Evolution of Physical and Flow Space in Urbanized Areas and Pathways for High-Quality Development: Postprint

Authors: Chen Mingxing, Chen Liangkan, Happiness first, Cheng Jiafan, Liang Longwu, Ma Jing

Date: 2024-03-27T00:00:00+00:00

Abstract

The construction of ecological civilization and Beautiful China has entered a critical period. Urbanized areas serve as crucial spatial carriers of the geographical vision of Beautiful China, where contradictions in human-land relationships are most pronounced and also represent key challenges in Beautiful China construction. Focusing on the physical territories of urbanized areas and employing big data technological methods, this study clarifies the spatiotemporal distribution and grouped evolution characteristics of impervious surfaces in Chinese cities, analyzes the structural characteristics of urban system flow networks from a space-of-flows perspective, and proposes preliminary reflections and policy recommendations for promoting high-quality development pathways in urbanized areas in the new era. These include building people-centered cities, guiding diversified urban development through hierarchical and categorical approaches, establishing a sustainable urban model that is green, resilient, and healthy, advancing scientific and technological innovation functions and smart city construction, and conducting regular urban health examinations, thereby supporting the realization of Chinese-style urbanization modernization and the goals of Beautiful China.

Full Text

Preamble

Geographical Landscape and Development Pathways for Building a Beautiful China

Citation Format: Chen M X, Chen L K, Xian Y, et al. Evolution of urbanized area' s entities and flow space towards high-quality development path in

China. *Bulletin of Chinese Academy of Sciences*, 2023, 38(12): 1950-1961, doi: 10.16418/j.issn.1000-3045.20230918001.

Authors: Chen Mingxing*, Chen Liangkan, Xian Yue, Cheng Jiafan, Liang Longwu, Ma Jing

Abstract

The construction of ecological civilization and Beautiful China has entered a critical phase. Urbanized areas serve as important spatial carriers in the geographical landscape of Beautiful China, yet they face the most prominent human-environment contradictions and represent the most challenging regions for this national initiative. Focusing on the physical territories of urbanized areas and employing big data techniques, this study clarifies the spatiotemporal distribution and grouped evolution characteristics of impervious surfaces in Chinese cities, analyzes the structural features of urban flow networks from a space-of-flows perspective, and proposes preliminary reflections and policy recommendations for promoting high-quality development pathways in urbanized areas during the new era. Key measures include advancing people-oriented urban development, guiding diversified urban development through classified and tiered approaches, establishing green, resilient, and healthy sustainable urban models, strengthening technological innovation functions and smart city construction, and implementing regular urban physical examinations. These efforts will support the realization of Chinese-path urbanization modernization and the Beautiful China goals.

Keywords: Beautiful China Initiative, geographic landscape, urbanized area, ecological civilization, Chinese path of modernization, new-type urbanization

Introduction

Since the 18th National Congress of the Communist Party of China in 2012, which proposed the strategic deployment of "vigorously promoting ecological civilization construction," China has achieved remarkable progress in ecological civilization and the orderly advancement of Beautiful China construction. The 19th National Congress in 2017 called for "accelerating ecological civilization system reform to build a Beautiful China," setting the goal of basically achieving Beautiful China by 2035. The 20th National Congress in 2022 further proposed "promoting green development and fostering harmony between humanity and nature." The next five years represent a critical period for building a modern socialist country in all respects, with particular emphasis on advancing Beautiful China construction and achieving significant improvements in urban and rural living environments. Major scientific programs such as the Chinese Academy of Sciences' Strategic Priority Research Program (Category A) "Scientific and Technological Engineering for Beautiful China Eco-Civilization Construction" have provided crucial technological support for these efforts.

Urbanized areas constitute essential spatial carriers for building the geographical landscape of Beautiful China, representing regions where human-land contradictions are most acute and where construction challenges are greatest. High-quality development of urbanized areas is a key component for enhancing urban modernization and promoting Chinese-style modernization and Beautiful China objectives. By 2022, China' s urbanization rate had reached 65%, placing it in the later stage of rapid development according to urbanization speed patterns. Additionally, China' s total population has peaked ahead of schedule, indicating that future urbanization patterns will shift from rapid scale expansion to quality improvement and optimization of existing stock, further advancing people-centered new-type urbanization.

