

On integrated urban and rural development

FANG Chuanglin^{1,2}

1. Institute of Geographic Sciences and Natural Resources Research, CAS, Beijing 100101, China;

2. Xinjiang University, Urumqi 830046, China

Abstract: Cities and the countryside have long been an inseparable organic whole. China's new model of high-quality urbanization requires integrated urban and rural development and rural vitalization. Problems inherent to urban areas are caused by problems inherent to rural areas, and vice versa. Such problems are closely linked, and the compound each other to create “urban-rural problems.” As such, rural vitalization is necessary to prevent problems associated with growing cities, and the new model of urbanization is required to prevent problems in rural areas. Based on a review of domestic and foreign research on integrated urban and rural development, this study analyzes the root causes of persistent urban and rural problems and their counterposing patterns on a theoretical level; analyzes the main factors and driving mechanisms as well as the underlying pattern and sustainability of integrated urban and rural development; constructs a measurement test for integrated urban and rural development; and proposes a triangular model of integrated urban and rural development. It confirms that China's integrated urban and rural development is in the late period of urbanization, which features a high degree of integration and more urban areas and fewer rural areas. Subsequently, it will enter the final period of urbanization and a stage of deep integration, with more urban and fewer rural areas. In the future, it will be necessary to implement a strategy of deeply integrated urban and rural development and use new urbanization and rural vitalization to solve urban-rural problems and improve the quality of urban and rural development. New theories and methods of integrated urban and rural development will need to be created and an evaluation system to judge quantitatively the depth of integrated urban and rural development will need to be established, in order to create desirable urban and rural areas. Future efforts should aim to develop greater synchronization, deeper integration, and mutual success between the new model of urbanization and rural vitalization, so as to improve the high-quality development of, and modernize, both urban and rural areas.

Keywords: integrated urban and rural development; driving mechanism; law of evolution; theoretical analysis

1 Introduction

As integral parts of urban and rural systems, cities and the countryside have always formed a contradictory organic unity and an inseparable integrated whole. The integrated development

Received: 2022-04-30 **Accepted:** 2022-05-25

Foundation: Innovation Research Group Project of National Natural Science Foundation of China, No.42121001; Major Program of National Natural Science Foundation of China, No.41590840

Author: Fang Chuanglin (1966–), PhD and Professor, specialized in urban geography, urban agglomeration development and the resource and environmental effects of urbanization. E-mail: fangcl@igsnrr.ac.cn

This paper is initially published in *Acta Geographica Sinica* (Chinese edition), 2022, 77(4): 759–776.

of urban and rural areas has long been an important goal of China's efforts to promote the overall development of urban and rural areas and realize their common prosperity. Since 1949, China's urban and rural development policy has evolved from dual development, harmonious development, and coordinated development, to unified development, and finally to integrated development. These policies have played an important guiding role in promoting China's new model of urbanization and rural vitalization as well as achieving deeply integrated urban and rural development (Fang, 2019). Tremendous achievements have been made in the integration of urban and rural populations, industry, infrastructure and public service facilities, pensions, and ecological and environmental protection. The systems and mechanisms of urban-rural integration have gradually improved, and a number of national urban-rural integration pilot areas have been established.

China's integrated urban and rural development also faces problems, however, such as persistent disparity, blockages in flows of factors of production, unequal public services, insufficient integrated development, and separate development strategies and policies between urban and rural areas (Liu *et al.*, 2016; Tan *et al.*, 2017). These problems have led to a decline in rural development, which in turn has posed a challenge to China's sustainable development (He, 2018). Urban-rural integration is the key to solving these issues, and it is a fundamental means of dissolving the old dual urban-rural structure, building a new urban-rural relationship, and building China's new model of urbanization (Zhang *et al.*, 2019).

The Report of the 19th National Congress of the Communist Party of China (CPC) proposed to establish and improve the institutional mechanisms and policy system of integrated urban and rural development. On April 15, 2019, the CPC Central Committee and the State Council issued the Guidelines on Establishing Sound Systems, Mechanisms, and Policies for Integrated Urban-Rural Development, which made further plans and arrangements for the integrated development of China's urban and rural areas. The Fifth Plenary Session of the 19th CPC Central Committee pointed out that to promote the equal exchange and two-way flow of urban and rural factors of production, enhance the vitality of agricultural and rural development, and solve the imbalance in urban and rural development, it is necessary to improve the mechanisms of integrated urban and rural development. Determining how to grasp scientifically and rationally the connotations and explore the evolutionary principles of urban and rural integration, as well as how to discover a way to achieve urban and rural integration that is tailored to local conditions, are vital to be able to leverage comprehensive geographical advantages and serve China's strategic needs.

Urban-rural integration can be traced back to the concept of urban-rural development in the theory of utopian socialism, which reflects the evolution of urban-rural relations (Rondinelli, 1983). The relationship between urban and rural areas is the most basic relationship in social development. Marx divided the urban-rural relationship into three stages: confrontation, separation, and integration (CCTB, 1995). He stated that urban-rural integration is an inevitable trend in the development of the urban-rural relationship. To study urban-rural integration, we must first understand the formation and development of urban-rural relations.

Western scholars have studied the urban-rural gap in developing countries and the problems that exist with integrated urban and rural development, and they have proposed theories including "Desakota," "regional network" (McGee, 2008), "urban-rural dualism" (Lysgard, 2019), "urban bias," and "urban-rural equalized development" (Liu *et al.*, 2013). Based on

