

# Future Development of Natural Villages in Rural China Based on the Analysis of Dissipative Structure Theory

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**Abstract:** Recently, urbanization, economic development, and industrial structural adjustment have been diminishing the permanent resident population in rural areas of China on a yearly basis; the rural population is aging, and natural villages are gradually declining and, in some cases, even dying out. Considering the overall situation of natural villages in rural China, we selected a typical village in Shandong province as the object for field research. This study analyzes the actual situation of rural houses and the population distribution in rural areas, and summarizes the specific characteristics that indicate the decline of natural villages. It also analyzes the underlying reasons for the decline using dissipative structure theory, and proposes that a new dissipative structure be established by opening and activating conventional villages, protecting featured villages, and integrating villages that have declined. Furthermore, the internal management of the updated villages should be improved to enhance the new system's cohesion and self-organizing ability.

**Keywords:** natural village; rural hollowing; dissipative structure theory; rural development

## 1 Introduction

Urbanization in China has risen continuously with the rapid advancement of industrialization and economic development. Proportionally, the urban population (51.27%) surpassed the rural population for the first time in 2011. Concurrently, the number of natural villages in the country has declined significantly, decreasing from 4.2 million to 2.8 million between 1990 and 2013, due to the combined effects of environmental changes, village mergers, population migration, land development, and other factors. At least 1.4 million natural villages have disappeared over those 23 years, representing a one-third decrease [1]. This is no longer a simple case of the reorganization of natural villages or their disappearance in the physical form; rather, it signifies a profound social change in the process of rural development and transformation. Village layout, residential style, living habits, social structure, local culture, organizational management, and employment security are all involved.

During this process, certain phenomena in the rural areas have stirred up great controversies in various sectors of society. Taking Shandong Province as an example, the provincial government invested more than 10 billion CNY in the period 2006–2010 to reform nearly 3000 villages, resettle more than 62 000 households, and rehabilitate more than 74 000 *mu* of land for agricultural use; the government also contributed almost 60 000 *mu* of

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land to the construction quota [2]. As a result, the village merger phenomenon has spread quickly across the province. Due to the aggressive promotion and diversified implementation models, it has also substantially impacted other regions in the country. Some scholars believe that village mergers comply with the laws of socioeconomic development and are therefore a rational choice for farmers and grassroots governments [3], as they represent the general trend for the future development of rural areas. Other scholars argue that this measure forces farmers “to move upstairs” (from single-story farmhouses to multi-story apartments), resulting in many suffering from the “three withouts” (without land, work, and social security). This is a major issue that directly affects social stability [4]: Its fundamental nature is a movement that eradicates villages and should be halted [5].

The *National New Urbanization Plan (2014–2020)* [6], which was issued by the State Council in March 2014, proposed new urbanization as the novel national development strategy. It received extensive attention, and the promotion of new urbanization was treated as a major item related to China’s comprehensive modernization drive and the overall establishment of a well-off society. It was expected to promote coordinated rural–urban development and social transformation, and significantly enhance various social needs and development motivations.

Based on the experiences of developed Western countries, China’s urbanization rate is predicted to reach 65% or even above 70% by 2030, meaning that only 400 to 500 million people will still be living in rural areas by then. This will exacerbate the mismatch between local environmental resources (such as land and other resources in the natural environment, and buildings and other resources in the human environment) and population and labor resources, thereby accelerating the development of and changes to natural villages in the rural areas. In this paper, dissipative structure theory (DST) is the starting point, and dialectical thinking is used to observe and contemplate the current situation and the future of villages in China, before conducting further research and analysis. Finally, suggestions for the future development of natural villages as a form are proposed. These may serve as references for the formulation of guiding and supporting policies that are in line with the actual rural situation.

## 2 Thoughts triggered by the hollowing of natural villages

Data released by the National Bureau of Statistics indicate that the urbanization rate of China’s residential population reached 60.6% as of the end of 2019 [7]. The massive influx of rural population into the cities has worsened the rural hollowing rate. To gain a more intuitive understanding, the author selected a typical natural village in Shandong Province and conducted a detailed house-to-house survey in October 2019. The village was first established during the Yongle era of the Ming Dynasty (1405), when a farm household relocated from Anhui, settled in the village, and the family grew. During the Kangxi era of the Qing Dynasty, a small number of farmers with different surnames moved in from nearby villages, and the village’s size grew continuously. Based on detailed information provided by the village committee and field survey data, there are currently 365 medium-sized (by local standards) rural households and a population of 936. There are 483 rural houses in total, with the per capita homestead and living areas being 54.5 m<sup>2</sup> and 20 m<sup>2</sup>, respectively. The layout and distribution of the rural houses and their year of construction are shown in Figs. 1 and 2.

