Rural Community Resilience in the Chengdu Plain, China: A Comparative Study of Three Community-Scale Cases

Yang, Wei [a]*

[a] Department of Urban Engineering, University of Tokyo, Tokyo, Japan

* Corresponding author: y-wei@urban.t.u-tokyo.ac.jp

ABSTRACT

Dujiangyan Irrigation District is located in the heart of the *Chengdu* Plain. Since ancient times, it has been the most economically developed area in the Sichuan Province and even the west of China. Historically, we created a sustainable and harmonious human settlement, especially in the rural areas, and it has shown great resilience and adaptability in dealing with natural disasters such as floods and droughts. However, with the acceleration of globalization and urbanization, the local communities in this rural area are increasingly facing different pressures of disturbance and change. This study analyses the environmental and socio-economic resilience of three communities in this area, by spatial date collection and analysis, as well as questionnaire interview. The results show that due to the centralized resettlement policy, the ecological pattern and landscape heterogeneity of some villages have been broken. Moreover, urbanization has also reduced social economic resilience of rural communities, such as household livehood,age strcture and social network, etc. At last, a strategic framework for community resilience planning is proposed in this paper. During the COVID-19 crisis, community resilience to withstand and recover from the COVID-19 outbreak has become a topical issue for addressing the pandemic, and other disturbances in society.

Keywords: *community resilience, social-ecological system, environment, socio-economy, China.*

INTRODUCTION

Resilience is the capacity of a system to absorb disturbance and still retain its basic function and structure. This sounds like a relatively straightforward statement but when applied to systems of humans and nature it has far-reaching consequences.

As our society grows more complex and the environments become less certain, it is increasingly difficult to make our social, economic, and ecological systems sustainable. Especially, our living city and urban areas as a complex social-ecological system, they are vulnerable to disasters, climate changes and other disturbances. We have to admit that there are “shocks” that may cause systems to fail, and be prepared to recover from the failure. We call the ability to withstand these shocks and

recover from the failure resilience. As a result, it is the right time to discuss resilience within the context of planning practice.This paper focus on the community resilience in rural *Chengdu* Plain, which has sustained over 2,000 years of both flourishing urban culture as well as probably the highest per-hectare regional production of grain and one of the most densely populated agricultural landscapes in China, especially considering its spatially dispersed settlement pattern (*linpan*).

In what follows, we first introduce the background of *Sandaoyan* town and sample villages where fieldworks were conducted. We then report the fieldwork results of how the situation of environmental and socio-economic resilience, followed by a discussion of the problems faced by the community in rural China. At last, a strategic framework for community resilience is proposed.

METHOD

Based on the social-ecological systems resilience theoretical framework, this survey mainly consists of two parts: spatial data collection and questionnaire interviews. In this way, research can be conducted from two dimensions of environmental and socio-economic resilience. Community-scale case studies of spatial morphological and household socio-economic variants on the regional trend help to articulate what is at stake.

Study Areas

Sandaoyan Town is located in the suburbs of *Chengdu*, 6 kilometers north of *Pidu* County center (Figure 1). At the same time, it is also the originally essential area in *Dujiangyan* Irrigation District, so it is a beneficial study case and area to reflect the current status of community resilience in rural *Chengdu* Plain. This town covers an area of 18.26 square kilometers, governs 8 villages (communities), and has a permanent population of 24,000. In this paper, three villages are selected from this town as the survey object, which named *Paotong* (A), *Qingta* (B) and *Qinggangshu* (C).

