Research Paper

Exploration of Rural Resilience Improvement Path from the Perspective of Civil Air Defense

Taking Zhanghai Town in China as an Example

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Abstract

As an emerging rural planning research topic and a new direction of rural revitalization, rural resilience is of great significance for exploring the path of sustainable rural development and solving the instability and vulnerability of rural areas. Under the background of rapid urbanization, the single development model of traditional Chinese villages cannot support the self-renovation of villages, resulting in the lack of sufficient resilience of their social, economic and ecological systems, and the problems they face are prominent and urgent. This paper takes Zhanghai Town, a traditional Chinese town with a long history and beautiful environment, as the research object, and discusses the synergistic relationship between rural and civil air defense construction.Based on resilience theory, through the civil air defense planning practice modeled by ArcGIS, a rural resilience improvement framework is constructed from the perspective of civil air defense, and the connotation of rural resilience improvement is proposed as " guarantee improvement" of engineering resilience + "active adaptation" of evolution resilience, which together constitute a rural social and ecological resilience network.The results prove that civil air defense planning is closely related to urban and rural areas, and is suitable for planning methods for the frequent occurrence of natural disasters and health incidents in urban and rural areas, making agricultural and rural areas more "resilient".

Keywords

Civil air defense planning, Rural resilience, Adaptive cycle, Evolutionary resilience

1. Introduction

In recent years, the concept of resilience and its planning have received more and more attention and research in the field of international government organizations and urban planning, and gradually changed from an emerging research topic direction to the mainstream direction (Kumar, 2015). At present, according to the relevant literature on resilience, the largest branch of resilience is divided into disasters and disaster risk reduction (Unisdr 2010, Timon 2014), and civil air defense system planning is an effective means to directly improve the ability of urban and rural areas to cope with disasters. However, at present, China's concept of resilience and the effective combination and application of urban and rural civil air defense space have not been studied in depth, and urban planners need to be further clarified (Zhang 2020).

In today's urban-rural integrated development, the countryside has important human history and natural resources. At the same time, as a reserve force for urban development and as the main distribution center for urban disaster prevention and evacuation, the importance of rural civil air defense planning and construction is equally self-evident. However, the insufficiency of many country's civil air defense

thinking in the peacetime led directly to the development of the rural air defense system in its initial phase. Due to the insufficiency of basic public service facilities, the fragmentation of ecological landscape, and the weakening of culture in rural areas (Zhang 2019, Li 2004), rural faced with the same number of challenges and threats, resulting in weak coping capabilities to respond to disasters or adverse shocks and challenges, which highlights the need for rural resilience building. The purpose of this paper is to respond to the above research problems and challenges, build the resilience of rural engineering to evolutionary resilience through the regional planning of civil air defense evacuation, strengthen the construction of civil air defense space, and then demonstrate the construction process at each phase through the adaptive cycle theory. Increased resilience level.

The purpose of this paper is to respond to the above research problems and challenges, build the resilience of rural engineering to evolutionary resilience through the regional planning of civil air defense evacuation, strengthen the construction of civil air defense space, and then demonstrate the construction process at each phase through the adaptive cycle theory, so as to increase rural resilience from the perspective of civil air defense.

2. Thought for improving rural resilience from the perspective of civil air defense

2.1. Resilience theory and rural resilience

"Resilience" is derived from the concept of toughness in physics, meaning "rebound" or return to the original state (KLEINA 2003), originally "engineering resilience". It was later introduced by ecologist Holling and called it "ecological resilience" (Holling 1973), which means that the system can still maintain a stable state after experiencing disturbances under uncertain threats and disturbances from the outside world, or even reach a new normal state. This multi-stability study is the origin of the application of the concept of resilience to the field of scientific research (Holling 1973). Later, it was used in the analysis of social-ecological systems and human-nature interactions (GUNDERSON 2002), which is called socio-ecological resilience (also called evolutionary resilience). Research on the concept of resilience shows that its system complexity and interdisciplinary nature determine that its conceptual connotation cannot be unified in the short term, but this does not affect resilience as a new perspective and effective model for modern cities to deal with risks and threats (Yan 2020).

At present, in the face of environmental, social and economic uncertainties and risks, "resilience" has also become the core goal of urban and rural planning, construction and development (Wang 2016). However, due to its complexity and dynamics, scholars hold different views on the concept of rural resilience, which can be divided into three categories: the first type emphasizes resilience, the second type emphasizes adaptive capacity, and the third type emphasizes resistance and adaptation. and transformation ability. The countryside is also a multi-dimensional composite system with many constituent elements and complex mechanisms (Li et al, 2018). Rural development in the new era must be dynamic, complex, and multidisciplinary integration. Therefore, rural resilience should refer to the social and economic development process of the countryside. Under the appropriate natural or unnatural external force, after having a certain impact on its natural, social and economic system, it can still evolve into a new state through self-organization within a certain period of time (Li 2021), showing the " development-protection-release-reorganization" (Figure 1, left) is a complex concept that balances resilience, adaptation and transformation. Research shows that rural resilience has important practical significance for enhancing the comprehensive strength of rural development and realizing rural revitalization (Tang 2018).