Fig. 1 shows that approximately 24.2% of the houses in the village are perpetually unoccupied. Many rural households’ neighboring units are vacant. As shown in Fig. 2, nearly a quarter of the rural houses in the village were built before 1949, and approximately 40% were built in the 30 years between 1949 and 1978. However, the proportion of houses built after 2000 is very low because the local government imposed strict control over the approval of new rural housing.

Information on all the village residents was collated and summarized, and their age distribution and that of the household heads are shown in Fig. 3(a) and 3(b), respectively.

In terms of the overall age distribution, the proportions of the population that are under 50 and 40 years old were 47.8% and 35.8%, respectively, which did not seem very low. However, only 14.7% of the household heads were under 50 years old, and only 3.5% were young that is under the age of 40, revealing severe periodization and hollowing. More worryingly, 3.5% of young household heads may relocate their family to a city one day, or their children will leave the village in the future to pursue further studies or start their own family, leading to further declines in the proportion of young families. In the long term, the village will not be able to develop and ensure continuity.

The realistic conclusion that was drawn from the data analysis is that the natural village, which has lasted over 600 years and still contains more than 100 century-old houses, is facing severe periodization and hollowing. In the

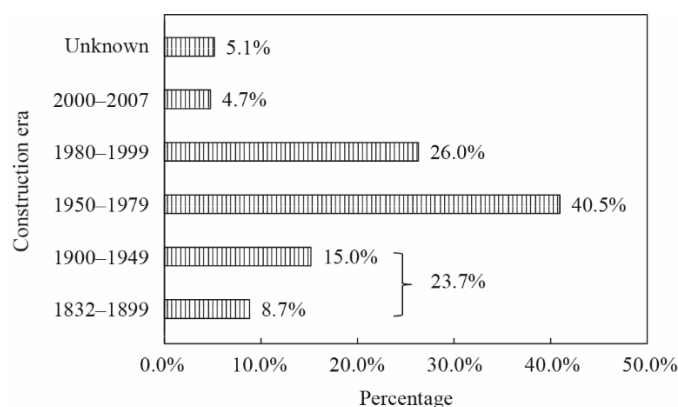
next two to three decades, there is a possibility that it will be completely abandoned. Although this conclusion applies to one particular village, it has representative significance for the general situation. Conducting further analysis and employing deduction based on this finding can lead to other conclusions that are more widely applicable.



**Fig. 1.** Layout of rural houses in the surveyed village.

*Note:* Units with a circle inside represent vacant and unoccupied houses.

*Source:* Drawn to scale based on photographs of the layout plan of rural houses in the village.



**Fig. 2.** Distribution of the village's existing rural houses by construction era.

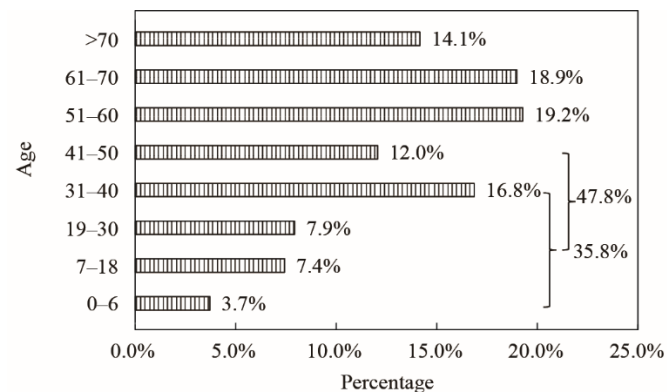
### 2.1 Declining residential population and increasing housing vacancy rates in natural villages

The phenomenon of residents in rural areas neither wanting nor daring to have offspring has become common due to various factors, including the earlier national family planning policies and the increasing cost of raising children there. Rural populations decrease yearly because existing residents continue to leave without any new people coming in as replacements. This lack of new growth is compounded by factors such as illness and accidents. Using the 2018 national average life expectancy of 74.8 years, the proportion of the population still living in villages will not exceed 20% in 20 years' time, that is, by 2040. The vacancy rate of rural houses will exceed 50% by then, leaving rural areas with aged, hollowed-out villages.