Urban physical territorial expansion represents one of the most significant spatial manifestations of urbanization, profoundly impacting land use, natural habitats, biogeochemical cycles, and surface energy balance. Flow space primarily involves spatial flows of population, economic, and other elements between cities, along with their agglomeration and diffusion effects, forming a spatial organizational model of urban networks that serves as a key mechanism for understanding urban system evolution and inter-city relationships. Physical urban space and flow space together constitute two important dimensions for comprehending high-quality urbanization development. This study first focuses on the physical space of urbanized areas, analyzing their geographical distribution and spatiotemporal evolution characteristics across scale groups, then examines the flow network structure of urban systems from a flow space perspective, and finally proposes pathway reflections for promoting high-quality development in urbanized areas during the new era.

1. Overall Evolution Characteristics of Urbanized Areas

Since the 1980s, land use in China' s urban physical territories has undergone significant changes, with spatial expansion of impervious surfaces (artificial surfaces) replacing natural landscapes such as farmland, forests, and grasslands. Impervious surfaces in artificial environments represent the physical territories of urbanized areas, providing spatial carriers for urban population aggregation, residential living, and industrial production while altering natural surface evapotranspiration processes, affecting regional ecological environments, and causing urban heat island effects. With rapid advancement in satellite earth observation technology, remote sensing inversion methods for impervious surface information have been developed, enabling rapid acquisition of large-area, high-resolution, long-term impervious surface data and making physical urban studies a research hotspot.

Based on the China Land Cover Dataset (CLCD), this study extracted annual impervious surface coverage information for China from 1985 and 1990–2020 at 30 m spatial resolution. Between 1985 and 2020, China' s urban physical territory area, represented by impervious surfaces, increased from 9.88×10^{4} km^2 to 26.13×10^{4} km^2, with a net growth of 16.25×10^{4} km^2 [Figure

1: see original paper]. According to the characteristics of annual growth rate and scale, four distinct phases can be identified. Phase I (1985-1993) represents the urbanization initiation stage, with impervious surface growth rates rising rapidly at 0.28×10^{4} km^2 per year. Phase II (1994-2001) marks rapid urbanization development, where although growth rates declined, the scale increased to 0.45×10^{4} km^2 per year. Phase III (2002-2012) represents accelerated urbanization, with stable growth rates and further expansion in scale to 0.55×10^{4} km^2 per year. Phase IV (2014-2020) signals a new-type urbanization stage of deceleration and quality improvement, with significantly declining growth rates and reduced expansion scale to 0.50×10^{4} km^2 per year. Overall, the growth trend of China' s urban physical territorial expansion is gradually slowing.

Spatially [Figure 2: see original paper], impervious surface proportions show significant regional differences. Corresponding to the Hu Huanyong Line, the southeastern half of China exhibits markedly higher impervious surface proportions than the northwestern half. Regions with high impervious surface proportions are primarily concentrated in the Yangtze River Delta, Pearl River Delta, Beijing-Tianjin-Hebei, Chengdu-Chongqing, and some urban clusters and metropolitan areas in central and northeastern China.

2. Evolution of Different Scale Groups in Urbanized Areas

Urbanization development has formed hierarchical urban systems of varying scales. Growth in large, medium, and small cities follows both objective laws of different city sizes and is influenced by national macroeconomic conditions and policy orientations. This study employs the GHS-FUA urban boundary data to identify urbanized areas and analyze the growth evolution characteristics of Chinese cities' physical territories (based on administrative boundaries). Based on impervious surface scales of 1,402 cities in 2020 and using the natural breaks method to maximize inter-group differences, cities were divided into four groups: super-large, large, medium, and small for analysis and calculation of impervious surface growth scale and fitted growth slopes from 1985 to 2020 [Figure 3: see original paper].

Super-large cities: With impervious surface scales of 1,369-2,897 km^2 in 2020, this group includes five cities such as Beijing, Shanghai, and Guangzhou, accounting for 18.28% of total impervious surface scale. The fitted growth slope from 1985-2020 is 54 km^2 per year, showing the most significant scale increase.

Large cities: With impervious surface scales of 578-1,369 km^2, this group includes 23 cities such as Wuhan, Hefei, and Zhengzhou, accounting for 44.08% of total scale. The fitted growth slope is 20.7 km^2 per year.

Medium cities: With impervious surface scales of 163-578 km^2, this group includes 110 cities such as Fuzhou, Qinhuangdao, and Luoyang, accounting for 28.33% of total scale. The fitted growth slope is 6.23 km^2 per year.