the above theories, scholars in Western countries have explored the practical paradigm of urban-rural integration using a regional concept of urban and rural land uses coexisting within the same geographical scope (Terry, 1991). Chinese scholars, meanwhile, have focused on the theoretical connotations, development mechanisms, and empirical studies of urban-rural integration. They have stated that urban-rural integration in China is still in the stage of deepening and polarizing (Chen *et al.*, 2020), and that the essence of urban-rural integration is to realize the coordinated and integrated development of urban and rural areas based on free flows, fairness, and sharing of urban-rural development factors (Liu, 2018). It has also been suggested that emphasis should be placed on the two-way development of urban and rural areas, encouraging supply-side structural reform, and building distinctive small towns to promote cultural integration between cities and villages (Li, 2018). Others have pointed out that urban-rural integration involves the integration of the structures, public services, infrastructure, economies, eco-environments, and many other aspects of urban and rural areas, and that urban-rural integration in China's stage of high-quality development means multi-dimensional integration of "population, space, economy, society, and environment" as well as mutual promotion and coordinated development of urban and rural areas (Dai *et al.*, 2015; Zhou *et al.*, 2019). It has been said that the key to integrated urban and rural development is to dissolve systemic barriers to flows of factors of production, structural integration, and exchanges of functions in the existing urban and rural area systems (Ge *et al.*, 2020), and that to promote urban-rural integration, we should pay more attention to the reform of urban-rural links and expand bidirectional opening up (Jin *et al.*, 2019). To judge the extent of integrated urban and rural development, scholars have devised index systems that have included economic, social, lifestyle, and ecological dimensions and that use subjective assignment methods, objective assignment methods, and combinations of subjective and objective assignment methods (Wu *et al.*, 2016; Gao *et al.*, 2019). In addition, the spatial evolution characteristics of integrated urban and rural development have been analyzed using spatial analysis, landscape analysis, and other methods (Che *et al.*, 2017; Wu *et al.*, 2020; Zhang *et al.*, 2020). It is believed that an important prerequisite for achieving integrated development is to have rational flows of resources and factors of production between urban and rural areas (Li, 2012), to promote the continuous optimization of the spatial distribution of society, economy, and ecology between urban and rural areas and so that the return on resources and factors of production are enjoyed by both urban and rural areas, which will ultimately lead to the equal development of urban and rural areas (Liu *et al.*, 2015). Using Chinese panel data to test empirically the impact of urban and rural factors of production on the development of urban-rural integration, it was found that the mismatch of production factors in China's agricultural sector is relatively severe, the integration of people and land plays a considerable role in promoting the coordinated development of urban-rural relations, and the mismatch in non-agricultural sectors is worsening, hindering integrated urban and rural development (Liu *et al.*, 2016). An urban-rural multi-level, multi-center network model has been proposed to optimize the integrated urban and rural development model (He *et al.*, 2019). Integrated urban and rural development policies have been formulated to promote urban-rural economic interactions and cultural information exchanges (Qian *et al.*, 2012; Liu *et al.*, 2018), as well as to promote the equalization of urban and rural public services and facilities and build a harmonious symbiotic relationship.

It is evident that the existing literature by Chinese and international scholars has revealed the basic ideas, theoretical hypotheses, practical paradigms, measurement methods, and integration models of integrated urban development. Nevertheless, in different stages of development and under different social systems, the characteristics, mechanisms, stages, laws, models, and policies of integrated urban and rural development differ. China has entered a new period of integrated urban and rural development. Under these new circumstances, it is necessary to meet the two major strategic requirements of implementing the new model of urbanization and achieving rural vitalization. Predicated on the national strategic task of promoting integrated urban and rural development, new features, mechanisms, principles, patterns, models, and methods of integrated development must be proposed in order to provide a systematic rigorous theoretical basis for alleviating urban-rural problems, reducing unbalanced urban-rural development, and achieving prosperity in both urban and rural areas.

2 Drivers and patterns of integrated urban and rural development

China's high-quality new model of urbanization involves integrated urban and rural development and rural vitalization. Problems inherent to urban areas are caused by problems inherent to rural areas, and vice versa. Such problems are closely linked. They cause and transform each other. They compound each other and lead to practical problems such as non-complementary advantages in urban and rural development, a widening gap between urban and rural development, dual structures in urban and rural areas, poor connectivity between urban and rural infrastructure, inequality of urban and rural public services, and the separation of urban and rural social spaces. The roots of these problems are unclear mechanisms, principles, paths, and models of integrated urban and rural development. To address this antagonistic pattern of development and swiftly establish a coordinated long-term mechanism, as well as meet national strategic needs and solve practical issues, the Chinese state has published a series of policies, including the Opinions on Establishing More Effective New Mechanisms for Regional Coordinated Development (2018), National New Urbanization Plan (2014–2020), Strategic Plan for Rural Vitalization (2018–2022), and Plan for a National Integrated Urban and Rural Development Pilot Zone (National Development and Reform Commission [2021] No.135). These were implemented to guide the development of the new model of urbanization and rural vitalization toward synchronization, integration, and common prosperity.

2.1 Analyzing urban and rural problems and the antagonistic pattern of development

China's urban development and rural development have long consisted of separate policies that have resulted in serious divisions and antagonism between urban and rural areas, leading to increasingly severe urban-rural problems. Problems inherent to urban areas and problem inherent to rural area have mutual causes, and they coexist and affect one another (Figure 1). They also share similar short- and long-range pathogenic factors. Under the influence of short- and long-range natural and human factors, there are "one-to-one," "one-to-many," and "many-to-many" interactive and coercive relationships between urban and rural areas. Urban problems and rural problems have mutually contagious paths and channels. The cure for urban problems is rural vitalization, and the cure for rural problems is the new model of

urbanization. Urban problems are caused by the disorderly influx of many rural migrants into cities, resulting in urban traffic congestion, housing shortages, overloaded infrastructure and public service facilities, difficulty finding employment and getting access to schooling and medical treatment, greater pollution, and governance issues. It has also led to the abandonment of farmland in rural areas, vacant housing, the hollowing out of industries, abandoned villages, an unregulated rural environment, women and children being left behind, and severe social fragmentation. It seems that if problems inherent to urban areas are solved, it will also solve problems inherent to rural areas, and vice versa.