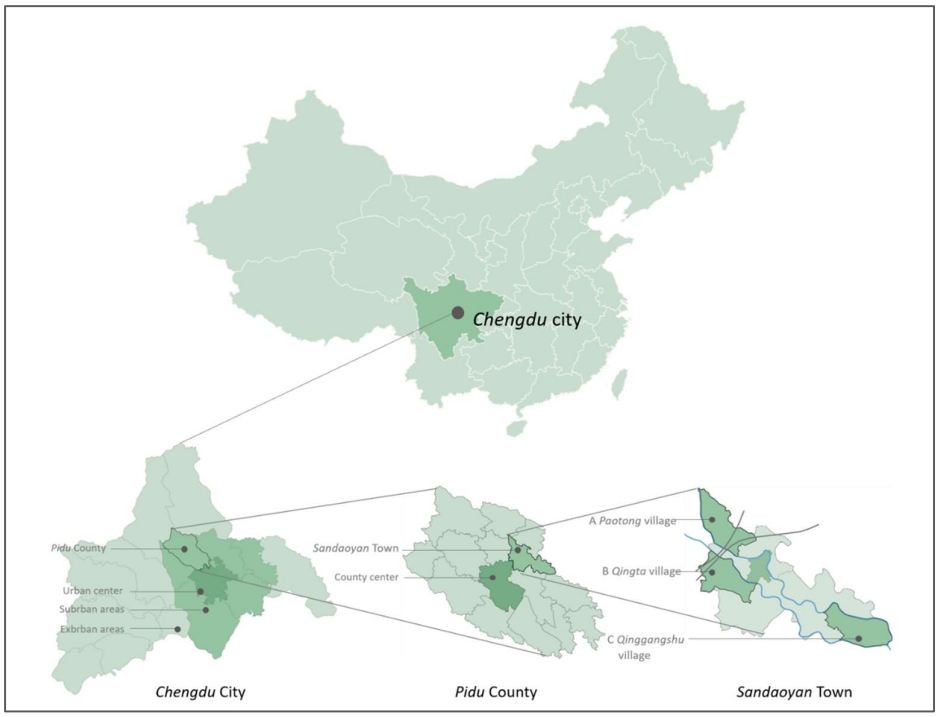

Figure 1: Location of study areas in *Chengdu*, *Sichuan*, China.

Fieldwork Methods

In landscape ecology, scale plays an important role in determining spatial patterns. Three scales were studied in each administrative village to evaluate measures of landscape structure that serve as indicators of community resilience. For the purposes of this paper, it was not possible to study community resilience at a broad landscape scale. Instead, scale was chosen as village scale, intermedieta scale and sample scale (Figure 2).

We conducted filed spatial data collection in July, 2017, which was guided by some indicators. This part was to survey the environmental resilience of the community from a spatial perspective. At the same time, we also conducted semi-structured interviews, which aimed to understand the socio-economic resilience of the community. A total of 118 households (32 in *Paotong*, 38 in *Qingta* and 47 in *Qinggangshu*) were interviewed, with the male householder as the interviewee but in a few cases other family members were also involved. Each interview lasted for 0.5-1 h, with questions regarding the household livelihood, income and expenditure, education, etc. Additionally, we also interviewed the heads of the town and villages to understand the overall conditions of the rural communities. In a all, the entire field survey is guided by the indicators in the Table 1.

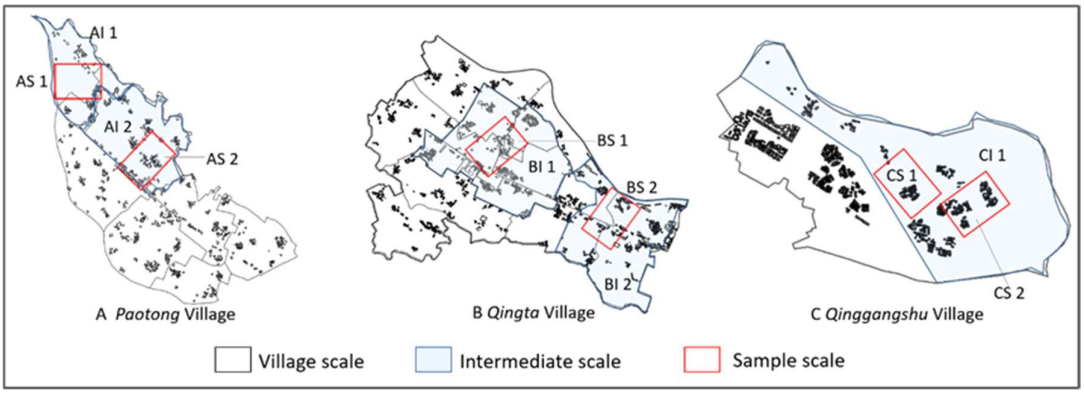

Figure 2: Study communities in the different scales.