Small cities: With impervious surface scales of 5–163 km^2, this group includes 1,264 cities, accounting for only 9.3% of total scale. The fitted growth slope is 0.85 km^2 per year.

Urban spatial expansion and morphological changes are crucial for understanding urbanized area evolution. Different scale urbanized areas exhibit distinct characteristics in impervious surface growth over time [Figure 4: see original paper]. Since 1985, impervious surface areas in Beijing, Shanghai, and Guangzhou have increased by 1,645.02 km^2, 1,850.87 km^2, and 1,420.68 km^2 respectively. Meanwhile, Wuhan, Hefei, Fuzhou, and Yinchuan have grown by 708.82 km^2, 556.34 km^2, 300.14 km^2, and 202.87 km^2 respectively. As urbanization progresses through different stages, super-large cities with substantial initial scales experienced rapid expansion primarily in earlier and middle phases, forming basic urban physical territorial configurations. In contrast, large, medium, and small cities with smaller initial urban areas have shown more pronounced stage-specific expansion characteristics in recent years.

Meanwhile, at different spatial scales—including building scale, grid units, and urban neighborhoods—building heights in various types of urbanized areas demonstrate hierarchical differences [Figure 5: see original paper]. Super-large cities as highly urbanized areas exhibit high-rise construction, intensive development, and high density, while small and medium cities show lower building heights, less intensive development, and lower density. Implementing zoning controls on building height types for different city scales can promote economical and intensive land use and rational development intensity, establishing new models of smart urban growth and refined spatial governance that meet the actual needs of urban residents' production and living activities.

3. Analysis of Flow Space Structure in Urbanized Areas

Based on Tencent migration heat data, this study collected 19,608 intercity population flow data points (origin-destination flows, hereafter "OD flows") covering 321 cities to analyze urban flow networks. Under the flow space context, different cities exhibit a clear core-periphery structure in influence. The Gini coefficient of OD flow heat is 0.51, indicating significant differences in intercity connection strength. Using model identification and the natural breaks method, the 321 cities were divided into three groups based on network coreness metrics: core cities, sub-core cities, and other cities.

(1) Core cities have coreness values of 0.10–0.33. The 18 core cities account for only 5.6% of the total but concentrate 30.8% of travel flow heat in the entire urban network. Located at important hub positions, these cities exert strong radiation and driving effects on the nation or large regions, including Beijing, Shanghai, Chongqing, Guangzhou, Shenzhen, Chengdu, Wuhan, Hangzhou, Xi'an, Zhengzhou, Nanjing, Dongguan, Suzhou, Guiyang, Kunming, Changsha, Tianjin, Nanning, Hefei, and Foshan. These cities form a diamond structure of China's intercity flow network, with Beijing, Shanghai, Chongqing, Guangzhou, Shenzhen, and Chengdu exceeding the group mean coreness value (0.19) [Figure 6: see original paper].

(2) Sub-core cities have coreness values of 0.03–0.10. The 85 sub-core cities have an average coreness of 0.05, accounting for 26.5% of the total number of cities but 38.2% of flow heat. They are mainly distributed in China' s southeastern half, forming a geographically dense and closely connected networked spatial structure. Sub-core cities in the northwest and northeast are primarily provincial capitals such as Urumqi, Yinchuan, Lanzhou, Hohhot, Shenyang, Changchun, and Harbin, serving as regional hub centers with a hub-and-spoke spatial structure distinct from the southeastern pattern.

(3) Other cities have coreness values below 0.03. These 218 cities represent the largest group (67.1% of the total) but account for only 31.1% of flow heat, with a mean coreness of 0.02 and relatively weak intercity connections.

4. High-Quality Development Pathways for Urbanized Areas

Urbanized areas are key regions for ecological civilization and Beautiful China construction. Both their physical and flow spaces are undergoing rapid evolution. How to promote high-quality development in urbanized areas during the new era, advance people-centered new-type urbanization, foster high-quality development and Beautiful China construction, and contribute to Chinese modernization goals requires systematic consideration. This study proposes five key pathways: building people-oriented cities, guiding diversified development through classification and tiering, creating green, resilient, and healthy sustainable urban models, strengthening technological innovation functions and smart city construction, and implementing regular urban physical examinations.