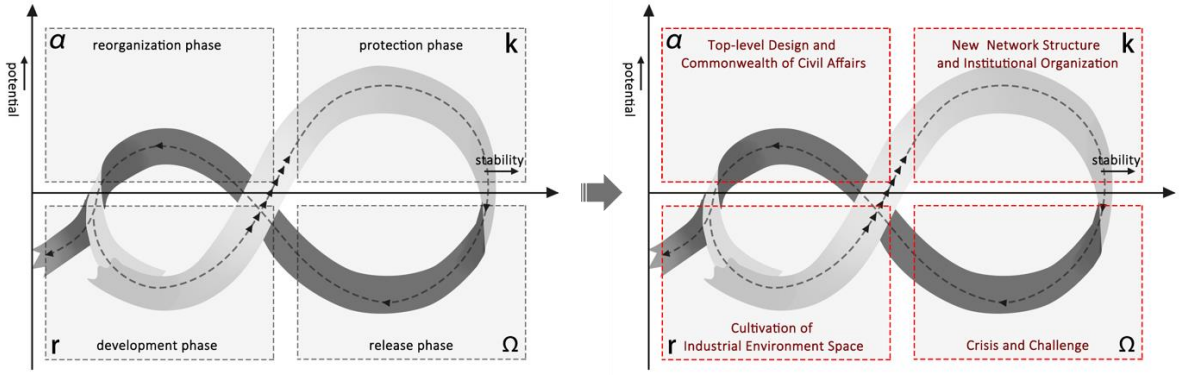


Figure 1. Adaptive cycle and rural adaptive cycle from the perspective of civil air defense. (Graphic by Author)

In the process of urban and rural development, the concept of rural resilience emphasizes the comprehensive disaster prevention and response capabilities of rural areas, and civil air defense planning and construction is the main way to improve rural disaster prevention capabilities, such as a series of construction work such as emergency shelters, emergency evacuation channels, and emergency rescue systems. Japan is a place with a high incidence of natural disasters. Since the 1960s, it has been committed to the management of community hazards, adding disaster prevention spaces and various disaster prevention facilities, so as to improve the comprehensive disaster prevention capabilities of community spaces (Wang 2012, Zhang 2013), and changed the thinking of rural governance, transforming "citizen participation" into "citizen subject" (Hu 2013), all of which are improving the self-organization ability of society. Therefore, the concept of civil air defense in the new era should not only highlight the engineering resilience of infrastructure construction, but also focus on building long-term ecological-social resilience (evolutionary resilience) based on engineering resilience. Its core idea can reflect the resilience concept of passive reflection and active improvement.

2.2. Rural resilience improvement framework

From a practical point of view, compared with cities, Chinese rural areas are more in line with the construction of a resilient system. The countryside has a large amount of land and a complete regional production and living collective. The relationship between people and land is close, and people have an innate sense of belonging and cohesion. It is the key content of the construction of the rural evolution system (Tang 2018). As the core mechanism of resilience theory (Figure 1, left), the adaptive cycle can well explain the dynamic operation process of the social-ecological system (GUNDERSON 2002). In the adaptive cycle process, resilience changes continuously with the operation of the system, so identifying the cycle phases of complex systems is crucial to the resilience research and construction of urban and rural systems (Yan 2020).

Based on the resilience theory and the adaptive cycle theory as the operating mechanism, the resilience of rural engineering is built through the regional planning of civil air defense evacuation. This process (Figure 1) is the development (R) phase: the cultivation of industrial environmental space; the construction of social network environmental space during the construction process, protection (K) phase: during this period, there may be many problems such as shortage of funds in the development process, unreasonable planning, and the separation of civil air defense projects from residents' lives. At this time, if the system cannot cope with the current crisis and challenges, it will enter the update reserve (α) phase for development, update and reorganization, until it successfully responds to the crisis and evolves a new knowledge network structure and institutional organization (Figure 2). It is worth noting that villages are composite systems, and village resilience is a dynamic construction process. In addition to specific resilience against known risks, the system must maintain general resilience to cope with unexpected

threats and shocks during the dynamic development process (Walker 20), avoiding undermining the diversity, flexibility, and ability to respond to unknown threats of resilience itself (Wu 2013).

