

Article

Research on the Development of Medium-sized Cities from the Perspective of a Metropolitan Area—A Case Study of Ziyang City in the Chengdu Metropolitan Area

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Abstract: The Chengdu metropolitan area serves as the hub of the western region's development and the western pole of the Chengdu-Chongqing region's twin-city economic circle. Chengdu metropolitan area is in the development stage of agglomeration as well as diffusion in rapid urbanization and economic globalization. As a medium-sized city in the Chengdu metropolitan area, Ziyang city must determine its urban function positioning in the future based on the spatial structure characteristics of the Chengdu metropolitan area for industrial and economic layout optimization as well as for the rapid and coordinated development of the entire Chengdu metropolitan area, more importantly, to maximize its benefits.

Keywords: Chengdu metropolitan area, Regional planning, Ziyang city, Medium-sized city

1. Introduction

The interaction and spatial structure of the urban system are continually changing due to fast urbanization and economic globalization, and regions are playing an ever-more-important role in globalization [1,2]. The rivalry between nations and governments has also given the rivalry between various nations and regions [3]. In China, regional space is currently dominated by metropolitan areas and changes in the spatial growth of these cities significantly impact regional development patterns.

Medium-sized cities in the metropolitan area have overall competitiveness that lags behind that of the core cities but outperforms that of other larger cities, and serve as a strong radiation and attraction to the surrounding municipalities and villages [4]. Medium-sized cities play an important role in breaking down administrative barriers, strengthening economic ties, and integrating regional resources in metropolitan areas, and are extremely useful in hastening metropolitan development [5–7]. To achieve reasonable and efficient metropolitan development, small, medium, and large cities must be cooperating. The characteristics of metropolitan areas at different stages of development differ, as does the focus on function enhancement in small and medium-sized cities. Therefore, the functional positioning of medium-sized cities within the metropolitan area, which dominates regional spatial development, is related not only to the development prospects of cities in regional development but also to the reasonable distribution of labor and industry collaboration within the metropolitan area. Thus, the positioning determines whether the metropolitan area can develop healthily.

2. Study Area

2.1. Chengdu Metropolitan Area

The Chengdu metropolitan area is located in Sichuan Province's central-eastern region, at the watershed between the Chengdu Plain and the western mountainous region, and is the focal point of the "One Belt, One Road" initiative and the Yangtze River Economic Belt strategy. The region covers Chengdu, the capital of Sichuan Province, and three prefecture-level cities of Deyang, Meishan, and Ziyang, containing 17 districts and 18 counties (cities) with a total area of 33,100 km² (Fig. 1).

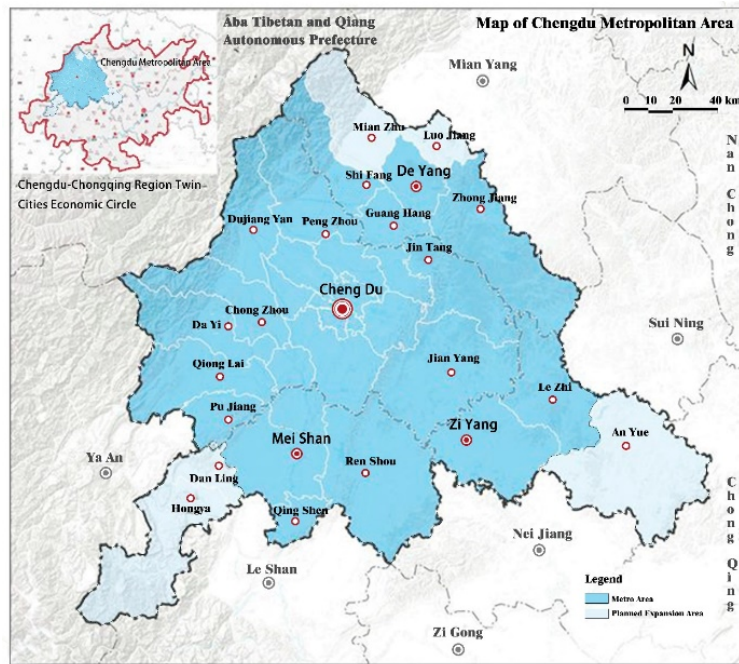


Fig. 1. Map of Chengdu metropolitan area.

2.2. Ziyang City

Ziyang City, with 1 district and 2 counties and a total area of 5747 km², is located in the southeast of Sichuan, between Chengdu and Chongqing, and is the only prefecture-level city that borders two national central cities at the same time. Ziyang has benefited directly from the national implementation of a main regional development strategy in the national strategy of building a twin-city economic circle in Chengdu and Chongqing (Fig. 2).

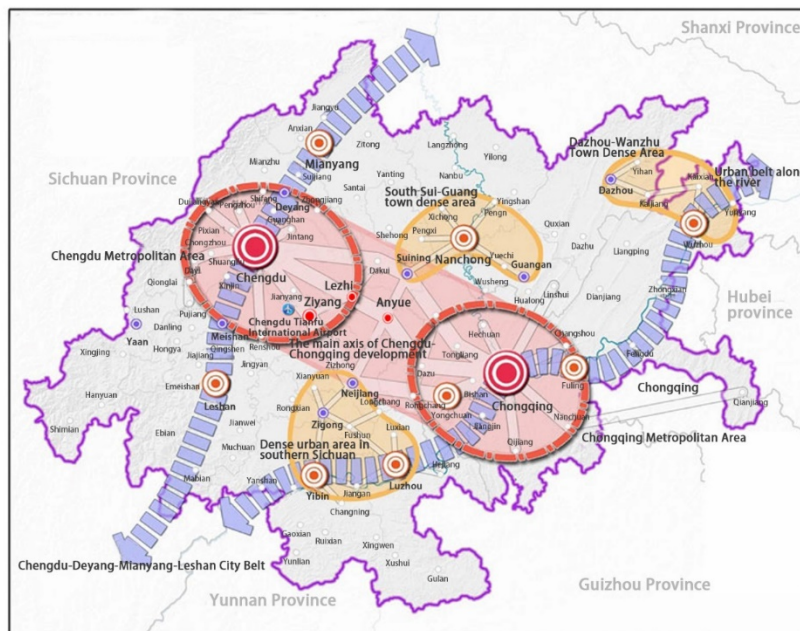


Fig. 2. Location map of Ziyang, a twin-city economic circle in the Chengdu-Chongqing region.

