

## Rethinking the socio-ecological resilience of linpan rural landscape under the threat of COVID-19

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### ABSTRACT

The rapid expansion of COVID-19 is incurring the rethinking of human society's capacity for coping with major public health events. While "big data" have been widely used to analyze the impact of COVID-19, very limited study was found in rural areas where such kinds of "data" are lacking. This situation will inevitably lead to an incomplete understanding of the pandemic impacts and biased decisions due to the fragmentary information. In this study, I focused on the agrarian communities in rural areas of Chengdu city where *linpan* system (wooded lots) characterizes as a cultural landscape. Considering COVID-19 as a threat, this study hopes to understand the socio-ecological resilience of *linpan* system under the external pressures both qualitatively and quantitatively, combining ethnographic interviews with geospatial analysis, landscape ecology and graph theory. It was found that the spatial pattern of *linpan* system managed by local communities shows a dispersed distribution pattern, which naturally maintaining a "social distance" while keeping socio-economic connections tightly through periodical rural-market systems. This indigenous knowledge and traditional practices have not been well understood and integrated into development planning, which led to a decrease of socio-ecological resilience against external shocks such as the pandemic or climate change.

**Keywords:** *Socio-ecological resilience, dispersed settlements, connectivity, rural markets, Covid-19*

### INTRODUCTION

The prevention and control due to the spread of the novel Coronavirus (COVID-19) have posed challenges for the medical and healthcare systems in the world and triggered the rethinking of various fields including urban and rural planning, on mitigating strategies under major public health events. Until now, the situation in China has almost stabilized, which provides opportunities for scholars to review this unprecedented event from a historical perspective and learn lessons for preparation in the future. Simultaneously, "resilience" has again become a buzzword when people

realize the importance of "plan ahead" after witnessing a severe shortage of medical resources and daily supplies, including paper towels and foods worldwide.

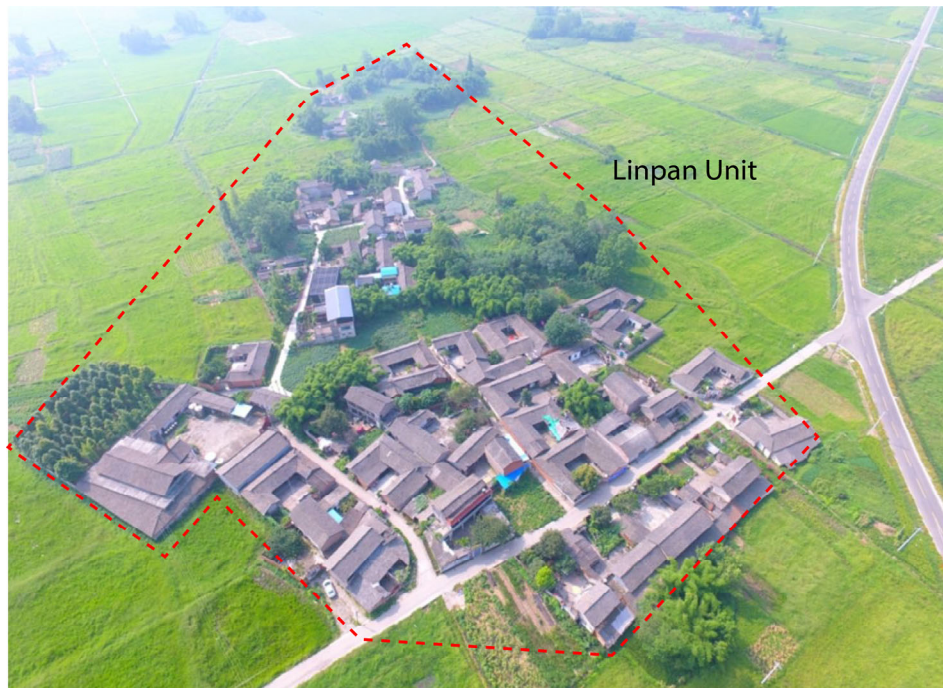


Figure 1: Drone imagery of one *linpan* unit in Chengdu Plain, Southwest China. Photograph by Jun Xiang, 2018.