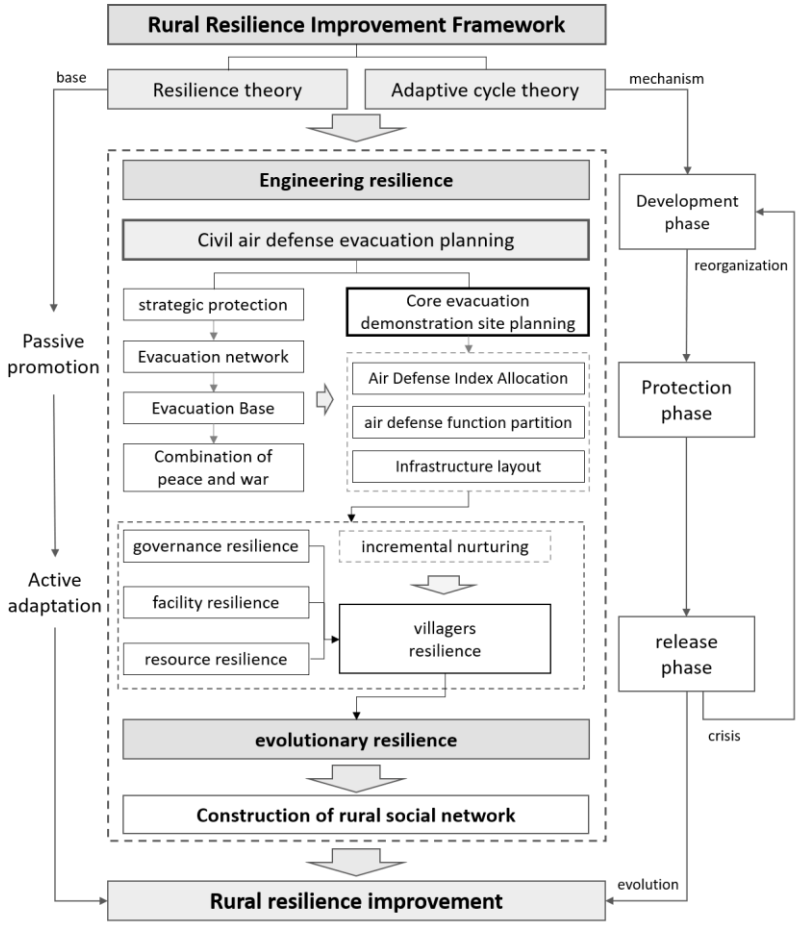


Figure 2. Rural resilience improvement framework from the perspective of civil air defense. (Graphic by Author)

3. Promotion connotation and strategy - "passive promotion + active adaptation"

The connotation of rural resilience lies in the ability of rural villages to adapt to future crises and challenges and to recover and update after being hit by disasters. China's current rural resilience construction focuses on farmers' livelihoods, land policies, and climate change (Chen et al, 2019), and it is biased towards "specific resilience" in rural construction. However, Mcmanus believes that social processes are an important factor affecting rural resilience, and the local economy, environment, and a strong sense of personal belonging help to improve rural resilience, especially in the urban-rural transition zone (Mcmanus 2012). Therefore, the construction of rural resilience should not only deal with "specific resilience", but also take this opportunity to enhance the social value of the countryside, cultivate the pride of residents, and transition to the construction of evolutionary resilience. Its core purpose is to cultivate "passive-uplift" industrial environment spaces such as improving rural infrastructure, traffic accessibility, and adding public spaces, to helping villages transition to "actively adapting" to future crises and challenges, and to construct their own society. The environmental network forms the strong vitality of the countryside, and this process must be grass-roots and gradual (Yan,Lu 2017).

3.1. Passive enhancement: engineering resilience - development and preservation phases

The engineering resilience brought by civil air defense evacuation regional planning to villages is reflected in the following phases: 1) strategic protection analysis; 2) evacuation road network planning; 3) evacuation base planning; 4) combined peace and war planning; 5) core evacuation demonstration sites planning, the process is in the development (r) and conservation (K) phases of an adaptive cycle.

Table 1. Adaptive construction evaluation system. Data Sources:Baidu POI, Yearbook Statistics, Field investigation

Type	Index factor	Weights
Precipitation	maximum annual rainfall	0.1028
	highest water level river buffer	0.0495
Land	land type	0.0381
	elevation slope	0.1634
	aspect	
Society	population density	0.0263
	public space density	0.0472
	number of public service facilities (schools)	0.1221
	number of public service facilities (sanitation stations)	
	number of infrastructure	0.0987
economy	GDP per land	0.0578
transportation	road network density	0.0442
	transportation accessibility	0.1727
	dangerous source distance	0.0772