4.1 Building People-Oriented Cities for a Better Life

Cities belong to the people, and development must adhere to a people-centered philosophy. As the principle states, "the quality of urban planning and construction should ultimately be measured by people' s satisfaction." Addressing residents' aspirations for a better life and current urban development challenges, we must strengthen public services including healthcare, education, housing, elderly care, green spaces, and cultural-sports facilities to enhance residents' well-being, with community-level improvements as a priority. Communities are the basic urban units and primary areas for residents' daily activities, requiring scientifically rational resource allocation to create livable, business-friendly high-quality modern communities.

Accelerating the citizenization of migrant populations requires deepening institutional reforms such as the household registration system, facilitating settlement for eligible migrants and their families, ensuring equal access to basic urban public services, and promoting social integration. Urban construction must respond to differentiated needs across population groups, including the elderly and low-income vulnerable groups, by considering variations in age, gender, education, income, and consumption capacity. Fully leveraging the principal role of people in urban construction—by granting citizens rights to information, participation, expression, and supervision in urban planning and development—encourages multi-channel public engagement in urban construction and governance, representing crucial content for building people-oriented cities.

4.2 Guiding Diversified Urban Development Through Classification and Tiering

Urban systems are organic wholes composed of closely connected and interacting cities of different scales and functional divisions within specific regions, characterized by integrity, hierarchy, and dynamism. Influenced by population size, economic level, historical foundations, and natural conditions, cities exhibit significant differences in development levels, pathways, and models that will persist. At the national level, top-level design and strategic layout should establish rational urban systems for urbanized areas, clarifying functional positioning and policy priorities for cities of different scales, levels, and types, while advancing people-centered new-type urbanization and constructing a new pattern of coordinated development among large, medium, and small cities.

Super-large and mega-cities function as economic engines and growth poles, making their development transformation crucial. According to the seventh national census data, 7 mega-cities and 14 large cities account for 20.7% of the national population and over 30% of GDP, necessitating accelerated development transformation and pioneering Chinese urban modernization in social integration, technological innovation, regional integration, resilient and sustainable development, and refined governance. Large cities should enhance urban functions, strengthen factor agglomeration, technological innovation, and high-end service capabilities, further leveraging regional central cities' scale and radiation effects while strengthening connections with super-large/mega-cities and small/medium cities, promoting functional diffusion through commuter circles, and cultivating modern metropolitan areas.

Medium-sized cities should identify their functional positioning, leverage comparative advantages and local central city roles, explore distinctive urban functions, industries, and cultural styles, scientifically plan urban scales, and coordinate production, living, and ecological spaces to build livable, business-friendly modern medium-sized cities. Small county-level cities should adapt measures to local conditions to address weaknesses, improve public services and industrial infrastructure, enhance urban development quality, attract rural residents for settlement and employment, and provide strong support for coordinating new-type urbanization and rural revitalization while promoting urban-rural integration. Small towns, as important links in urban systems and urban-rural integration, require objective understanding of their evolving roles in Chinese-characteristic new-type urbanization, with selective and focused promotion of healthy development.

4.3 Creating Green, Resilient, and Healthy Sustainable Urban Models

Global urbanized areas face common challenges including climate change, economic crises, and public health events, urgently requiring transformation toward green, resilient, and healthy sustainable cities. Green cities must achieve low energy consumption and carbon emissions, promoting green transformation in high-consumption and high-emission sectors such as buildings, energy, and transportation through energy-efficient green buildings, green circular economies, and public transport-dominated networks. Intensive and efficient land use avoids resource waste and long-distance transportation-induced high energy consumption and pollution. Systematic and balanced development of urban blue-green spaces should rationally allocate community parks and ecological green infrastructure.

Resilient cities emphasize urban elasticity in responding to climate change, natural disasters, and other risks. Scientific comprehensive disaster prevention planning should reserve emergency rescue spaces for floods, storms, fires, and epidemics, fully leverage urban ecological regulation functions, and strengthen intelligent transformation of pipelines, transportation, power grids, sewage, and waste treatment systems to improve disaster emergency response and rapid recovery capabilities. Economic resilience, including industrial chain and supply chain security for key urban industries, is also essential. Public health events have prompted greater attention to human health, integrating public health into all aspects of urban construction to achieve comprehensive healthy development for urban residents, designing healthier built environments to reduce exposure risks, and building safe, inclusive communities through refined social governance to achieve social integration and health equity.