Although many cities in China such as Wuhan has been dramatically impacted during this pandemic, it is lucky to see that the disease has not penetrated rural China this time (only a few cases found in peri-urban areas). One of the reasons is the strict policy of maintaining social distance conducted in China and the relatively sparse settlements and limiting population flowing in rural areas. However, we should also be aware that rural areas, with somewhat less developed economies, are often more vulnerable to external threats. Although "big data" such as migration and transportation data in given cities were used to analyze spatial-temporal patterns of epidemic spread and supporting decision-making, minimal attention has been paid to rural areas where such data are still missing.

Rural resilience is the cornerstone of almost all nations in the world. For instance, according to the US Census Bureau report, rural counties are far more likely to have greater proportions of high-risk populations, i.e. 30% of all rural counties are high-risk compared to 14% of all urban counties (US Census Bureau, 2020). In China, under the pressure of rapid urbanization in the last few decades, many dispersed farmhouses have been replaced by intensified settlements, similar to those compacted apartments in cities. Most of the traditional household-based farming in China has been transformed into a monoculture in a large scale. It is surprising to find that agriculture's intensification is almost parallel to farmers' settlements' intensification during this modernization process. However, the compacted modern living mode has posed several challenges during this pandemic – the difficulty of keeping social distance and lack of smooth supply of living necessities during the lockdown. In this study, I use the long-surveyed Chengdu Plain in China as an example to explore the traditional knowledge and practices of local farmers in maintaining the spatial pattern of

*linpan* landscape and analyze the advantages of traditional marketplaces in keeping the connectivity of agrarian society as a whole.

The *linpan* landscape of rural Chengdu has been studied by various scholars over the past years, all of which have proved its socio-ecological resilience (Abramson, 2019) and the sustainability in supplying sufficient food to locals in the long term. Due to the ancient Dujiangyan irrigation system, this region is far from natural hazards such as floods and drought. This article analyzes the spatial characteristics of traditional dwelling form on this plain and the resilience under the new threat – COVID-19, trying to understand whether this spatial pattern could also be beneficial to prevent social shocks such as major public health events and the adaptation strategies that local people take. Meanwhile, another hypothesis of this study is that the connectivity of dispersed *linpan* units (farmhouses) is maintained socio-economically through hierarchical rural markets in referring to the nodes and edges model of graph theory.

## **THEORY**

The first theory adopted in this study is socio-ecological resilience. The concept of resilience originated from natural sciences, which means the system's ability to recover from external disturbances and shocks (Holling, 1973). At present, it is recognized that human survival and well-being often depend on the resilience of society and ecosystem, and resilience is a type of "insurance" for human society when it is exposed to external pressures or shocks. When external pressures or shocks come, this "insurance" mechanism can provide the socio-ecological system with enough space and time to respond, allowing the system to activate its adaptation mechanism and reduce the losses caused by external shocks. Socio-ecological resilience especially emphasizes the complex nature of our built environment, where the physical aspect and social-cultural aspect of resilience are both crucial. Until today, the economic indicator such as GDP per capita is still the main measure of a country's or region's resilience (Bergamini et al., 2013), however, researchers are trying to find more comprehensive measurements, involving social, cultural and natural factors together (UNU-IAS, 2013). The COVID-19 triggered us to think human society's ability to cope with major public health events should also be assessed with an integrated measurement toolbox.

The second theory used in this study is graph theory. Graph theory appears widely in math and computer science and has been introduced into landscape ecology in the 2000s (Urban and Keitt, 2001). Graph theory analyses connectivity through links and nodes (graphs) and can inform us about how different habitats are connected and the degree of connectivity in this landscape. It can also illustrate which node is more important in connection and finds strong or weak ties in this system. Meanwhile, it has profound implications in disease control - as Bunn, Urban & Keitt (2000) mentioned in their article, a certain distance is kept in the natural world to prevent disease spread among species, but species are not so far from each other, so genes can also flow within the system. This idea has a broad impact on human society as humans share many things in common with nature. I use graph theory to understand rural markets' nexus function in connecting dispersed *linpan* settlements and maintaining the integrity of the socio-ecological system (e.g., agrarian society) in both natural and socio-cultural ways.

## **METHOD**

The dispersed settlement form on Chengdu Plain is called "*linpan*", translated as "wooded lot" in English, while some other scholars translated it as "home gardens" or "forest plate". To understand

the spatial pattern of *linpan* landscape quantitatively, I use Arcgis 10.6 combined with software Fragstats to calculate landscape metrics such as the number and density of *linpan* patches. I calculated these metrics in two villages, Paotong and Qinggangshu, both located in the same township – one remains as a traditional village with *linpan* reasonably intact. Still, another has been transformed into the concentrated mode with condensed apartments. The landscape metrics together with carrying capacity of these two villages were calculated and compared.