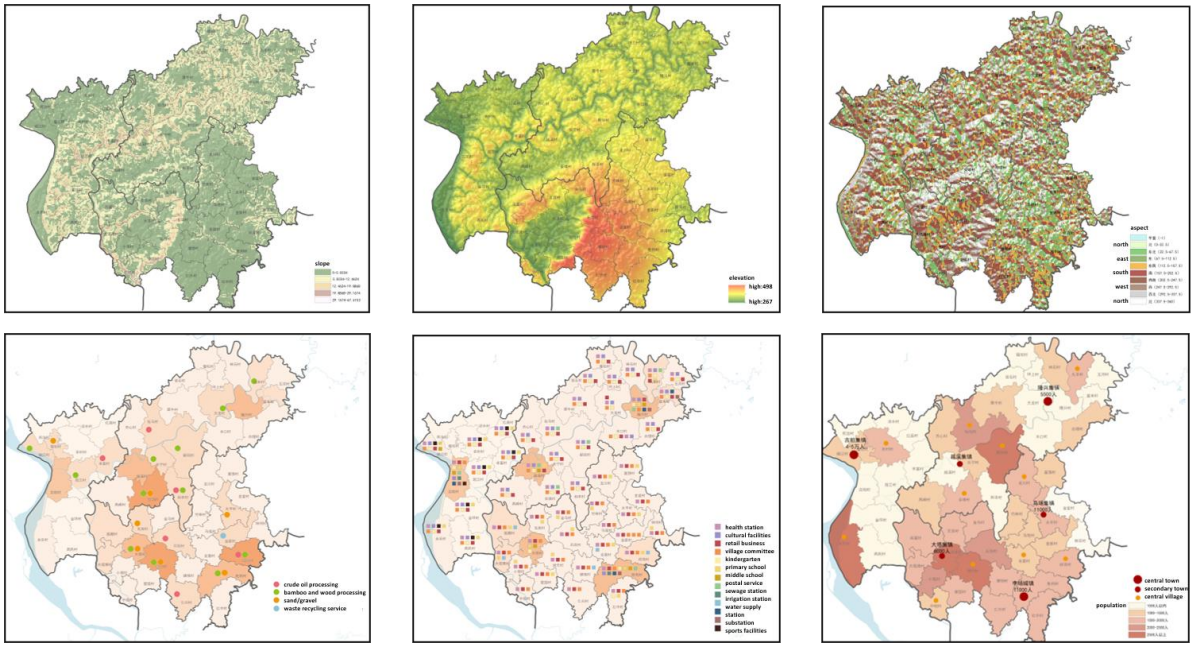


Figure 3. Partial construction adaptability evaluation. (Author self-made by Arcgis)

(1) strategic protection analysis

Strategic protection analysis is divided into location and protection area division and local construction adaptability evaluation. After the civil air defense evacuation area under the protection zone is determined through the upper-level planning, the construction evaluation is carried out after on-site investigation and data collection of the research base. The construction evaluation elements include

precipitation, land, population, society, economy, roads and other types of construction factors (Table 1), and the corresponding weights are assigned to different types through the Analytic Hierarchy Process (AHP), and then ArcGIS software is used to achieve single-factor analysis. (Figure 3), and finally superimposed to obtain a comprehensive construction adaptability evaluation. This evaluation is not only suitable for site selection evaluation and ecological sensitivity evaluation of civil air defense bases, but can also be used as an effective basis for future rural planning and construction and functional zoning.

(2) Evacuation network planning

The location path of the civil air defense evacuation base emphasizes areas with smooth roads, convenient transportation and better concealment conditions. Through the collection of current data such as the grade and width of suburban roads, combined with ArcGIS shortest path analysis, evacuation road network planning was carried out, and 7 evacuation routes from scattered points to townships were sorted out to form a network-like smooth evacuation system. Clarify the skeleton of evacuation roads in urban and suburban areas, conduct road infrastructure investigation, maintenance, and repair by formulating detailed civil air defense evacuation traffic plans, and add new smart transportation system facilities, such as smart light poles and smart buses that can collect big data in real time. The data also lays the foundation for real-time changes in the actions of civil air defense teams and rescue teams during wartime, and coordinates urban and rural disaster relief and assistance issues. At the same time, good and smooth road traffic is not only to ensure the efficient operation of evacuation and rescue systems during wartime, but also to speed up the surrounding urban areas to enter the phase of consumption-oriented development in rural areas, thereby driving urban and rural "weekend economy", stimulating tourism consumption, and promoting the rural economy. Effective guidance can build the expansion resilience of urban-rural interaction.