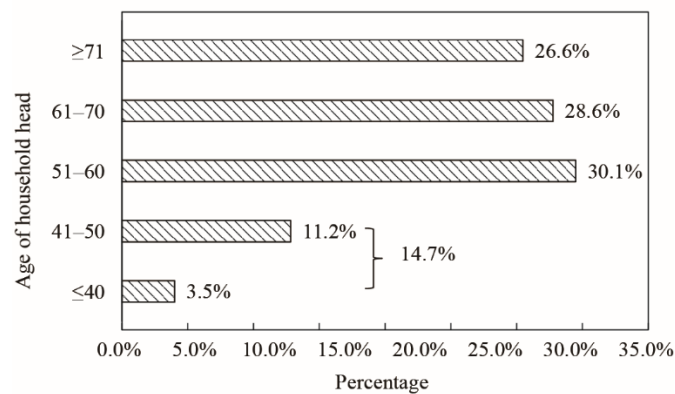
### 2.2 Poor rural infrastructure and difficulties in enhancing appearance

At present, most village collectives in the rural areas have essentially no source of economic income and are predominantly dependent on financial funding from the national and local governments for improvements to basic

infrastructure such as tap water, roads, sewage facilities, the village committee building, and clinics. Construction of rural infrastructure is lagging due to the accrual of historical debts, as well as a lack of planning, adequate financial support, and strict and effective supervision and management. Consequently, village appearance has deteriorated and is relatively poor. Most existing rural area residents are either middle-aged or elderly. Their routine activities are primarily watching over the houses and growing crops, and they are not demanding when it concerns their housing quality. They hold the view that as long as their houses are habitable, it is not necessary to spend money on renovations. As a result, they lack the enthusiasm—and more importantly, the physical ability—to personally participate in measures to remediate the village's living environment. These factors have contributed to the daunting difficulties faced when attempting to enhance village appearance.



(a) Villagers' age distribution



(b) Household heads' age distribution

**Fig. 3.** Age distribution of all villagers and household heads.

### 2.3 Loss of cultural emotions and the drifting apart of kinships and neighborly relations

The rural areas are presently experiencing various cultural and emotional losses, including the loss of local, clan, and neighborhood cultures. Farming income and profit margins have declined with increasing agricultural production costs. Those who still cultivate land in the villages are mostly older and physically weak. Their ability to work has weakened yearly with aging, causing them to gradually lose their enthusiasm for farming. One after another, they have transferred their land to big business operators. The younger residents in the villages often have a strong desire to escape as soon as possible because all aspects of village life lack vitality, given how hard it is to earn good money, coupled with the disillusioning atmosphere that living beside vacant houses evokes. Once they leave, exchanges with once-familiar relatives, friends, and neighbors become less frequent over time, and the spatial distance accelerates the psychological distancing between parties. Young people who have been away for long periods lose their emotional attachment to the land and no longer find it valuable. With continuous exposure to urban culture, they also become disinterested in the traditional customs and culture of the rural areas, and they forget about the good memories they made there.

Next, the underlying reasons behind these phenomena will be further interpreted from the perspective of DST.

### 3 Interpreting the evolution of natural villages based on DST

#### 3.1 DST

Belgian physicist Prigogine [8] proposed DST in the 1970s. According to this theory, when changes in external conditions reach a particular threshold ( $\lambda$ ), quantitative changes in an open system that is far from equilibrium may cause qualitative changes. After a continuous exchange of matter, energy, and information with the outside world, the system may transform from its original state of disorder to a new state characterized by temporal, spatial, or functional order. The state that is far from being a balanced, stable, and ordered structure is known as a dissipative structure. The entropy balance is shown in Fig. 4, and its equation in an open system, based on the non-equilibrium thermodynamic equation, is as follows:

$$dS = dS_e + dS_i \quad (1)$$

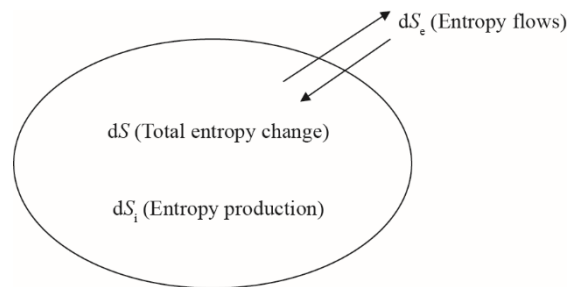


Fig. 4. Schematic diagram of entropy balance.