	Scale	Indicators	Measures
Spatial data collection	Village	Land use (%)	Official arable land, Farmland, Forest land
	Intermediate (neighbor distance)	Dwelling dispersion	Total # dwellings, Total # Residential patches Mean area of Residential patches Average # dwellings per residential cluster Range of # dwellings per residential cluster (min. –max.)
	Sample (400m x 300m area)	Landscape heterogeneity	Total # Fields, Mean area of fields (m^2) Total # *Linpan*, Mean area of *Linpan* (m^2)
		Crop diversity and food production	Total # main crop types Average # crop types per field
Questionnaire interviews	Village	Social economy	Total # households Average annual income (RMB) Average past-12-month expenditure (RMB) Age structure, Family structure Education, Social network

Table 1: Indicators and measures of community resilence in this study.

RESULTS AND DISCUSSION

Community Environmental Resilience

Village scale

The village scale is defined by the administrative boundaries of the village. This scale is used to observe broader scale land use composition and configuration. From Figure 3 and Table 2, it can be intuitively reflected that *Paotong* and *Qingta* have a higher proportion of farmland and forest land, while *Qinggangshu* is lowest.The reason is that the northern part of *Qinggangshu* is largely used for centralized construction, actually it is tourism. Although the development of rural tourism can help improve the rural building environment and infrastructure, the urbanization process of large-scale construction land and road hardening brought some damage to traditionally ecological space of the village, which will make it difficult for the village to have enough environment to buffer the disturbance caused by the disaster when responding to floods or extreme climate changes.

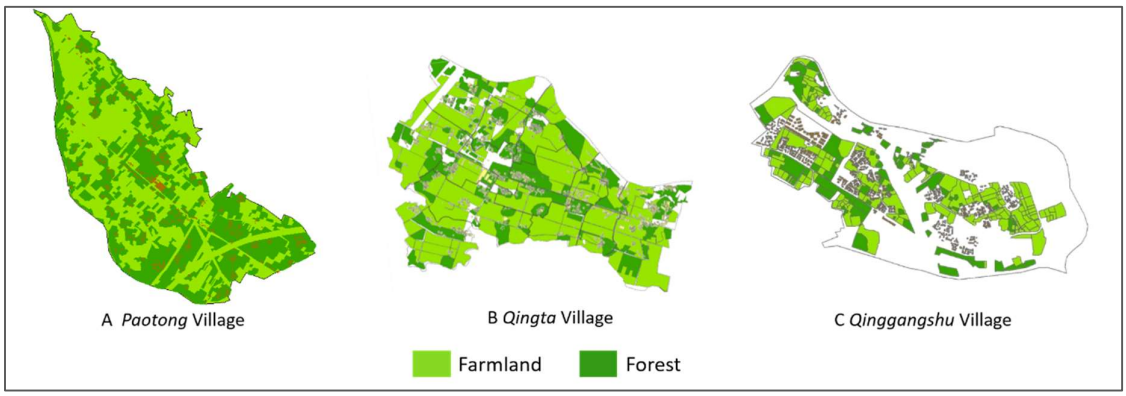

Figure 3: Land use of three villages.

	Paotong	*Qingta*	*Qinggangshu*
Official arable land	79%	64%	70%
Farmland	52.02%	65.92%	22.55%
Forest land	43.97%	24.43%	11.36%

Table 2: Land use of three villages.

Intermediate scale

For indicators of settlement pattern and measures such as nearest neighbor distance between houses, a scale named intermediate area between the sample area and village scale was used.