Figure 2: Traditional farmhouse settlements (left) were transformed into newly built villages with condensed apartments (right), a common practice under recent modernization in rural Chengdu. Photograph by Shuang Wu, 2019.

Apart from geospatial analysis, I conducted interviews with 30 villagers using a snowball sampling strategy in the third village called Dantu, where the traditional rural market is still functioning periodically. This village preserves the traditional *linpan* landscape surrounding the village center, i.e. a traditional market street. The purpose of this step is to understand the functions of a village-based rural market in networking dispersedly distributed farmers' households as a society, especially its role of social connection played during the external shock coming, such as a pandemic.



Figure 3: Dantu village during regular market days (left) and during COVID-19 lockdown (right). Photograph by Shuang Wu, 2019 and Min Tian, 2020.

## RESULT AND DISCUSSION

### *Spatial pattern of linpan landscape*

*Linpan* is a dwelling type and integrated with productive functions, which means local farmers always cultivate crops and vegetables in the farm fields nearby and raise livestock or poultry in their gardens.

They also built their own houses using the bamboo collected from their home gardens or community woodlands. Geospatial analysis results show that the density of *linpan* patches on the Chengdu Plain varies in different locations. Generally speaking, *linpan* units (patches) present a small and dense pattern in the core irrigated flat areas to large and sparse pattern in the gently hilly regions on the fringe of Dujiangyan watershed. It is mainly due to the allocation of natural resources (e.g. water, soil condition) related to agricultural production and then the carrying capacity of land. For the core of irrigated areas, water is sufficient and the soil is fertile enough to support a dense mode where local people choose to live near. In contrast, people need a larger space for living and production for the gently hilly areas since the carrying capacity of land declines.

Compared with other high-density rural areas of China, the Chengdu Plain shows a high carrying capacity due to its high agricultural productivity. Whiting et al. (2019) stated that this region has long been a leading food exporter, only until recently started to import food from outside due to both farmlands' shrinkage and loss of laborers (migrating to urban areas). Compared to other agricultural regions in China, such as the "Yangtze River Delta" and "Pearl River Delta" or even the rural areas of northern China, Chengdu Plain has no big villages (Skinner, 1954; Abramson, 2019). Instead of forming a big village, farmers prefer to live in a dispersal mode and maintain a certain spatial interval from each other. Typically, 2-3 households live in one *linpan* unit, which forms a relatively independent settlement cluster surrounding by woodlands and farm fields. The average spatial distance between *linpan* units is around 200-300 m (Liu, 2017). For some large (over ten households) and medium-sized (five to ten households) *linpan*, the distance between them could be about 1 km or even more (Fang, 2013). This dispersed pattern of *linpan* landscape indicates a naturally 'social distance' maintained by traditional agrarian society. Sufficiently interval space between these settlement clusters guaranteed the 'niches' not to overlap, and residents would not encounter 'rigid' confrontation with the acquisition of natural resources.

#### *Recent change of farmers' living space*

With the rapid urbanization in Chengdu Plain, many farmers' households were moved to newly constructed villages or townships where the centralized apartments or townhouses replaced the rural landscape's previous farmer houses. The intensification of "farmer villages" reduced the ecological heterogeneity or agricultural diversity of landscapes and resulted in further inconveniences for farming activities, energy consumption, and high living cost. Because the living places of farmers are far away from their farming fields, most of them (the majority are elderly farmers) have to give up traditional livelihood (e.g. grain crop cultivation). Viewing from public safety, the centralized residence model brings many new risks for fire protection, epidemic control, "social distance" maintenance, and psychological well-being. The easy and quick infection of COVID-19 in urban areas reminds us that human dwellings' intensification should be carefully considered in urban and rural planning in the future. On the other hand, according to the geospatial calculation, we can find that the traditional mode does not sacrifice the carrying capacity of land compared to the new concentrated settlement.