(3) Evacuation Base Planning

Civil air defense evacuation bases should be selected in the direction of urban population evacuation, try to avoid important economic targets and the main direction of enemy air strikes, and have convenient transportation, easy to cover and camouflage, maneuver, protect, and survive. Therefore, the location of the civil air defense evacuation base should not only select the safest and most convenient area, but also recommend that the township resident community or qualified village (community), tourist attractions, and various parks should be used as the basic unit for planning and construction. The overall layout adopts the strategy of "careful intervention", fully respecting nature, protecting the original topography and the ecosystem. Adopting the layout principle of "one focus and multiple points" which is relatively scattered and guided by the center, as a municipal civil air defense evacuation area, a total of 9 civil air defense evacuation bases are planned in the study area, which can evacuate a population of 170,000. One of them is a regional tourist scenic spot, serving as a demonstration site for a provincial-level civil air defense evacuation base. According to the cultural heritage and tourism resources of each village, the civil air defense evacuation bases with different positioning and strong locality are planned.

(4) Combination of peace and war planning

The base innovation adopts the development mode of combining both peace and war (Figure 5), which should be planned in a unified manner and can be implemented in one or in phases. The functional areas of the provincial civil air defense evacuation demonstration sites are divided into peacetime and wartime functions, and combined with civil construction projects such as parks, scenic spots, industrial parks, farms, squares, stadiums, open-air parking lots, schools, etc. Table 2). This development model can gradually help improve rural roads, power grids, tap water construction and other infrastructure. At the same time, its usual function can be used as tourism development, attracting cultural and commercial settlements, and promoting the economic development of the village tourism industry. While meeting

the basic requirements of the evacuation base, it can improve the "hardware" capability of the village, enhance the intrinsic value of the village, and lay a solid foundation for "engineering resilience" in the rural resilience.

Table 2. Combination function of peace and war. Material Source: Provincial Civil Air Defense Evacuation Base Construction Standards

Number	Usual Function	Wartime Function				
		evacuation command area	temporary resettlement area	material reserve area	medical security area	transit area
1	tourist center	▲	△	△		
2	office building	▲	△	△	△	
3	hotels, guesthouses, homestays	△	▲	△	△	
4	residential, residential	△	▲			
5	School	△	▲	△	△	
6	township hospital				▲	
7	nursing home		△		▲	
8	storehouse		△	▲		
9	workshop		△	▲		
10	open-air car park		△			▲
11	square		▲	△	△	▲
12	open space		▲	△	△	▲
13	stadium	△	▲	△	▲	

Ps. "▲" Indicates functions that should be preferentially combined;

"△" Indicates functions that should be combined

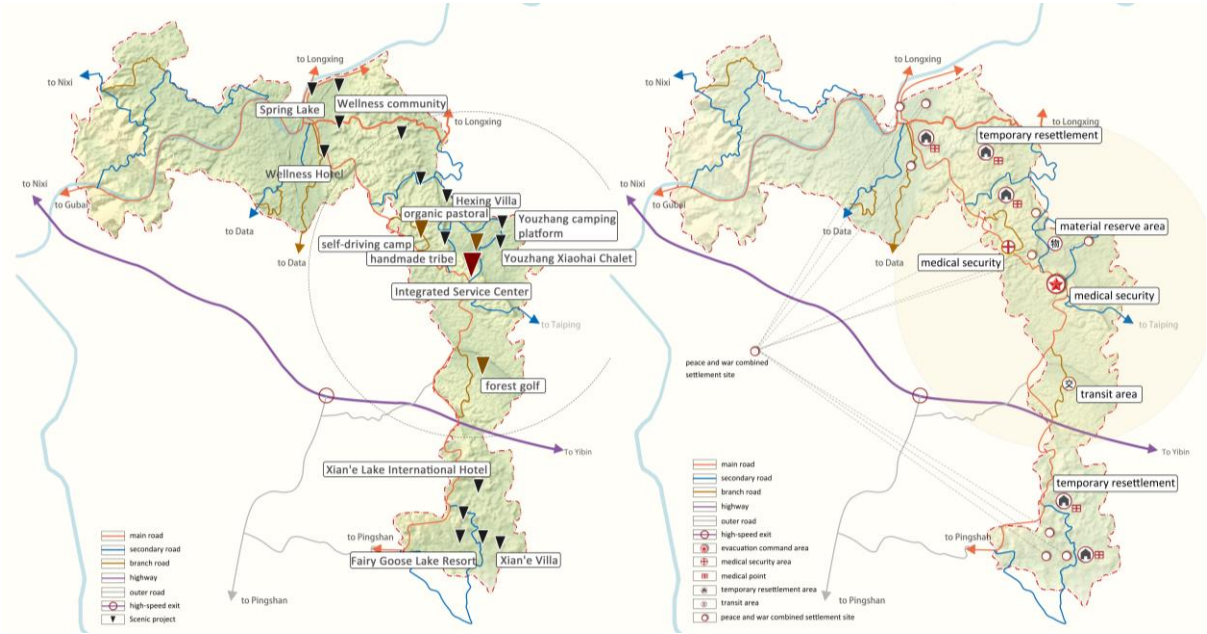


Figure 4. Analysis of peacetime and wartime combined planning (left: peacetime function analysis, right: wartime function analysis)