In Eq. 1,  $dS$  is the system's total entropy change;  $dS_e$  is the entropy flow, which refers to the changes in entropy entering and exiting the open system, and can be either positive or negative; and  $dS_i$  is entropy production, which is the entropy produced within the system, and according to the second law of thermodynamics, can only be greater than or equal to 0. When the negative entropy flow entering the system is greater than entropy production, the system's total entropy will be less than 0. According to Boltzmann's order-disorder principle, the system's orderliness will increase, whereas its disorderliness will decrease, making the overall system more orderly.

According to Prigogine, the basic conditions for the formation of a dissipative structure are open systems that are far from equilibrium and have non-linear effects and fluctuations. DST can answer the question of how open systems transform from a state of disorder to order; additionally, it can explain the phenomenon of biological evolution and degradation. It is significant in terms of providing general guidance for the study of physical, chemical, biological, social, life, and thought systems.

#### 3.2 Interpreting the evolution of natural villages based on DST

The consistency between DST and the development and evolution of natural villages manifests in two aspects: (1) both involve problems with systems (a natural village is a system that continuously exchanges material, energy, and information with the outside world) and (2) both examine the ordered structure formation process. Historically, the emergence of every new, orderly village system can be treated as the spontaneous formation of a new dissipative structure. Therefore, DST provides important revelations when examining directional questions related to the formation, development, evolution, and demise of the natural village system.

##### 3.2.1 Openness

Humans' natural needs drive the formation of settlements and villages. In the early stages of living and production, people gradually discovered that when they live together, they can use their collective power for mutual assistance and cooperation. This has facilitated the achievement of various goals such as resource acquisition, defense, and reproduction. Throughout the history of rural development in China, over several millennia, the origins of initial village formation can be traced to multiple households congregating, sovereigns dividing and conferring land and property to feudal lords, garrisons being stationed to guard the frontiers, and people fleeing from famine or being displaced for other reasons.

Subsequently, the scale of the villages gradually expanded through various methods including villagers' sustained reproduction, marriages, the in-migration of villagers with other surnames, and merging with other villages, as illustrated in the aforementioned case study. Regardless of whether it occurred during the initial establishment of the village or in the subsequent development stage, maintaining the system's openness established the foundation for a dissipative structure and long-term orderly development. This openness is reflected in the geographic space, the form of housing, population size, material and information, and many other aspects.

### 3.2.2 Equilibrium

Equilibrium refers to the state in which the driving force of the system's internal movements is infinitely small. When approaching or reaching such a state, the system's developmental power is exhausted and lost. It presents as a static state that is extremely lacking in vigor and vitality, and it manifests concretely in the village system as a closed system that is gradually stagnating and in a steady state. This is similar to the *Peach Blossom Spring* about which Tao Yuanming wrote. The people's thoughts and the social conditions there are still in a state of complete isolation and oblivion with regard to changes in the outside world. With increasing generations and the differentiation of families in the villages, the prestige of elders from the same clan and the cohesion among various generations have both gradually declined. Traditional methods of food production suffer from inefficiency and high costs, placing the smallholder economies in a weak position when facing market competition and stunting their chances of healthy growth. Coupled with China's long-standing system of a dual rural-urban structure, the basic elements (land, labor, capital, and surplus grain) upon which rural areas rely for development have been continuously siphoned away by cities. Such extensive, long-term siphoning, coupled with insufficient inputs, inevitably led to difficulties with agricultural development, underscored the contradictions of grassroots governance in rural societies, and exacerbated those societies' disorderliness (increased entropy). Under the combined effects of various internal and external factors, village societies have experienced various phenomena including the lack of a contract of equality, a decline in trust among acquaintances, and the dissipation of villagers' sense of belonging. This led to a decline in collective organization and action, such that the village system approached equilibrium and spontaneously tended toward disorderliness and chaos, eventually becoming completely decrepit.

### 3.2.3 Non-linear effects within the system

After the form of the village settlement had been established, the original simple linear relationship that existed internally gradually transformed into a new hierarchical network. The village's functions also became more comprehensive and multi-dimensional, with the various interactions exhibiting diversity and non-linear effects. Such effects of non-linear interactions point to synergy and coherence between the system's factors, which are the external driving forces that promote the orderly development of village organizations. From a macroscopic perspective, the orderly development of the village system is the result of the coordination and unification of its various subsystems. These subsystems span multiple levels, such as personnel, society, family, economy, politics, environment, and humanities. These levels are not isolated from each other. Instead, there are non-linear interactions that involve mutual influence, constraint, stimulation, and dependence. Each subsystem plays an important role in the village's orderly development. If the various subsystems fail to identify their own positioning accurately, or if they are displaced from their position, orderly development may be adversely affected.