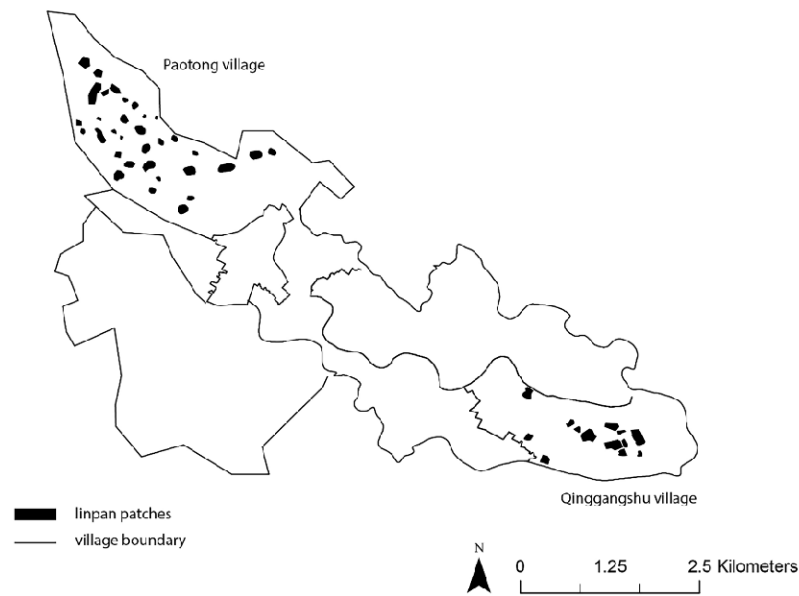


Figure 4: Map showing traditional dispersed *linpan* patches in Paotong village (left) and the concentrated settlements after modernization in Qinggangshu village (right). Map by Shuang Wu.

	Paotong village (dispersed form)	Qinggangshu village (concentrated form)
Area	2.17 km <sup>2</sup>	2.4 km <sup>2</sup>
Population	2332	2251
Population Density	1074/ km <sup>2</sup>	936/ km <sup>2</sup>
<i>Linpan</i> Density	15.2 unit/ km <sup>2</sup>	5.4 unit / km <sup>2</sup>

Table 1: Comparison of traditional *linpan* dwelling form (dispersed) with modern living mode (concentrated) in two villages in Sandaoyan township, Chengdu, China. Results show that dispersed dwelling form can carry the same population density compared to concentrated living form but keep enough distance between dwellings.

#### *Rural market's role in linpan landscape*

Due to the rapid social and economic development in the past 30 years, especially the economic globalization and infrastructure development, the traditional functions of rural markets are gradually weakening. Following the "concentration of living space" policy, urbanized townships have replaced many traditional marketplaces in rural areas. Many traditional townships with periodic markets have been transferred to higher-level administrative centers, which integrated many small markets or administrative villages into a large one. Although natural villages have maintained some social service facilities, the centralized governance system could not provide enough and timely services for local communities who live in a much wide area, particularly for vulnerable groups such as elders and the poor.

Through reviewing historical records and conducting field surveys in Dantu village, we found that rural markets in the Chengdu plain are periodic, the marketing day being 2-3 times per week. During those marketing days, people not only trade products or buy daily necessities but also visit hospitals, temples, and friends, i.e. the functions of a rural market, including economic and socio-cultural (Fang, 2013). GW Skinner, an anthropologist from the USA and surveyed rural Sichuan at the end of the 1940s, found out that the rural market system formed a hexagon shape with the service range (radius) of about 3 km (Skinner, 1964). Within this service range, most farmers could go to the marketplace once a few days on foot. By conducting field survey in Dantu village and its neighboring six markets in townships, it is found that the mean distance in between Dantu and other markets is about 5-6 km. The shape is not a perfect hexagon but resonates with Skinner's theory (see Figure 6).

Speaking from a graph theory perspective, markets function as "nodes" in the graph, and the information, energy, and trade flow between those markets are "edges". If one node (marketplace) is missing or close during the lockdown, there are other "redundant" nodes (markets) in this network that can sustain the function of the whole system. But a node like Dantu village is essential in this case. Once it is removed, the entire system's connectivity will be disrupted, which can be explained in an easier way that Jiancha township and Sanxing township (see Figure 6) would be too far away. Villagers live in between those two nodes would need to travel a long distance to get daily supplies, or the information could not pass timely from one node to the other. The diversity of nodes (various small or big markets) can compensate for their functions and enhance a network's connectivity, therefore decreasing the potentially catastrophic failure when external shock happens.