Patch size (area) is the average size of patches of a particular land use type. Patch area is perhaps the single most important and useful piece of information that can be obtained from a landscape analysis. Patch number is the total number of patches in a given land use, and this is a measure of landscape configuration. From an ecological perspective, more patches in a single land may assure redundancy within a landscape, thus reducing the risk of loss due to disturbances such as a pest outbreak, flood or drought.

As can be seen from Table 3, the mean area of residential patches under the intermediate scale of *Qinggangshu* are significantly larger than those of *Paotong* and *Qingta*, while the number of residential patches in *Qinggangshu* was lower than that other two villages. Due to the policy of centralized resettlement, the dwelling dispersion of *Qinggangshu* show a concentration and homogenization trend. Although from the perspective of rural society, centralized resettlement is conducive to the

efficient allocation of infrastructure and the sharing of public resources, but large-scale residential patches intensify the instability of regional ecosystems and weaken the environmental resilience of rural ecosystems. In contrast, the dwelling dispersion of *Qingta* shows the characteristics of moderate scale in number and size, which greatly supports the community resilience in the dimension of environmental ecology.

	Paotong		*Qingta*		*Qinggangshu*
Intermediate scale	AI 1	AI 2	BI 1	BI2	CI 1
Total # dwellings	140	104	352	367	293
Total # Residential patches	54	65	109	126	20
Mean area of Residential patches	466.32	625.04	322.05	315.69	3971.5
Average # dwellings per residential cluster	1.93	2.15	3.23	2.91	14.65
Range of # dwellings per residential cluster (min. –max.)	7-1	9-1	13-1	11-1	36-4

Table 3: Dwelling dispersion of three villages in the intermediate scale.

Sample scale

Sample areas were chosen to gain a better understanding and representation of land use, particularly the spatial relationship between agricultural fields and other land use types. This scale offers a proxy for the landscape heterogeneity and crop diversity.

In western China, the landscape is distinguished by the irrigation system's near absence of dams and levees, as well as a peculiar dispersed-but-densely populated pattern of settlement, consisting of small clusters of forest-and-bamboo-shaded dwellings called *linpan*. Locals value linpan for its cultural and ecological significance, a socio-ecological system that has persisted for thousands of years.

From Table 4 and Figure 4, *Qinggangshu* residents incurred significant trend to outfit their new houses as rural tourism guesthouses and had less field and *linpan* now. In the mean time they had given up all individual control over farm production. *Paotong* and *Qingta*, on the other hand, left the basic landscape structure intact and continued to use their land primarily for agriculture, but they maintained a more diverse mix of crops, including significant grain and food produce as well as ornamentals. Their heterogeneity and diversity reveal further challenge to continuing resilience in the *linpan* landscape.

	Paotong		*Qingta*		*Qinggangshu*	
Sample scale	AS 1	AS 2	BS1	BS2	CS 1	CS 2
Total # Fields	87	207	184	92	11	42
Farmland (%)	29%	70%	69%	67%	15%	45%
Forest land (%)	50%	25%	10%	17%	22%	19%
Residential land (%)	16%	3%	20%	13%	1%	13%
Total # *Linpan*	10	7	8	5	0	5
Mean area of *Linpan* (m^2)	37079	7014	14717	6892	0	1836
Total # main crop types	7	7	7	9	3	3
Average # crop types per field	2.46	2.53	2.78	3.81	1	1

Table 4: Landscape heterogeneity of three villages in the sample scale.

Figure 4: Land use of three villages in the sample scale.

Community Socio-economic Resilience

Income and expenditure

For income, *Qinggangshu* and *Qingta* have higher income than *Paotong*, because of land transfer and more non-agriculture works. But for expenditure, *Qinggangshu* is also much higher than two others because of investment on tourism facility. And for *Qingta*, its household income profiles reveal further challenge to continuing resilience in the economic life (Table 5).

	Paotong	*Qingta*	*Qinggangshu*
Total # households	32	38	47
Average household annual income (RMB)	13,000	73,000	60,000
Average household past-12-month expenditure (RMB)	9000	23,000	68,000

Table 5: Household livelihood of three villages.