### 3.2.4 Fluctuations in the village system

In the natural sciences, fluctuations refer to small, random volatilities in the parameters of the system's macroscopic state. Such fluctuations hover around their average values. When the system is in or near equilibrium, fluctuations represent negative interference with the organizational structure's stability. In the evolutionary process of natural villages, minor fluctuations do not undergo sudden changes. When fluctuations continue to strengthen and accumulate, eventually crossing a certain threshold, the village system may become structurally unstable, triggering the original system's progressive collapse. In the natural village system, fluctuations and their triggers are due to either internal or external factors. Internal factors include population growth or decline, increased or decreased productivity, and the strengthening or weakening of organizational and management abilities. External factors include climate change, natural disasters, military warfare, economic growth or recession, forced relocation, and supporting policies. All these will promote the disappearance or reorganization of the village's existing morphological pattern.



## 4 Suggestions for the future development of natural villages based on DST

The current situation of rural villages in China dictates that a new pathway is needed to realize their future development. A rural revitalization implementation strategy was proposed during the 19th National Congress of the Communist Party of China, followed by the State Council's issuance of the *Strategic Plan for Rural Revitalization (2018–2022)* (hereinafter referred to as the “SPRR”) in September 2018 [9]. The SPRR proposed categorizing villages into four types for differentiated development: clustered for improvement, integrated with suburban areas, protected due to inherent characteristics, and relocated for merging with others. Premised upon these classifications, China's natural villages were further classified into three types in this study: regular villages, characteristic villages, and declining villages. Suggestions for the development of each type were then put forward based on DST.

### 4.1 Regular villages: Maintain openness to prevent them from reaching equilibrium

As pointed out in the SPRR, most existing villages are existing large-scale central villages and other regular villages that will continue to exist. These comprise the focus of rural revitalization. Based on DST, openness is the primary condition for village development. Therefore, it is necessary to attract various resources by opening up the villages' spaces, personnel flow, information, material, and energy. Villages that are antiquated with deteriorated material environments are often in a state approaching equilibrium. This means that they are gradually disappearing. Only when the village system is reformed into an orderly structure that is far from equilibrium can it radiate new vitality.

For the system to be in a state of non-equilibrium, its various components must not be balanced or consistent. The greater the differences between the various subsystems, the farther away the system is from equilibrium. However, a system cannot be completely open to the outside world. Otherwise, it becomes a component of another system or of the general environment, and loses its relative independence [10]. Therefore, the villages' inherent comparative advantages should be tapped as the basis to scientifically determine their respective developmental direction. In addition, industries should be activated and the environment optimized to boost their development potential, while protecting and preserving the rural characteristics and culture.

### 4.2 Characteristic villages: Conduct in-depth explorations of their protection and development potential, and promote the evolution from disorderliness to orderliness

A large number of villages with rich natural, historical, and cultural characteristics and resources still exist in various regions in China. These include famous historical and cultural villages, natural villages, ethnic minority villages, and renowned scenic and tourist villages. After long periods of honing and interaction with the surrounding environment, these villages have accumulated substantial memories and renewal abilities that allow them to better adapt to the changing environment and serve as important carriers for highlighting and transmitting traditional Chinese culture. Therefore, it is necessary to conduct in-depth explorations of their characteristic resources—including the ecological environment, history and culture, spatial layout, architectural style, and unique landscape—to determine their future developmental value and direction, and promote their orderly renewal. Their characteristic resources should serve as one of the sustaining forces for the village system's stable long-term existence. In recent years, characteristic villages in some parts of the country have relied on tourism and characteristic industries for development. Doing so has endowed them with renewed vigor and vitality in the new era, against the larger background of rural revitalization and village beautification [11–14].

### 4.3 Declining villages: Control external fluctuations affecting their orderliness, and promote steady and cautious village mergers

At present, many natural villages in China have been or are on the path to decline due to poor living conditions, fragile ecological environments, frequent natural disasters, and population migration and outflow. These villages have not been able to spontaneously form a new orderly structure from within. This has led to an issue that governments at all levels must confront, alongside the villagers themselves: can these villages remain in their abandoned state, or should they be either demolished or rationally renewed? In this situation, it is often necessary to rely on external forces and other organizational methods, and tap DST's ideas of the rise and fall of systems to determine the best course of action. Specifically, such natural villages can develop in the dual directions of rise and

fall. By promoting the former and minimizing the latter, they can achieve a new order or revert to the original order. The strategies the state has proposed in recent years—new urbanization, rural revitalization, and the development of an ecological civilization—can all be regarded as opportunities for other organizations to reverse the decrepit village system and transform it into a new, stable, and orderly state. The organizational structure will then become more orderly. This process inevitably involves village mergers. To avoid excessive social contradictions, the rise and fall of the external order must be properly controlled. This approach should be promoted cautiously and steadily, and implemented with full respect for the farmers' wishes.