4.4 Strengthening Urban Technological Innovation Functions and Building Smart Cities

Innovation capability is a crucial indicator of national and ethnic core competitiveness, with comprehensive national strength competition among major powers fundamentally being competition in innovation capability, while cities serve as innovation sources and agglomerations. Enhancing innovation capabilities of universities and research institutions and cultivating innovative talent creates original innovation sources. Promoting industry-university-research-application integration forms collaborative innovation mechanisms that coordinate functional and resource advantages across production, education, and research to generate economic and social benefits from innovations.

Leveraging new technological revolutions represented by geographic knowledge graphs, IoT, cloud computing, big data, artificial intelligence, and 5G communications creates new "IoT+Internet" models for urban services and smart governance. Countries such as the UK, Japan, and Australia have made smart cities a key strategy for economic recovery. Information technology transforms interactions among government, enterprises, and the public, enabling cities to respond quickly and intelligently to various needs including public safety, urban services, environmental monitoring, and economic-social activities, thereby improving urban operational intelligence and efficiency.

4.5 Implementing Regular Urban Physical Examinations

"Urban management should be as meticulous as embroidery." Regularly conducting full-process urban physical examinations of "examination-evaluation-governance-improvement" can diagnose urban development problems and promote organic renewal for healthier, more sustainable urban development. Using people' s happiness and satisfaction as core measurement standards for urban examinations, combining rigid constraints with flexible control, and integrating qualitative and quantitative approaches, a reasonable multi-dimensional indicator system should be established. Dynamic monitoring and analysis of various indicators should be conducted with visualization and multi-scenario predictive analysis to identify prominent issues and risks in urban development regarding livelihood security and other aspects.

Analyzing indicator status during examination and evaluation processes helps dissect problems and underlying mechanisms to identify root causes of urban diseases at the source. Establishing urban governance mechanisms enables timely and effective feedback, updating, optimization, and adjustment of governance processes. Multi-department collaborative governance mechanisms should be strengthened to enhance communication, coordination, and urban governance efficiency. Further institutional guarantees and long-term working mechanisms for regular examinations should be established, leveraging urban physical examination and evaluation' s important role in urban territorial spatial planning formulation, implementation, and dynamic monitoring to continuously improve urban construction and development and advance urban modernization.

References

1. Ge Q S, Fang C L, Jiang D. Geographical missions and coupling ways between human and nature for the Beautiful China Initiative. *Acta Geographica Sinica*, 2020, 75(6): 1109-1119. (in Chinese)
2. Yang L S, Deng H Y, Liao X Y, et al. Progress and prospect of the construction of Beautiful China supported by science technology. *Chinese Journal of Environmental Management*, 2022, 14(6): 17-24. (in Chinese)
3. Lu D D. Research content framework of geography on urbanization field. *Scientia Geographica Sinica*, 2013, 33(8): 897-901. (in Chinese)
4. Fan J, Zhao Y N. China' s regional development pattern oriented toward modernization: The scientific connotation and strategic priorities. *Economic Geography*, 2021, 41(1): 1-9. (in Chinese)

5. Fang C L. Basic rules and key paths for high-quality development of the new urbanization in China. *Geographical Research*, 2019, 38(1): 13-22. (in Chinese)
6. Chen M X, Zhou Y, Tang Q, et al. New-type urbanization, well-being of residents, and the response of land spatial planning. *Journal of Natural Resources*, 2020, 35(6): 1273-1287. (in Chinese)
7. Bren d' Amour C, Reitsma F, Baiocchi G, et al. Future urban land expansion and implications for global croplands. *Proceedings of the National Academy of Sciences of the United States of America*, 2017, 114(34): 8939-8944.
8. Brockmann D, Helbing D. The hidden geometry of complex, network-driven contagion phenomena. *Science*, 2013, 342: 1337-1342.
9. Gong P, Li X C, Zhang W. 40-Year (1978-2017) human settlement changes in China reflected by impervious surfaces from satellite remote sensing. *Science Bulletin*, 2019, 64(11): 756-763.
10. Li L, Zhan W F, Hu L Q, et al. Divergent urbanization-induced impacts on global surface urban heat island trends since 1980s. *Remote Sensing of Environment*, 2023, 295: 113-124.
11. Manoli G, Fatichi S, Schläpfer M, et al. Magnitude of urban heat islands largely explained by climate and population. *Nature*, 2019, 573: 55-60.
12. Weng Q H. Remote sensing of impervious surfaces in the urban areas: Requirements, methods, and trends. *Remote Sensing of Environment*, 2012, 117: 34-49.
13. Li X C, Gong P, Zhou Y Y, et al. Mapping global urban boundaries from the global artificial impervious area (GAIA) data. *Environmental Research Letters*, 2020, 15(9): 094044.
14. Yang J, Huang X. The 30 m annual land cover dataset and its dynamics in China from 1990 to 2019. *Earth System Science Data*, 2021, 13(8): 3907-3925.
15. Sun B D, Jin X X, Lin J. China' s new pattern of urbanization toward coordinated development of large, medium and small cities: Evolution and determinants of city size distribution since 1949. *Geographical Research*, 2019, 38(1): 75-84. (in Chinese)
16. Chen M X, Ye C, Lu D D, et al. Cognition and construction of the theoretical connotation for new-type urbanization with Chinese characteristics. *Acta Geographica Sinica*, 2019, 74(4): 633-647. (in Chinese)
17. Zhang W Z, Xu J X, Ma R F, et al. Basic connotation, current situation, and development orientation of high-quality development of Chinese cities: Based on the survey of residents. *City Planning Review*, 2019, 43(11): 13-19. (in Chinese)