Age structure

The age structure can reflect the social resilience of the community in terms of human capital. More young age structure can support capacity to cope and adapt to various fluctuations and change. In

general, the majority of three villages is middle age between 40-60, but *Qinggangshu* have more young adults than the other two (Figure 5). This age structure reflects that new village construction and industry development due to the land transfer, attracting more young people to return and work on tourism, commerce or service in the village without work outside.

Family structure

From the comparison of the size of the family in Figure 6, it can be drawn that there are a large proportion of nuclear family (small family) composed of 3 to 4 people in *Qinggangshu* and *Paotong*. Conversely, in *Paotong*, large family with 4 to 5 persons or more are the majority. Family size and structure can not only reflect the social and economic level of the village, but also affect the stability of the rural social ecosystem to a certain extent. Generally, the existence of extended families is associated with low productivity levels. Therefore, a family with reasonable structure is a basic social organization to support community resilience.

Education

The level of family education is also one of the important socio-economic indicators that supports community resilience. Education will not only play a vital role in the social development of the village, but also affect the villagers 'knowledge and abilities to adapt and respond to natural disasters. In general, the education level of three villages is relatively low, most of the villagers have primary or junior school education, proving that the villages are traditional and agricultural. Among them, *Qinggangshu* have more educated people (Figure 7).

Social network

In terms of social network, we add a question on whom to ask for help when villagers meet troubles like borrowing money, looking after kids or the old, or being in sick. The answers range from the family and adjacent neighbor to friends in the village, in the town or farther. This question to some extent can indicate the adaptive and social self-organization ability of a community. The results show that three villages have most network confined to family and neighbor. Comparing the other two, *Paotong* has the smallest scope while the other two can reach farther (Figure 8).

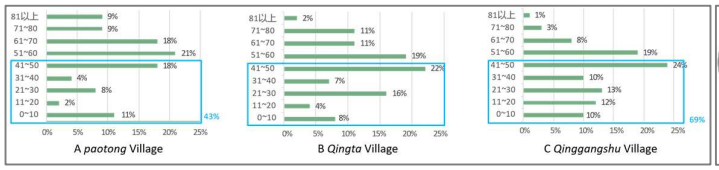

Figure 5: Age structure of three villages.

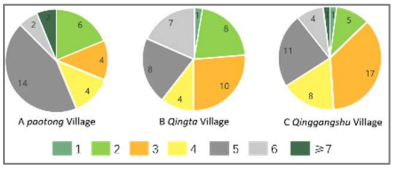

Figure 6: Family structure of three villages.

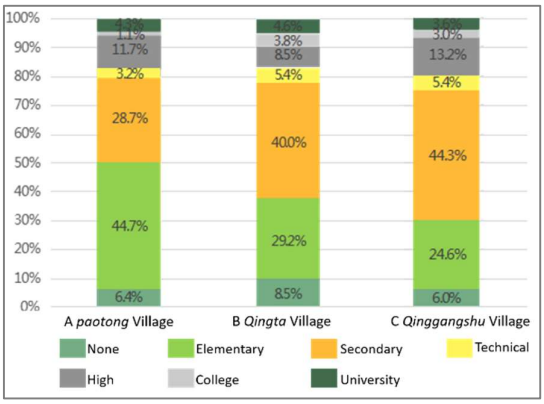

Figure 7: Education of three villages.

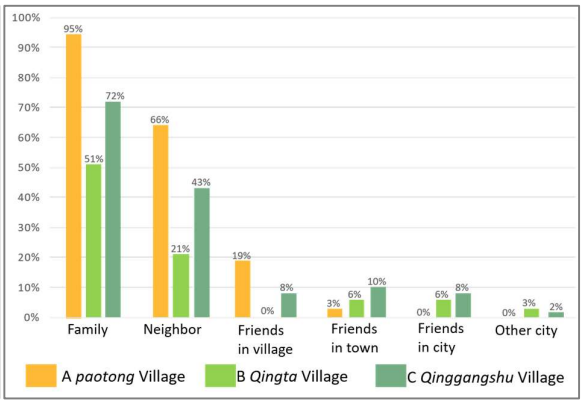

Figure 8: Social network of three villages.