#### **4.4 Renewed villages: Strengthen their internal management, and enhance the new system's cohesion and ability to self-organize**

The abovementioned proposals for the future development of the three types of village can be summarized as follows: opening and activating regular villages, strengthening protection for characteristic villages, and organically integrating declining villages. Regardless of whether natural villages are renewed as new villages or communities, this is equivalent to the formation of a new dissipative structure. However, if that structure is not maintained in a timely and effective manner, it will eventually enter a state of equilibrium or disorder.

Under the influence of external conditions, natural systems' internal elements or subsystems attain a certain tacit understanding through inherent coherence and synergy. The process of spontaneously producing specific structures or functions is known as self-organization [15]. After the village system has been renewed, the internal management system and the capacity for self-organization must be strengthened. Firm, orderly villager management can reduce internal contradictions, effectively minimizing increases in negative entropy within the system and ultimately realizing the goal of enhancing the cohesive force's ability to attract.

In sum, the core approach to continuously promote the coordinated, orderly development of villages entails strengthening the rural areas and their environment. This involves openness between the rural and urban areas, and between the rural areas and the natural environment, as well as increasing the input and output of the flows of consciousness, information, and materials [16].

##### 4.4.1 Flow of consciousness (improve farmers' ideological awareness)

The fastest and most direct exchange of flows between the environment and the system is related to consciousness. This exchange can be carried out in various ways such as through text, language, and images. The advent of modern tools such as computers, communication tools, and the Internet has allowed these exchanges to occur at very large volumes and rapid speeds, and even generate immediate effects. The exchange of consciousness plays a very important role in humankind's historical movement. Resultantly, many countries' modern societies have advantageously elevated the input and output of the flow of consciousness to a crucial position.

##### 4.4.2 Flow of information (strengthen rural information exchange, such as via the Internet)

Information contains social elements that encompass almost all aspects of society, such as politics, the economy, culture, science and technology, and daily life. An enormous amount of information is exchanged in modern societies: for a large city, the information flow per second reaches the order of several hundred G ( $1\text{G} = 10^9$ ). The total amount can almost be a proxy for measuring a society's openness, and information usage is an important indicator of the degree of social civilization.

##### 4.4.3 Flow of materials (exchange of economic factors)

This is the social exchange of physical objects between the system and the environment, especially exchanges related to economic activities. The main elements include funds, equipment, labor, products, and resources, but physical objects constitute the foundation. Rural population retention is especially critical: revitalization strategies are useless if the villages are devoid of people. However, ancient methods of retaining people (such as slash-and-burn farming) are no longer applicable. Instead, new ideas, concepts, technologies, capital, and other elements should be injected to achieve mechanization, informatization, and electrification. These will greatly improve the value of rural areas, allowing them to enter a brand new stage of development. During this historical process, it is vital to maximize the use of the rural ecological environment, especially land resources, to increase the production of organic food, fruits, vegetables, and meat. This will upgrade the entire country's consumption and help the rural



areas generate more economic benefits. Only then can the rural population truly be retained, which will, in turn, thoroughly modify the rural areas' characteristics.

## 5 Conclusion

With the advancement of urbanization in China, economic development and industrial structural adjustments have caused the rural areas' residential population to decrease year by year. Given the aging population, an increasing number of natural villages are gradually declining or even disappearing. Developing these villages rationally in the future is an issue that all sectors of society must seriously address. In this paper, DST was used to analyze the deep-seated reasons behind the decline of natural villages. This led to the following proposal: to construct a dissipative structure from three aspects, namely opening and activating regular villages, strengthening protection for characteristic villages, and organically integrating declining villages. Suggestions for development were put forward to enhance the new system's cohesion and its self-organization ability. These include strengthening the input and output of the flows of consciousness, information, and materials between the rural areas and the environment, and strengthening the internal management of the renewed villages. These can serve as a reference for the formulation of guiding and supporting policies that are in line with the actual rural situation.

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