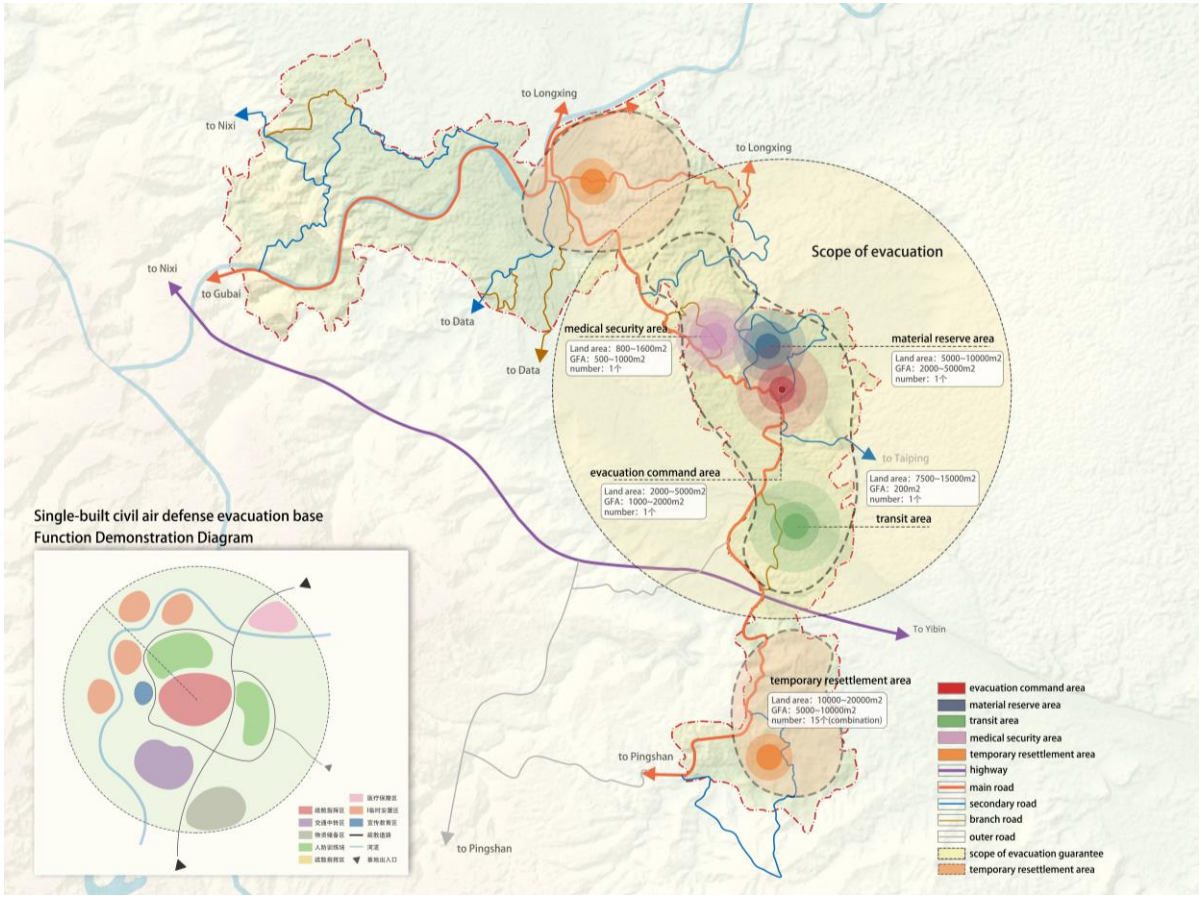
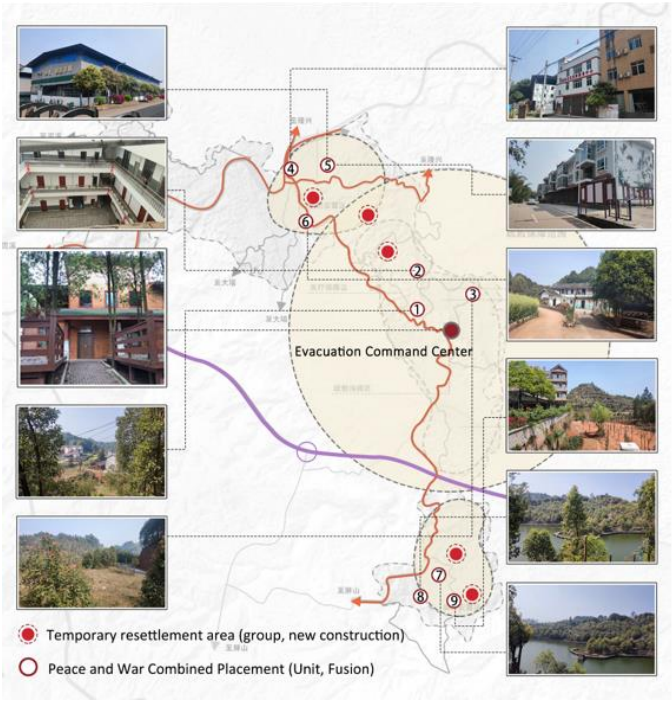