Summary of Results

According to the analysis, among the three sample villages, *Qingta* has the best environmental resilience due to the moderate settlement size, pattern of *linpan* and high landscape heterogeneity and biodiversity. On the other hand, because of the centralized resettlement and the construction of rural tourism in *Qinggangshu*, centralization and homogenization has destroyed the original ecological spatial pattern of the village to a certain extent.

In terms of socio-economic resilience, it is not easy to evaluate *Qingta* or *Qinggangshu* which is better, but it could be said that *Paotong* is the worst one. It showed some problems of traditional Chinese villages when them faced with urbanization, for example, The aging of villagers and the decreasing in youth. Many young people go out to work in cities and towns for higher income, leaving only old people in the village. Additionally, simplification of land use, livelihoods and social network also give some damage to the socio-economic resilience of community in rural China.

CONCLUSIONS

Since the 21st century, with the acceleration of the wave of globalization and urbanization, China's cities and villages are facing many risks and challenges. The rapid evolution of the rural community in China is a spatial representation of the agglomeration of economic factors, the flow of population resources, and the dualization of the urban-rural system during the rapid urbanization process. The spatial differences in the urban-rural regional relationship have led to different rural populations and land evolution. So, this is a good case to understand the real situation of community resilience in rural China.

Firstly, ecological space structure, moderate settlement size, pattern of *linpan*, and high landscape heterogeneity and biodiversity promote the sustainability of rural ecosystems and support environmental resilience in this local area.Then, rural areas in China are vulnerable to modernization and urbanization, and local communities show poor adaptability in terms of age structure, livelihood and social network, etc. Now, institutional planning and policies are needed to rebuild the socio-economic resilience of rural communities.Finally, based on this case study, considering the characteristics of resilience, the strategic framework for community resilience is proposed (Figure 9) .

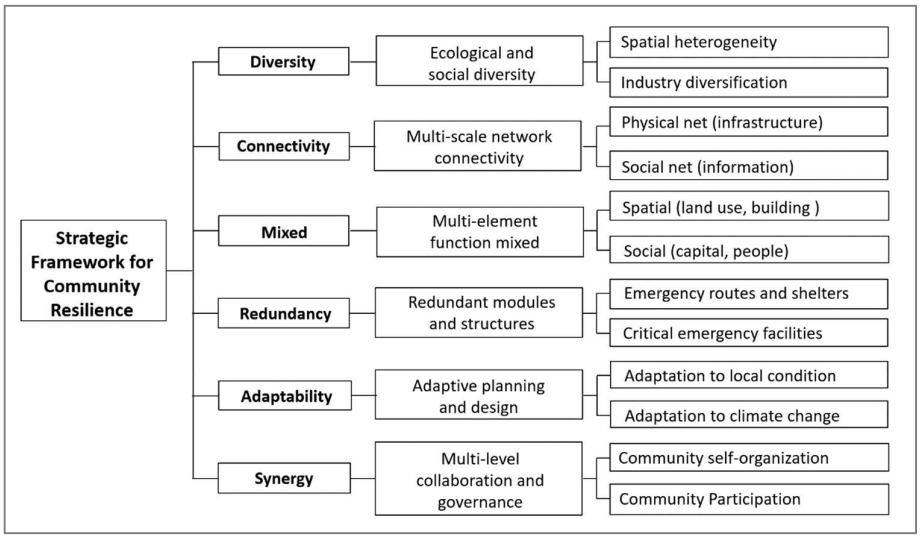

Figure 9: A strategic framework for community resilience.