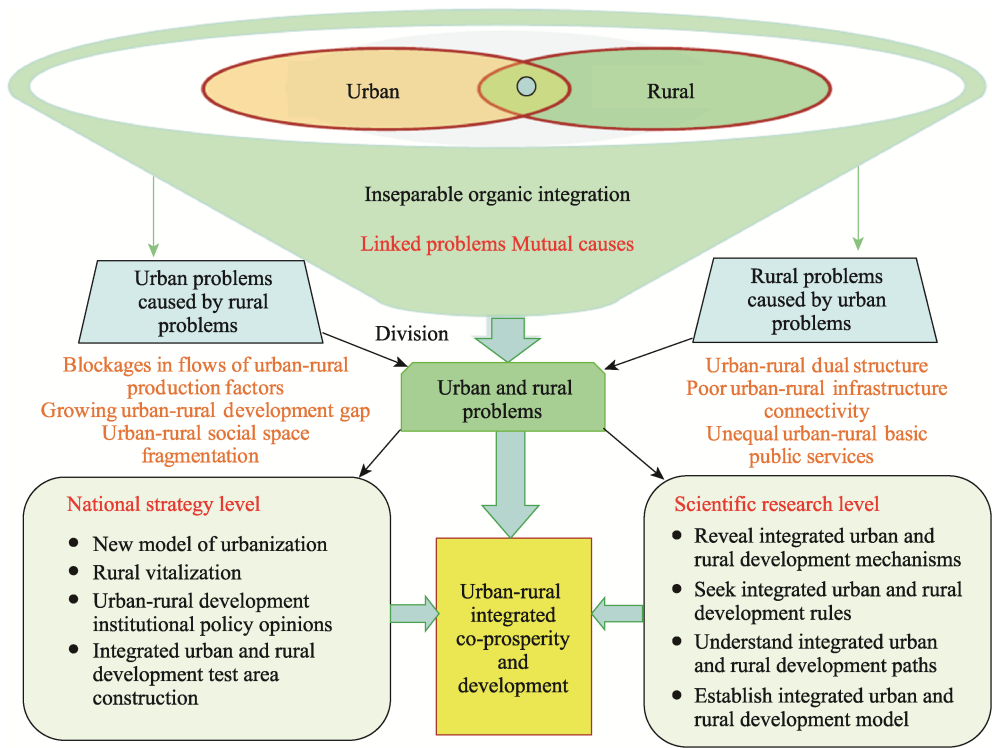


Figure 1 Analysis of urban-rural problems caused by urban-rural segmentation

In view of the amplification effect on urban and rural segmentation of chronic urban and rural problems, which are compounded to form urban-rural problems, there is an urgent need to clarify empirically the urban-rural coupling mechanism, reveal the principles of urban-rural coupled development, measure the degree of urban-rural integration, and optimize the integrated development model, in order to transform urban and rural development from a highly antagonistic pattern to a deeply integrated one. The overall research idea of this study is shown in Figure 2.

2.2 The controlling elements and drivers of integrated urban and rural development

The new model of urbanization and rural vitalization are two different means to solve urban and rural problems and improve the quality of urban and rural development, and there is an inevitable internal coupling mechanism between the two. The main controlling factors of

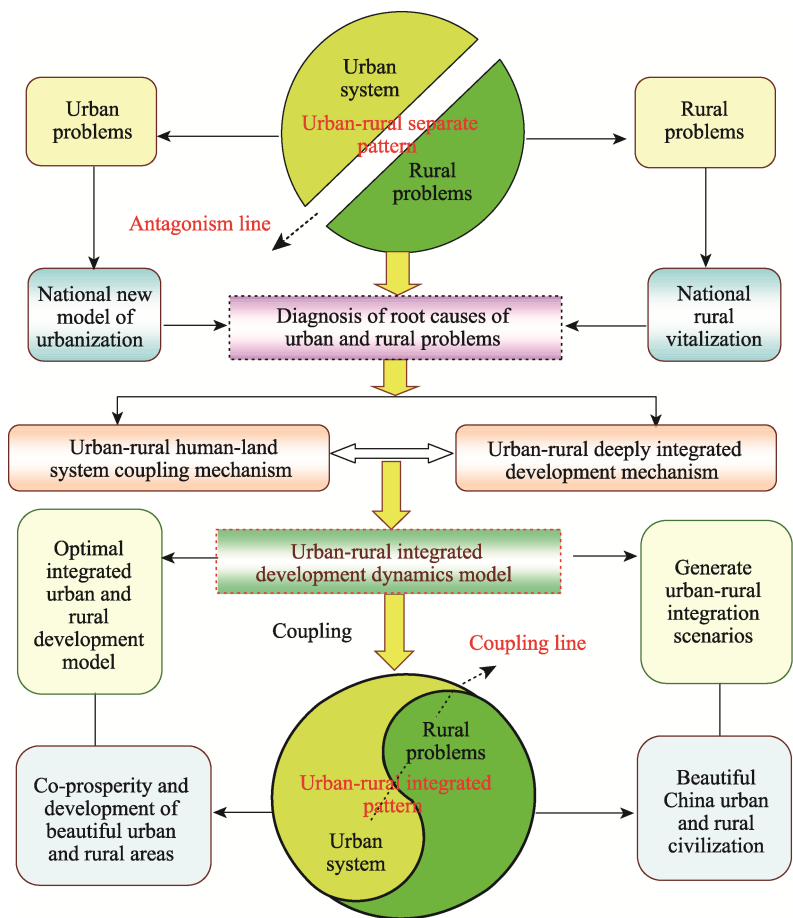


Figure 2 The research ideas of urban-rural coupling development mechanism and deep integration development mode

urban-rural coupled development include population, land, water use, climate, energy, carbon emissions, industries, labor, trade, living environment, and pollution transfer of urban and rural areas. It is necessary to coordinate elements such as the human-water, human-land, human-power, human-climate, human-carbon, human-pollution, human-industry, human-ecology, and other multi-element relationships in urban and rural areas (Figure 3), so as to further coordinate the coupling relationship between urban and rural area systems at the system scale.

On the basis of clarifying the main controlling factors affecting the coupled development of urban and rural areas, and adopting the perspective of the inter-regional long-range scale, intra-regional short-range scale, and short- and long-range scale coupling, this study explores the mutual coercion and coupling relationship between urban and rural area systems under the influence of short- and long-range natural factors (water, ecology, land, energy, climate, and environment) and human factors (population, economy, infrastructure, society, innovation, policy, and globalization). We analyze the influencing mechanisms of “urban” areas on “rural” areas and those of “rural” areas on “urban” areas, as well as the rational flows of various factors of production, such as urban and rural population, land, water resources, economic, trade, transportation, energy and market factors; the driving mechanisms

of integrated urban and rural development; the relocation of pollution sources and pollution offsetting between urban and rural areas; and co-construction and co-governance mechanisms for the urban and rural eco-environments. We reveal short- and long-range integration mechanisms, stages, and types of urban and rural area systems and summarize the coupling laws of urban and rural area systems. We construct the equation $UE=f(Ui-Gj)$, $i=1, 2, 3, \dots, m$, $j=1, 2, 3, \dots, n$ of the coupling relationship between urban and rural area systems to reveal quantitatively the integrated urban and rural development curve, with the degree of integrated development divided into six types: low integration, quite low integration, moderate integration, quite high integration, high integration, and complete integration, which correspond to random integration, indirect integration, loose integration, collaborative integration, close integration, and controlled integration. We then build an urban-rural integration tower to provide an empirical basis for coordinating the relationship between urban and rural areas (Fang *et al.*, 2019).