18. Chen M X, Sui Y W, Guo S S. Perspective of China' s new urbanization after 19th CPC national congress. *Geographical Research*, 2019, 38(1): 181-192. (in Chinese)

19. Zhang W Z. Theoretical basis and methods of city health examination evaluation in China. *Scientia Geographica Sinica*, 2021, 41(10): 1687-1696. (in Chinese)

20. Chen M X, Ye C. Thoughts and suggestions on deepening the development of new urbanization and urban-rural integration. *Governance*, 2020, (32): 42-45. (in Chinese)

21. Zhou Y X. *Urban Geography*. Beijing: The Commercial Press, 2003. (in Chinese)

22. Fang C L. A review of Chinese urban development policy, emerging patterns and future adjustments. *Geographical Research*, 2014, 33(4): 674-686. (in Chinese)

23. Chen M X, Liu W D, Lu D D. Challenges and the way forward in China' s new-type urbanization. *Land Use Policy*, 2016, 55: 334-339.

24. Fang C L, Liang L W, Wang Z B. Quantitative simulation and verification of upgrade law of sustainable development in Beijing-Tianjin-Hebei urban agglomeration. *Science China Earth Sciences*, 2019, 62(12): 2031-2049.

25. Chen M X, Zhang H. The changing role of small towns in China and suggestions for their high-quality development. *Governance*, 2022, (8): 21-26. (in Chinese)

26. Chen M X, Xian Y, Wang P L, et al. Climate change and multi-dimensional sustainable urbanization. *Acta Geographica Sinica*, 2021, 76(8): 1895-1909. (in Chinese)

27. Elmqvist T, Andersson E, Frantzeskaki N, et al. Sustainability and resilience for transformation in the urban century. *Nature Sustainability*, 2019, 2(4): 267-273.

28. Keith M, Birch E, Buchoud N J A, et al. A new urban narrative for sustainable development. *Nature Sustainability*, 2023, 6(2): 115-117.

29. Zhao R D, Fang C L, Liu H M. Progress and prospect of urban resilience research. *Progress in Geography*, 2020, 39(10): 1717-1731. (in Chinese)

30. Lu F, Yu L, Qiu P Y. On geographic knowledge graph. *Journal of Geo-Information Science*, 2017, 19(6): 723-734. (in Chinese)

31. Vinuesa R, Azizpour H, Leite I, et al. The role of artificial intelligence in achieving the Sustainable Development Goals. *Nature Communications*, 2020, 11: 233.

32. Wang G T, Li F. Construction of new smart city powered by informatization—Effects thinking of COVID-19 epidemic on urban development.

ChinaRxiv 中X

Bulletin of Chinese Academy of Sciences, 2020, 35(8): 1024-1031. (in Chinese)

CHEN Mingxing is a Professor (distinguished core position) at the Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences (CAS), and a Professor at the University of Chinese Academy of Sciences. He serves as Deputy Director of the CAS Key Laboratory of Regional Sustainable Development Modeling. His main research fields focus on urbanization, regional development, and spatial governance. E-mail: chenmx@igsnrr.ac.cn

Corresponding author

Responsible Editor: Zhang Fan

Note: Figure translations are in progress. See original paper for figures.