Resilience has emerged as a system-based concept that explains how systems respond to shocks. During the COVID-19 crisis, community resilience to withstand and recover from the COVID-19 outbreak has become a topical issue for addressing the pandemic. Some cases show community self-help and mutual support have become critical to the survival of many individuals, lending a lifeline to some of the most vulnerable populations in our society. Enhancing community resilience has to be adopted to decrease vulnerabilities in urban system and achieve sustainable development. So, It needs further explore the implications of building community resilience to address disturbances and crisis like the Covid-19 pandemic.

ACKNOWLEDGEMENTS

The author gratefully thank Prof.Daniel B Abramson (University of Washington) who gave guidance to this research and survey, and student participants from Department of architecture, Sichuan University who assisted this survey in summer, 2017. The author acknowledge funding by Sichuan University Immersion Programs. Finally, the author are grateful for insightful comments from two anonymous reviewers.

REFERENCES

Walker, B., Holling, C. S., Carpenter, S. R., & Kinzig, A. (2004). Resilience, adaptability and transformability in social–ecological systems. *Ecology and society*, 9(2).

Ahern, J. (2011). From fail-safe to safe-to-fail: Sustainability and resilience in the new urban world. *Landscape and urban Planning*, *100*(4), 341-343.

Bergamini, N., Blasiak, R., Eyzaguirre, P., Ichikawa, K., Mijatovic, D., Nakao, F., & Subramanian, S. M. (2013). *Indicators of resilience in socio-ecological production landscapes (SEPLs)*. United Nations University Institute of Advanced Studies (UNU-IAS).

Cabell, J. F., & Oelofse, M. (2012). An indicator framework for assessing agroecosystem resilience. *Ecology and Society*, 17(1).

Xu, L., Marinova, D., & Guo, X. (2015). Resilience thinking: a renewed system approach for sustainability science. *Sustainability Science*, 10(1), 123-138.

Sherrieb, K., Norris, F. H., & Galea, S. (2010). Measuring capacities for community resilience. *Social indicators research*, 99(2), 227-247.

Scott, M. (2013). Resilience: a conceptual lens for rural studies?. *Geography Compass*, 7(9), 597-610.

Ilmola, L. (2016). Approaches to measurement of urban resilience. In *Urban Resilience* (pp. 207-237). Springer, Cham.

Sharifi, A., & Yamagata, Y. (2016). Urban resilience assessment: Multiple dimensions, criteria, and indicators. In *Urban Resilience* (pp. 259-276). Springer, Cham.

Abramson, D. B. (2019). Ancient and current resilience in the Chengdu Plain: Agropolitan development re-'revisited'. *Urban Studies*, DOI: 10.1177/0042098019843020.

Whiting, S. H., Abramson, D., Yuan, S., & Harrell, S. (2019). A Long View of Resilience in the Chengdu Plain, China. *The Journal of Asian Studies*, 78(2), 257-284.

Tippins JL (2014) *Planning for resilience: A proposed landscape evaluation for redevelopment planning in the linpan landscape*. Master's Thesis, Urban Planning, Seattle, WA: University of Washington.

Norris, F. H., Stevens, S. P., Pfefferbaum, B., Wyche, K. F., & Pfefferbaum, R. L. (2008). Community resilience as a metaphor, theory, set of capacities, and strategy for disaster readiness. *American journal of community psychology*, 41(1-2), 127-150.

Frankenberger, T., Mueller, M., Spangler, T., & Alexander, S. (2013). Community resilience: Conceptual framework and measurement feed the future learning agenda. *Rockville, MD: Westat*, *1*.

Cox, R. S., & Hamlen, M. (2015). Community disaster resilience and the rural resilience index. *American Behavioral Scientist*, *59*(2), 220-237.

Song, Y., Zhang, Y., Song, X., & Swiderska, K. (2016). Smallholder farming systems in southwest China. *Exploring key trends and innovations for resilience. IIED, London*.

APRUSecretariat (2020). Bottom-Up Resilience? Civil Society Responses under COVID-19, from https://www.youtube.com/watch?v=z6GVTn-0FTQ