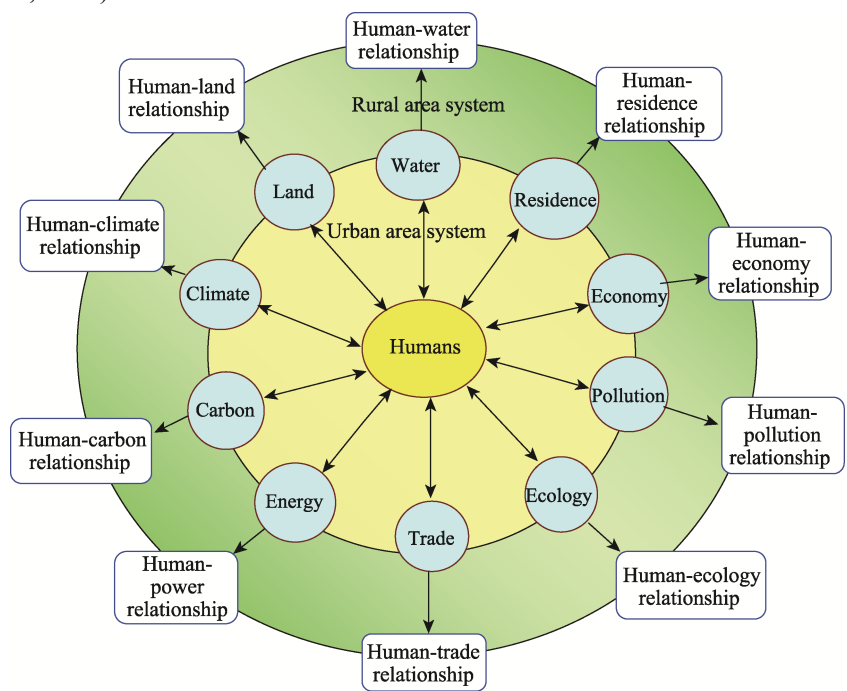


Figure 3 The relationship of main controlling factors of urban-rural coupling development

2.3 Eco-environmental coercion effect of integrated urban and rural development

China’s new model of urbanization and rural vitalization will inevitably affect or even harm the eco-environment. Once the eco-environment has been damaged, it will eventually pose a threat to the development of urban and rural areas. To coordinate the relationship between integrated urban and rural development and the protection of the eco-environment and find the optimal balance between high-quality urban and rural development and a high level of environmental protection, it is necessary to reveal the mechanisms of mutual coercion between them, analyze the mutual coercion and coupling between the development systems (including such factors as population, economy, infrastructure, and society) and eco-environmental systems (including such factors as water, land, energy, ecology, climate,

and environment) of urban and rural areas, analyze the demand and impact of urban and rural high-quality development on the eco-environment, and show the promotional and restrictive effects of eco-environmental improvements on high-quality development in urban and rural areas. It is also necessary to reveal the coupling mechanism, degree, and laws of the mutual coercion between urban and rural development and the eco-environment; identify the degree to which urban and rural eco-environments satisfy urban and rural development needs using the coupling boost effect, the coupling decompression effect, and the coupling constant pressure effect; simulate the dynamic fluctuation process of interactive coupling between urban and rural development and the eco-environment, revealing the contingent random fluctuation mechanism in the evolution process; quantitatively show the self-adaptive threshold of interactive coupling between urban and rural development and the eco-environment; and conduct monitoring and early warning of urban and rural development quality and eco-environment quality coupling, to ensure a sound eco-environment for integrated urban and rural development and provide development support for the construction of desirable urban and rural areas and a beautiful China.

2.4 Multi-scenario test and integration analysis of integrated urban and rural development

Based on integrated urban and rural development mechanisms, important eco-environmental factors such as urban and rural water, land, and energy were regarded as the main controlling elements of urban-rural coupled development, and SD (system dynamics) modelling was used to construct an urban-rural integration dynamic model that combines multiple factors, scales, and scenarios, which was used to calculate the interactive integration threshold for urban-rural development and the eco-environment. We also developed a multi-integration and multi-scenario test for urban-rural development, as well as a decision support system for integrated urban and rural development. We then adjusted the main control variables, designed multiple test scenarios, and adjusted critical thresholds of mutual load and mutual coercion and ran repeated simulation calculations.

We also adjusted the integrated urban and rural development scenario proposals that were compatible with the critical threshold and resource and environmental capacity, and simulated and generated proposals such as low integration, moderate integration, and high integration between urban and rural areas. We constructed an urban-rural multi-integration measurement index system (Figure 4), which is composed of eight types of integration, namely population, science and education, industrial, land-use, infrastructure, environmental, regulatory, and policy integration, and developed a model for measuring the degree of integrated urban-rural development using the following calculation:

$$U = h_1U_1 + h_2U_2 + h_3U_3 + h_4U_4 + h_5U_5 + h_6U_6 + h_7U_7 + h_8U_8 = \sum_{i=1}^8 h_iU_i$$

where U_1 is the degree of integration of urban and rural populations; U_2 is the degree of integration of urban and rural science and education; U_3 is the degree of industrial integration of urban and rural areas; U_4 is the degree of land use integration of urban and rural areas; U_5 is the degree of infrastructure integration of urban and rural areas; U_6 is the degree of regulatory integration of urban and rural areas; U_7 is the degree of environmental integration of urban and rural areas; U_8 is the degree of policy integration of urban and rural areas; and h_1 ,

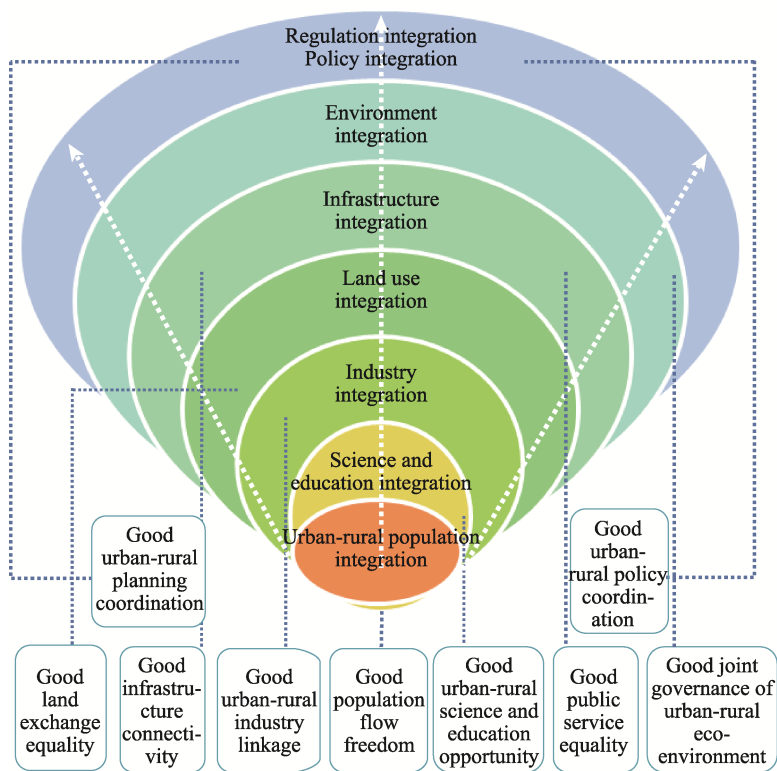


Figure 4 Scheme of deep integrated urban and rural development

$h_2, h_3, h_4, h_5, h_6, h_7$, and h_8 represent the weight coefficients of integration.