Figure 6. Functional zoning diagram of civil air defense evacuation demonstration base (Graphic by Author)

(5) Core evacuation demonstration site planning

In line with the planning principle of "small to large, regional linkage", a provincial demonstration evacuation base is planned in the Zhanghai area of the forest tourism world in the base research area. It includes key tourism items such as Yuexi River Bamboo Camphor Gallery, World Zhanghai and Long Beach Zhanglin. The World Zhanghai Scenic Area involves 5 village committees of Fufeng Village, Anjing Village, Changning Village, Hefeng Village and Shiba Village in Zhanghai Town, with a total area of 26.36 square kilometers. According to the integrated layout principle of "relative independence and close connection", the planning divides the functions of the core evacuation demonstration points into five areas: evacuation command area, material storage area, traffic transfer area, medical security area, and temporary resettlement area. The function demonstration map of the air defense evacuation base (Figure 6), and according to the evacuation population and the evacuation base level, the indicators are allocated to each functional zone and the construction requirements are put forward. Among them, the temporary resettlement area is mainly responsible for the evacuation of a large number of people during wartime. Through on-the-spot investigation and statistics, 14 temporary resettlement areas combined with peace and war have been identified (Figure 7). 9 outside the inner core functional area, the layout form adopts the group-unit type.

Table 3. Construction index table. (Author self-made)



	Usual project name	Land area (m2)
1	handmade tribe	5589
2	Hexing Villa	15000
3	Youzhang camping platform	1333
4	Spring Lake	5783
5	Wellness community	27362
6	Wellness Hotel	5264
7	Fairy Goose Lake Resort	4415
8	Fairy Goose Lake Resort	14013
9	Xian'e Villa	3486

Figure 7. Project analysis chart of temporary tesettlement area. (Graphic by Author)

3.2. Active adaptation: evolutionary resilience - release and restructuring phases

In rural resilience, engineering resilience mainly enhances the “specific resilience” ability of rural villages to deal with known risks in the future, such as flood disasters, transportation systems, infrastructure construction and other issues. Walker and Salt pointed out that, in addition to this, it is also necessary to maintain the “general resilience” of the rural resilience system to deal with unknown threats and challenges (WALKER 2006), in order to maintain the redundancy of the resilience system. Young et al. found through research that the use of digital network facilities can achieve rural resilience development, and explained that strong government leadership and the active participation of farmers can comprehensively strengthen the ability of rural areas to cope with disturbances (Young 2019).

While gradually building system engineering resilience, the civil air defense evacuation regional planning proposes four aspects of "governance resilience, facility resilience, resource resilience, and villagers resilience" for the study area, and jointly build evolution resilience to achieve an adaptive cycle. The release (Ω) of the reorganization (α) phase to enhance the active adaptive capacity of the rural system. It is worth noting that the whole phase of "active adaptation" and "passive improvement" should be a process that complements each other, progresses step by step, and runs through each other.

(1) Governance resilience: top-level design and market injection

The transformation and development of villages is inseparable from the government’s governance and capital injection. The district-level government of the study area has held discussions with town cadres, village representatives, and social capital for many times. The conflicts and contradictions between the two parties jointly decided to build the research area into a "civil air defense highland and a new tourism destination". All parties concerned about the construction of civil air defense infrastructure, while improving the "hardware and software" capabilities of the countryside, and bringing the rural areas to the forefront. Agree on this approach to the tourism economy. It should be pointed out that the air defense evacuation plan is a bridge for the government and residents to build mutual trust, and the core

purpose of improving rural resilience is to ensure the living conditions of residents and the background of the countryside, and at the same time to tap and enhance the value of the countryside. Therefore, although government governance and market injection are important guarantees, the rural subjects must also be considered throughout the process.

In the process of implementing and guaranteeing the civil air defense planning in the study area, a whole-process command system and guarantee system have been established, and the responsibility is assigned to the person to the post. This process is inseparable from the whole-process management and policy formulation of the government. Therefore, the governance of resilience requires not only the intervention of the government, but also an in-depth understanding of the impact of the construction process on the future of the countryside, so as to make effective decisions.

