Merritt et al., 2016; Shiferaw et al., 2014). As pointed out by Hoon, Singh, and Wamali (1997), a modeling of livelihood resilience helps to explain how the elements that constitute a livelihood system change over time.

It is argued that here, due to the dynamicity and complexity of state of livelihood resilience, it is necessary to address the link between livelihood resilience and multi-stresses including natural disasters through quantitative assessment and dynamic simulation. For this purpose, we attempt to establish the numerical model based on structural dynamics from four dimensions of livelihood quality, livelihood promotion, livelihood provision and disaster stress, the model enables us to capture different states of system and tendency of changes in livelihood resilience, identify major driving variables that relate

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