2.5 Analysis of the urban-rural multi-integration development model and deep integration pattern

The focus of integrated urban and rural development is the countryside, and its driving force is cities. Based on a scenario simulation plan of integrated urban and rural development, and drawing on the experience of international advanced areas of urban-rural integration, we selected an urban-rural multi-integration development model that is conducive to the rational flow of urban and rural elements, narrowing the urban-rural development gap, and breaking the urban-rural confrontation pattern. We created an urban-rural multi-integration development triangular model featuring the integration of science and education, land use, industry, infrastructure, regulation, environment, and policy, and which is driven by reform, opening up, and innovative development (Figure 5), so as to reshape integrated urban and rural development as a new pattern of deep integrated development. The integration of population is the core, the integration of science and education is the key, the integration of land use is the carrier, the integration of industries is the support, the integration of infrastructure is the link, the integration of regulation is the guide, the integration of the environment is the foundation, and the integration of policies is the traction. The multi-integration experimental model promotes a shift in urban and rural development from duality to integration, from single integration to multiple integration, and from the planning of integration to the execution of integration, so as to promote the rational allocation of urban and rural elements and the sharing of public services; encourage the gradual expansion of urban infrastructure and pub-

lic service facilities to rural areas; accelerate rural vitalization; advance the transformation of urban and rural development from an antagonistic pattern to an integrated pattern; promote the co-construction, sharing, and joint operation of urban and rural infrastructure; improve the quality of both urban development and rural development; and achieve the modernization of both urban and rural areas. Using the quality coupling effect, quality division effect, and quality differentiation effect, we propose an adjustment model and high-quality improvement path for urban and rural common development and prosperity, which transforms low-quality areas of urban-rural antagonism into high-quality areas of urban-rural integration. It also provides policy support for developing an in-depth integrated urban and rural development model with high degrees of freedom in terms of urban and rural population flows, of equality in land exchanges, of integration of urban and rural industry chains, of infrastructure connectivity, and of inclusiveness of public service facilities. This will facilitate a change in weak areas of urban and rural antagonism to strong areas of urban and rural integration, and it will make turn urban and rural areas into places where people can fulfil their hopes for a better life.

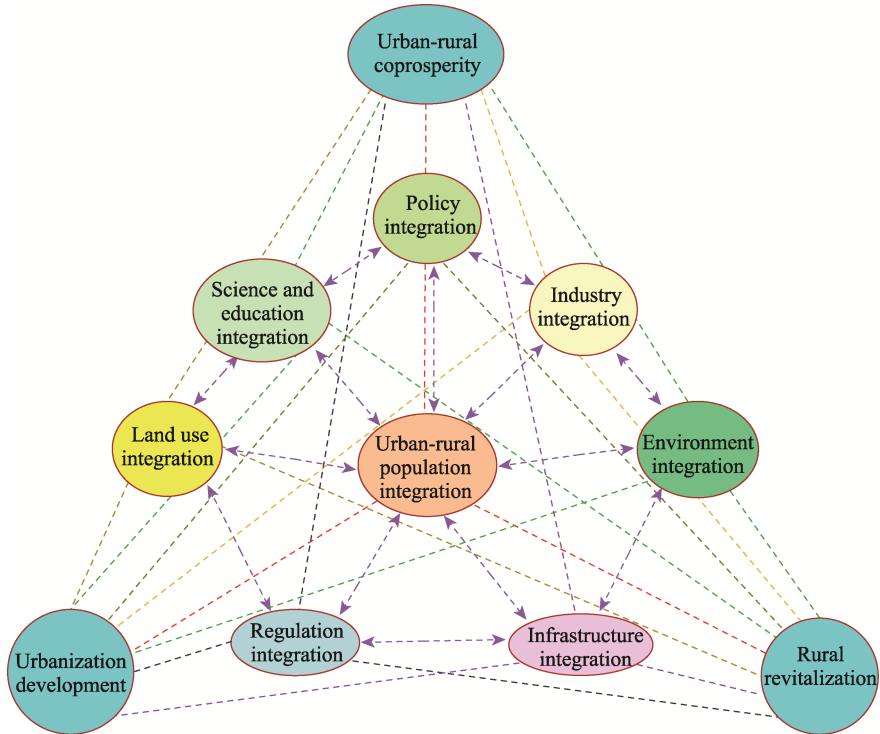


Figure 5 The triangular pattern of urban-rural integration development

3 Analysis of the underlying pattern and sustainability of integrated urban and rural development

3.1 Underlying pattern of integrated urban and rural development

Analyzing urban-rural population integration, the underlying pattern of integrated urban and rural development is basically consistent with the four-stage pattern of high-quality urbanization. The four-stage pattern of high-quality urbanization comprises the initial period of

urbanization (when the urbanization level is 1%–30%, the early period) which is the low-quality stage; the middle period of urbanization (30%–60%, the growth period) which is the medium-quality stage; the later period of urbanization (60%–80%, the mature period) which is the relatively high-quality stage; and the final period of urbanization (above 80%, the climax period) which is the high-quality stage.

Corresponding integrated urban and rural development also exhibits a four-stage pattern, i.e., the initial period of urbanization is the stage of low-level integrated urban and rural development; the middle period of urbanization is the stage of moderate integrated development; the later period of urbanization is the stage of relatively high-level integrated development; and the final period of urbanization is the stage of deeply integrated development. The degree of integrated urban and rural development differs in each stage of urbanization. This is the underlying pattern of integrated urban and rural development (Figure 6).