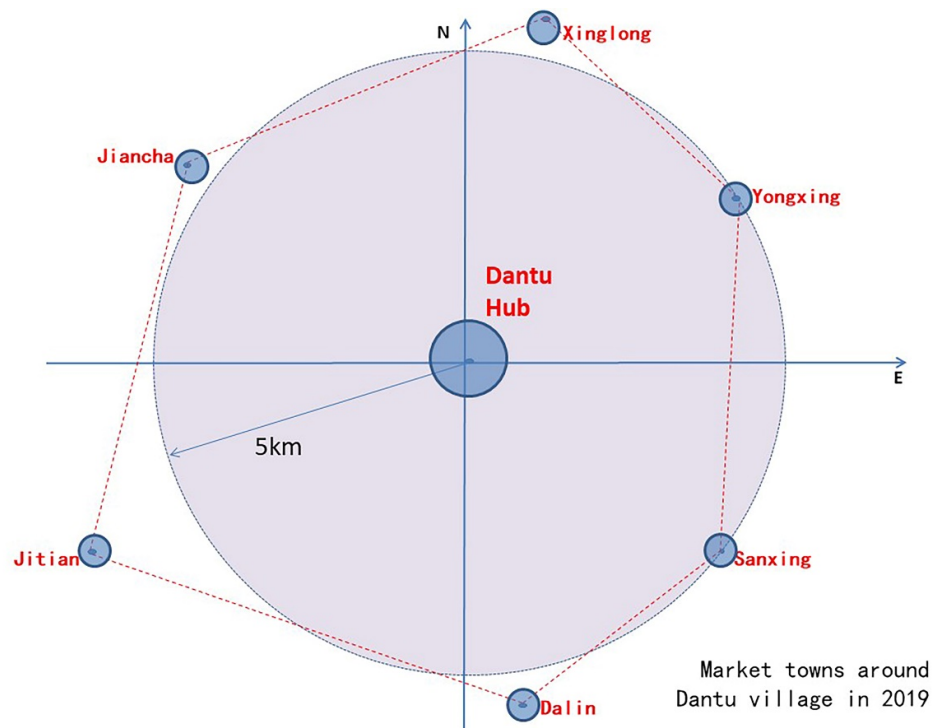


Figure 6: Diagram showing Dantu market in the center and the neighboring market townships

The importance of a lower level rural market is also proved to be essential with our interviews. We interviewed 30 local farmers in Dantu village using a snowball sampling strategy. It is found out that while major public health incidents were occurring, the clinics, prevention stations and village committees based in the traditional marketplace could be responsible for medicine or vaccine dissemination, knowledge sharing, capacity building and "social distance" monitoring. During the spread of COVID-19 in February 2020, all of the village committees of rural Chengdu including Dantu village were assigned as the basic units for monitoring "social distance" maintaining and checking the body temperature of all villagers under the guidance of local clinics and supports of volunteers (local young farmers). This kind of working group was also responsible for distributing face mask and disinfectant to local people, regular patrolling on non-native visitors, and providing support to vulnerable groups such as single elders or low-income families.

Without the functioning nexus such as the rural marketplaces or village committees, the local farmers living dispersedly in *linpan* units were difficult to be organized for coping with a significant external shock such as pandemic efficiently and effectively. Farmers living not too far away from a certain marketplace could quickly obtain services, information, knowledge, materials, and skills related to medical care, epidemic prevention, and even economic support for vulnerable groups, thereby sustaining the resilience of the socio-ecological system under the threats of the pandemic. Combing with the experiences accumulated in controlling "pig flu" in 2018, a decentralized epidemic prevention system and health care system is crucial for rural areas.

## **CONCLUSION**

The Chengdu Plain is one of the most important agricultural areas in China's history. The developed water network and fertilized soil have supported agricultural landscape sustainability, maintaining a prosperous human society for hundreds or even thousands of years. This study illustrates that the traditional living mode of local farmers in the *linpan* landscape is important for maintaining the socio-ecological system's resilience in coping with external pressures or shocks such as the pandemic. The newly centralized 'villages' reduce the convenience of agricultural production and make the original social prevention and control system more vulnerable, thereby increasing the possibility of the spread of infectious diseases. Furthermore, more attention should be paid to the socio-cultural functions of traditional rural markets. Although modern supermarkets and e-business could partly replace rural markets' economic function, the social, cultural and political services provided by the rural marketplace will be very important for networking dispersed households living in *linpan* units as an integrated society. Thus, traditional knowledge and practice related to resilience enhancement should be analyzed in detail and integrated into rural planning in the future.

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