(2) Facility resilience: smart facilities and global linkage

With the development of big data, the smart construction of infrastructure can better stabilize the robustness of rural resilience. Starting from the four aspects of smart transportation, smart facilities, smart scenic spots and smart governance, the research area has established a new smart civil air defense construction team headed by the leaders of the district government to jointly build a new concept of civil air defense construction. At the same time, the disclosure and sharing of big data will be realized, and the project will be coordinated with the project in the city's "5-year plan for the construction of new smart cities" to realize the linkage between urban and rural areas, and effectively improve the real-time and efficiency of civil air defense evacuation during wartime. It is worth noting that rural resilience is complex and dynamic, and this process requires cross-regional collaboration, incremental cultivation and maintenance to achieve infrastructure robustness.

(3) Resource resilience: civil defense bases with local characteristics

Beel et al. discussed the role of cultural industries in the development of rural resilience, and put forward the view that "a resilient village needs the support of diversified industries" (Bell, Wallance 2017). Natural resources and cultural resources are the inherent potential and necessary value for the resilience of rural evolution. We excavates the natural background and human history of the study area and classifies them into: root carving culture, bamboo weaving culture, rice fragrant culture and fruit and vegetable processing bases, bamboo and wood Handmade base. On-site construction of villages where potential civil air defense bases are located, combined with local advantageous industries to create civil air defense bases with rural characteristics, avoid formalized and streamlined rural construction. In order to make development and protection coexist, ecological function zoning should be carried out in the construction adaptability evaluation in the pre-analysis phase, and resources should be mined while protecting rural ecological diversity to the greatest extent, which is the basis for the resilient development of rural evolution.

(4) Resilience of villagers: residents actively learn and innovate

Residents' cognitive learning and innovative use of their own environment are the internal driving force for building resilience in rural evolution. The village is a collective society, and the cohesion among the villagers is strong, but the ability to learn new knowledge and new ideas is weak. The civil air defense planning will characterize the evacuation bases in the study area, and invite capable and skilled rural elites to settle in them to drive and transform the livelihood of the villagers. The core evacuation base is planned as an adult defense park, which has comprehensive functions of recreation, pension, learning, and education. What is important is that to improve the self-organization ability of villagers, it is necessary to provide villagers with efficient, dynamic and shared living space and a platform for self-construction, in order to stimulate the endogenous power of individuals and drive regional development.

Figure 8. a. The usual function is the evacuation command area of the mission area. b. Villagers' self-government activity space near the community. c. Renovated Civil Air Defense Park. d. Renovated civil air defense park. (Photography by Author)

The construction of "evolutionary resilience" relies on the "engineering resilience" of civil air defense evacuation regional planning to systematically improve the resilience of villagers with active adaptability, resource resilience, facility resilience, and governance resilience that plays a role in decision-making. In this process, the ability to actively adapt (self-organize) is the inherent logic of evolution resilience, and its role is to promote the mutually beneficial cooperation of individuals within the organization, thereby constructing an adaptive rural social network. Improving the fairness and stability of rural society in this way is a key factor in improving rural resilience. At the same time, empirical evidence from Taomi Village in Taiwan, Hongcun Village in Anhui Province, and Dashan Village in Nanjing tells us that the gradual accumulation of resilience throughout the entire resilience adaptive cycle is the basis for maintaining good development (Tang 2018).

4. Conclusion and discussion

Civil air defense engineering is an important defense measure under the new situation facing the world, and its combination with rural areas can also drive and enhance the coordinated development of urban and rural areas. Civil air defense evacuation planning can be used as an effective means to improve rural resilience at present, and the logic of rural resilience improvement is traceable. Starting from resilience theory and adaptive cycle theory, the resilience foundation of rural engineering is constructed from the perspective of civil air defense, and at the same time, rural areas are improved in phases. "Evolutionary resilience" constitutes the connotation of rural resilience improvement with the common functions of "passive improvement" and "active adaptation". At present, China's rural areas are in a phase of rapid development and complex changes, and the improvement of rural resilience is also multi-faceted and multi-phase. How to realize rural revitalization in an all-round way and keep rural resilience in a stable development phase, the civil air defense evacuation planning in the new era is only one of the effective ways, and the improvement of rural resilience requires multi-system, multi-time, multi-angle exploration and practice.We proposes a method for improving rural resilience under the planning from the perspective of civil air defense, aiming to provide an effective exploration approach for rural revitalization in the new era.

Ackonwledgments

This work was designed by team members LI, R.C., Yu, Y.M., Chongqing University. Map data copyrighted OpenStreetMap contributors and available from https://www.openstreetmap.org.

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