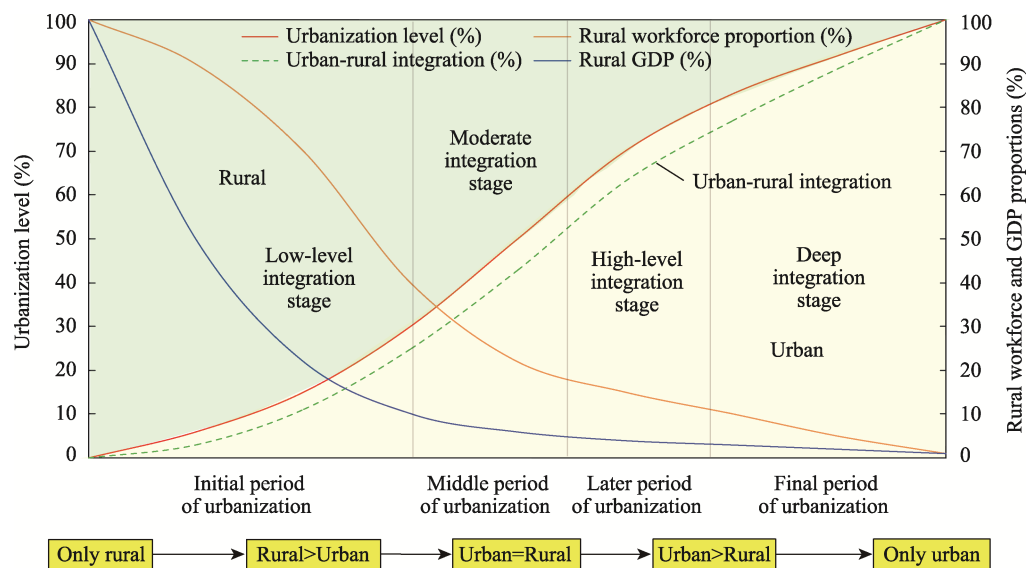


Figure 6 Schematic diagram of the theoretical curve of integrated urban and rural development succession

In theory, the development process of urban-rural integration is an evolution process, from no urban areas, to more rural areas than urban areas, to equal urban and rural areas, to more urban areas than rural areas, to no rural areas. The level of urbanization, proportion of the rural workforce, and the proportion of the rural economy also undergo corresponding changes. The degree of urban-rural integration generally lags behind the urbanization process, but it generally develops toward deep integration, and integrated urban and rural development displays a spiral upward process. This underlying pattern indicates that urban and rural development in a specific period is inseparable. Urbanization that is too fast and rural vitalization that is too slow are not conducive to integrated urban and rural development. The processes of urbanization and rural vitalization need to be coordinated in terms of their speed, quality, planning, policy formulation, and implementation. If one lags behind the other, it will increase urban and rural problems brought about by urbanization. Moreover, the four-stage pattern of urban-rural integration requires coordination of the dialectical relationship between the speed and quality of urban-rural development, which will be quicker or slower in different stages.

3.2 Verifying and analyzing the underlying pattern of integrated urban and rural development

Based on the underlying pattern and evolution process of integrated urban development, we can analyze the development trajectory of urban-rural integration in China from 1952 to 2019 (Figure 7). Urban-rural development in China from 1952 to 2000 was the low-level integration stage and initial period of urbanization, with more rural areas and fewer urban areas. 1952–1980 was the zero-integration stage of urban-rural dual development, and 1980–2000 was the coordinated urban-rural development stage. From 2000 to 2010, as the urbanization level reached 50%, China entered the middle period of urbanization of moderate integration when urban and rural areas were equally populated; this was the stage of coordinated urban and rural development. From 2011 to 2019, China was in the moderate integration stage of unified urban and rural development. When the urbanization level reached 60% in 2019, China moved out of the middle period of urbanization and entered the later period of urbanization. In the future, China will enter the deep integration stage in the final period of urbanization, in which there are more urban areas than rural areas and eventually only urban areas. It can be seen that China’s integrated urban and rural development generally conforms to the underlying pattern of integrated urban development (Figure 7).

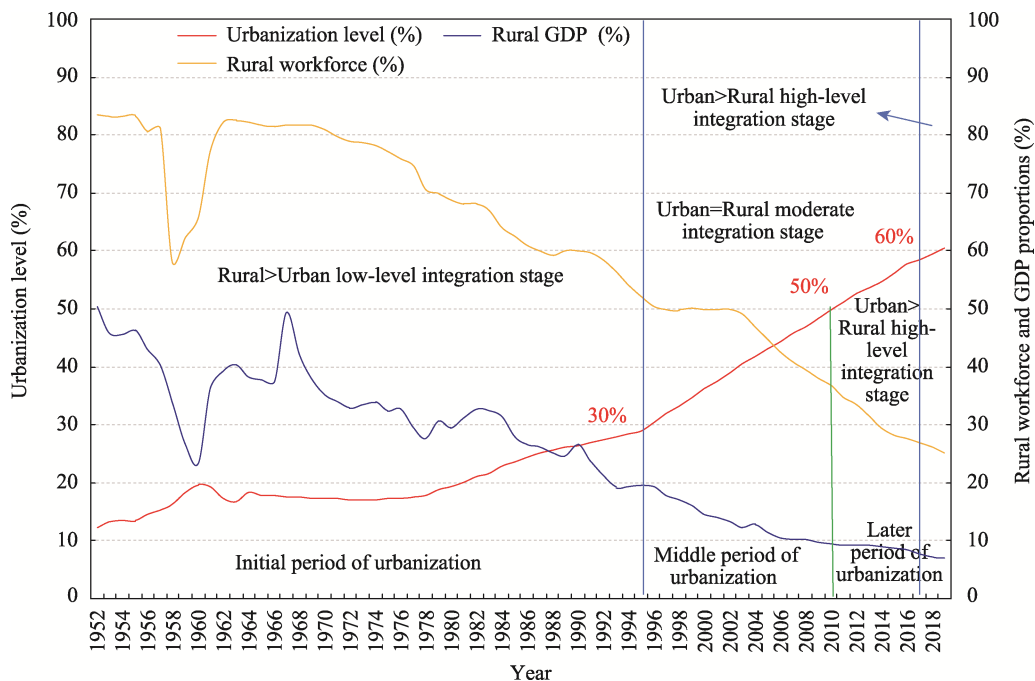


Figure 7 Schematic diagram of the evolution path of integrated urban and rural development in China 1952–2019

3.3 Analysis of the sustainability of integrated urban and rural development

The sustainability of integrated urban and rural development depends on eight attributes: high efficiency, low carbon, ecology, environmental protection, conservation, innovation, intelligence, and safety (Table 1). China is still a developing country, and it must continue to give top priority to achieving the sustainable development of urban and rural areas. Development is an absolute principle and the primary objective, but China requires efficient and

intensive sustainable development, not extensive and disorderly traditional development. In the process of development, it must gradually transform its development structure and function, change its high-carbon urban and rural industrial and energy structures, reduce carbon emissions, achieve low-carbon development, and build low-carbon cities and villages.

Table 1 Analysis of the sustainability of integrated urban and rural development

Integration attribute	Integrated urban and rural development aim	Integrated urban and rural development method
High efficiency	Sustainable development of the economy	Build an urban-rural integrated economic system with smart growth, mutual benefit, and high-quality development
Low carbon	Sustainable lower-emission development	Build low-carbon cities, low-carbon villages and low-carbon communities, and advocate low-carbon consumption, low-carbon transportation and low-carbon society
Ecology	Sustainable development of ecology	Build ecological cities, beautiful cities and a beautiful countryside, and protect urban and rural ecological environment
Environmental protection	Sustainable development of the environment	Build environmentally friendly cities and villages, and simultaneously and efficiently control urban and rural environmental pollution
Conservation	Sustainable development of resources	Build water-, energy-, land-, and material-saving cities and villages, build a resource-saving urban-rural economic system, and ensure the efficient flow and sustainable utilization of urban and rural resources
Innovation	Sustainable development of science and technology	Build innovative cities, promote the integration of urban and rural scientific and technological development, and build a scientific and technological innovation system with deep urban and rural integration
Intelligence	Sustainable development of knowledge	Build digital cities, smart cities, smart communities and digital villages, and form a smart urban and rural construction system
Safety	Sustainable development of society	Build safe cities and safe villages, and build a security system that integrates urban and rural areas

While integrating urban and rural development, it is also necessary to maximize the intensive use of natural resources, build water-, energy-, land-, and material-saving cities and villages, and build a resource-saving urban-rural economic system. It is necessary to protect the urban and rural eco-environments to the greatest extent, comprehensively control urban and rural environmental pollution, build desirable cities and villages, and make cities and villages beautiful places that people wish to live (Fang *et al.*, 2019). To improve the quality of integrated urban and rural development, it is necessary to use innovation to drive progress; aim to construct smart urban and rural areas; promote unified scientific and technological development in urban and rural areas; build a scientific and technological innovation system with deep integration between urban and rural areas; build digital cities, smart cities, smart communities, and digital villages; and form a smart urban and rural construction system. To ensure the security of development, the eco-environment, and the living environment in urban and rural areas, it is necessary to build safe cities and safe villages as well as to build an integrated urban and rural safety guarantee system. Without security guarantees, sustainable urban and rural development will be impossible. Security is the premise and goal of all work related to integrated urban and rural development.

4 Conclusions and discussion

(1) Cities and the countryside have always formed a contradictory organic unity and an inseparable integrated whole. China’s new model of high-quality urbanization requires integrated urban and rural development and rural vitalization. The process of integrated urban and rural development is relatively complex, and it has always been an important topic for

government departments and academia. It is also an important problem that will not be resolved in the short term. Problems inherent to urban areas are caused by problems inherent to rural areas, and vice versa. Such problems are closely linked. They cause and transform each other. They compound each other and form “urban-rural problems.” As a result, the advantages of urban and rural development are not shared; the gap between urban and rural development is widening; the dual structure of urban and rural areas is becoming more prominent; connections between urban and rural infrastructure are not smooth; urban and rural public services are unequal; and urban and rural social spaces are divided. Urban and rural problems have mutual causes and channels. The cure for problems inherent to rural areas is the new model of urbanization, as eradicating urban problems will naturally cure rural problems.

(2) The theory of integrated urban and rural development is still in the exploratory stage. The main controlling factors of integrated urban and rural development include the population, land, water use, climate, energy, carbon emissions, industries, labor, trade, living environment, and pollution transfer of urban and rural areas. Based on the need to coordinate elements such as the human-water, human-land, human-power, human-climate, human-carbon, human-pollution, human-industry, human-ecology, and other multi-element relationships in urban and rural areas, we built an urban-rural multi-integration measurement index consisting of the eight integrations of population, science and education, industry, land use, infrastructure, environment, regulation, and policy; establish an urban-rural integration measurement model; designed test scenarios; and simulated and generated urban and rural low-level integration, moderate integration, high integration and other solutions. We also created an urban-rural multi-integration development triangular model featuring the integration of science and education, land use, industry, infrastructure, regulation, environment, and policy, and which is driven by reform, opening up, and innovative development, so as to reshape integrated urban and rural development as a new pattern of deep integrated development. Integrated urban and rural development will inevitably have an impact on the eco-environment. How to coordinate the non-linear relationship between integrated urban and rural development and eco-environmental protection, reveal the mutual coercion between the two, and discover the perfect balance in the relationship between high-quality urban-rural development and high-level protection of the eco-environment will be the main focus of future research.

(3) The underlying pattern of integrated urban and rural development is basically consistent with the four-stage pattern of high-quality urbanization. The initial period of urbanization is the stage of low-level integrated urban and rural development; the middle period of urbanization is the stage of moderate integrated development; the later period of urbanization is the stage of relatively high-level integrated development; and the final period of urbanization is the stage of deeply integrated development. The degree of integrated urban and rural development differs in each stage of urbanization. In theory, the development process of urban-rural integration is an evolution process, from no urban areas, to more rural areas than urban areas, to equal urban and rural areas, to more urban areas than rural areas, to no rural areas. The level of urbanization, proportion of the rural workforce, and the proportion of the rural economy also undergo corresponding changes. The degree of urban-rural integration generally lags behind the urbanization process, but it generally develops toward deep integration. China has been through the low-level integration stage and initial period of ur-

banization, when there were more rural areas and fewer urban areas, and the middle period of urbanization of moderate integration, when urban and rural areas were equally populated. It is currently in the later period of urbanization, in which there are more urban areas and fewer rural areas. In the future, China will enter the deep integration stage in the final period of urbanization, in which there are more urban areas than rural areas and eventually only urban areas.

(4) The force of national policies has played an important role in promoting integrated urban and rural development. These policies to promote urban and rural development in China have evolved from coordinated development to unified development, and finally to integrated development. They have played an important role in promoting China's new model of urbanization and rural vitalization as well as realizing deeply integrated urban and rural development. Nevertheless, China's urban development and rural development have long consisted of separate policies that have resulted in serious divisions and antagonism between urban and rural areas.

(5) In the future, urban and rural development needs to become more in step and deeply integrated. Responding to challenges such as persistent disparity, blockages in flows of factors of production, unequal public services, insufficient integrated development, and separate development strategies and policies between urban and rural areas, it will be necessary to use the new model of urbanization and rural vitalization to solve urban and rural problems and improve the quality of urban and rural development. It is also necessary to create new theories and methods of integrated urban and rural development; accurately study and evaluate new characteristics, new mechanisms, and new principles of integrated urban and rural development; and propose a new patterns, models, and paths of integrated urban and rural development. It is necessary to change the current practice of independent urban and rural strategies, planning, implementation, and policy systems. The government should convene joint central urban and rural work conferences as well as formulate a joint National Integrated Urban and Rural Development Plan. We must implement the development strategy of deeply integrated urban and rural development; create a strategic blueprint, guiding ideology, objective, and implementation plan as well as a policy system for integrated urban and rural development; and transform the low-quality areas of urban-rural antagonism to high-quality areas of urban-rural integration. We should provide policy support for the construction of an urban-rural in-depth integration development model with high degrees of freedom in terms of urban and rural population flows, of equality in land exchanges, of integration of urban and rural industry chains, of infrastructure connectivity, and of inclusiveness of public service facilities. We must also guide and promote the development of new urbanization and rural vitalization toward greater synchronization, integration, and common prosperity.

References

- Central Compilation and Translation Bureau (CCTB), 1995. Selections of Marx and Engels. Beijing: People's Publishing House, 35–46.
- Che B Q, Lu Y Q, Wang Y, 2017. Research on spatial form evolution of urban and rural integration development in Jiangsu Province. *Resources and Environment in the Yangtze Basin*, 26(7): 1022–1031. (in Chinese)
- Chen K Q, Long H L, Liao L W *et al.*, 2020. Land use transitions and urban-rural integrated development: Theoretical framework and China's evidence. *Land Use Policy*, 92: 104465.
- Dai H, Sun T, Zhang K *et al.*, 2015. Research on rural nonpoint source pollution in the process of urban-rural integration in the economically-developed area in China based on the improved STIRPAT model. *Sustainability*, 7(1): 782–793.

- Fang C L, 2019. Basic rules and keypaths for high-quality development of the new urbanization in China. *Geographical Research*, 38(1): 13–22. (in Chinese)
- Fang C L, Cui X G, Liang L W, 2019. Theoretical analysis of urbanization and eco-environment coupling coil and coupler control. *Acta Geographica Sinica*, 74(12): 2529–2546. (in Chinese)
- Fang C L, Wang Z B, Liu H M, 2019. Exploration on the theoretical basis and evaluation plan of Beautiful China construction. *Acta Geographica Sinica*, 74(4): 619–632. (in Chinese)
- Gao B, Kong L, 2019. An analysis on the economic growth effect of the integration of urban and rural development in China. *Journal of Agrotechnical Economics*, 8: 4–16. (in Chinese)
- Ge D Z, Long H L, 2020. Rural spatial governance and urban-rural integration development. *Acta Geographica Sinica*, 75(6): 1272–1286. (in Chinese)
- He R W, 2018. Urban-rural integration and rural revitalization: Theory, mechanism and implementation. *Geographical Research*, 37(11): 2127–2140. (in Chinese)
- He Y H, Zhou G H, Tang C L, 2019. The spatial organization pattern of urban-rural integration in urban agglomerations in China: An agglomeration-diffusion analysis of the population and firms. *Habitat International*, 87: 54–65.
- Jin S L, Cao D Q, Lin X L, 2019. From urban and rural dual to urban and rural integration: Evolution and enlightenment of urban-rural relations in the 70 years since the founding of new China. *Economic Review Journal*, 8: 13–19. (in Chinese)
- Li B D, 2018. Grasping the law of rural construction and promoting urban-rural integration. *People's Tribune*, 35: 104.
- Li Y H, 2012. Urban-rural interaction patterns and dynamic land use: Implications for urban-rural integration in China. *Regional Environmental Change*, 12(4): 803–812.
- Liu C F, Zhang Z Y, 2018. From town-country integration to urban-rural integration: New thinking on the relationship between urban and rural areas. *Scientia Geographica Sinica*, 38(10): 1624–1633. (in Chinese)
- Liu M H, Lu F, 2019. Study on the influence of factor mismatch on urban-rural integration development: Evidence from Chinese provincial panel data. *Journal of Agrotechnical Economics*, 2: 33–46. (in Chinese)
- Liu Y S, 2018. Research on the urban-rural integration and rural revitalization in the new era in China. *Acta Geographica Sinica*, 73(4): 637–650. (in Chinese)
- Liu Y S, Cheng C, Li Y R, 2015. Differentiation regularity of urban-rural equalized development at prefecture-level city in China. *Journal of Geographical Sciences*, 25(9): 1075–1088.
- Liu Y S, Lu S S, Chen Y F, 2013. Spatio-temporal change of urban-rural equalized development patterns in China and its driving factors. *Journal of Rural Studies*, 32(32): 320–330.
- Liu Y S, Yan B, Wang Y F, 2016. Urban-rural development problems and transformation countermeasures in the new period in China. *Economic Geography*, 36(7): 1–8. (in Chinese)
- Lysgard H K, 2019. The assemblage of culture-led policies in small towns and rural communities. *Geoforum*, 101: 10–17.
- McGee T G, 2008. Managing the rural-rural transformation in East Asia in the 21st century. *Sustainability Science*, 3(1): 155–167.
- Qian H, Wong C, 2012. Master planning under urban-rural integration: The case of Nanjing, China. *Urban Policy and Research*, 30(4): 403–421.
- Rondinelli D A, 1983. Secondary Cities in Developing Countries Policies for Diffusing Urbanization. Beverly Hills: Sage Publications, 29–31.
- Tan X L, Yu S Y, Ouyang Q L *et al.*, 2017. Assessment and influencing factors of rural hollowing in the rapid urbanization region: A case study of Changsha-Zhuzhou-Xiangtan urban agglomeration. *Geographical Research*, 36(4): 684–694. (in Chinese)
- Terry M, 1991. The Emergence of Desakota Regions in Asia. Honolulu: University of Hawaii Press, 22–26.
- Wu X, Cui P, 2016. A study of the time-space evolution characteristics of urban-rural integration development in a mountainous area based on ESDA-GIS: The case of the Qinling-Daba Mountains in China. *Sustainability*, 8(11): 1085.
- Wu Y, Li H B, 2020. Spatial change and correlations of desakota regions in a metropolitan area using NPP/VIIRS nighttime light data: A case study of Wuhan City. *Progress in Geography*, 39(1): 13–23. (in Chinese)
- Zhang X L, Qiu F D, Zhu C G, 2020. Evolution of urban-rural integration in Huaihai Economic Zone from the perspective of spatio-temporal interaction. *Journal of Natural Resources*, 35(8): 1867–1880. (in Chinese)
- Zhang Y N, Long H L, Ma L *et al.*, 2019. Research progress of urban-rural relations and its implications for rural revitalization. *Geographical Research*, 38(3): 578–594. (in Chinese)
- Zhou J N, Qin F C, Liu J *et al.*, 2019. Measurement, spatial-temporal evolution and influencing mechanism of urban-rural integration level in China from a multidimensional perspective. *Chinese Journal of Population, Resources and Environment*, 29(9): 166–176. (in Chinese)