2.3. Data Sources

Statistical data are primarily obtained from the Chengdu, Deyang, Ziyang, and Meishan 2016–2019 Statistical Yearbook, as well as from the official websites of the People’s Government and the Bureau of Statistics. Data is corrected according to the statistics from various cities in Sichuan Province.

3. Development Characteristics of Chengdu Metropolitan Area

3.1. Development Stage of Chengdu Metropolitan Area

The Chengdu metropolitan area is in the late stage of industrialization. In 2021, the GDP of the Chengdu metropolitan area is 2.5 trillion yuan, which is only half that of the Shenzhen metropolitan area. The GDP is similar in size, and the GDP per capita is 80,000 yuan which is about half of the Shanghai metropolitan area. The Shanghai metropolitan area is just entering the primary stage of a developed economy (Fig. 3). However, the GDP per capita of Chengdu, the central city, is significantly higher than the average of the metropolitan area and Sichuan province. In 2020, the primary industry employment ratio in the three peripheral cities of Deyang-Meishan-Ziyang was as high as 41.5% (only 7.6% in the eight peripheral cities of the Shanghai metropolitan area), while the secondary industry employment ratio was only 25.2% (52.2% in the eight peripheral cities of Shanghai metropolitan area). The statistics indicates that the Chengdu metropolitan area is still in the growth and development stage.

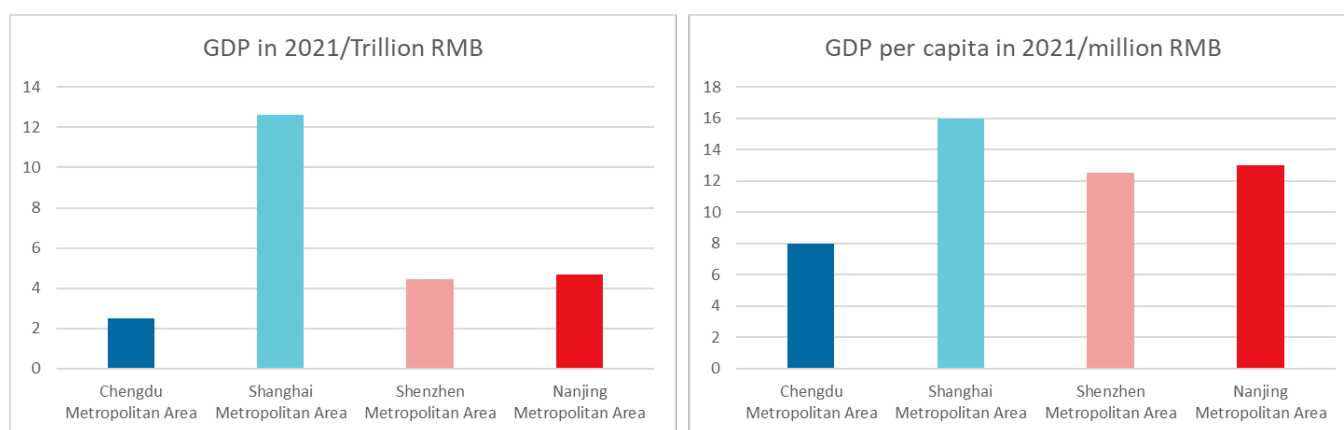


Fig. 3. GDP of Chengdu metropolitan area and other metropolitan areas.

3.2. Spatial Structure of Chengdu Metropolitan Area

The Chengdu metropolitan area currently has a typical circle structure with three circles and three development axes. The first circle is the core circle which includes Chengdu’s central city, and its districts (cities) and counties. The central circle is concerned with boosting the city’s capacity and capabilities that drive the common development of the surrounding areas and continuously enhance the capability and level of leading radiation. The second circle is the close circle, which includes the cities of Deyang, Meishan, and Ziyang. The close circle focuses on taking over the core circle’s non-center function spillover, strengthening multi-discipline cooperation with the core circle, integrated comprehensive transportation construction, and co-location. The opportunity circle layer, which includes Mianyang, Leshan, Ya’an, Suining, Neijiang, and Zigong, is the third circle. The opportunity circle’s focus is to drive the common radiation of the core circle and the close circle [8].

The Central Optimization Development Axis, which stretches from Chengdu’s central city southward to Mianyang and northward to Leshan, is one of the three development axes. It is a high-end service gathering zone that caters to creative people and integrates the local tourism industry. The basic manufacturing and heavy equipment industry belt east of Longquan Mountain is the eastern integrated development axis, which accelerates opening to the east, docks to the Yangtze River Economic Belt, and takes over the eastern industry cluster-based movement as well as the transfer and transformation of innovative successes. The Longmen Mountain ecological control zone is located to the west of the third axis, and Chongqing is located to the east of it (Fig. 4).

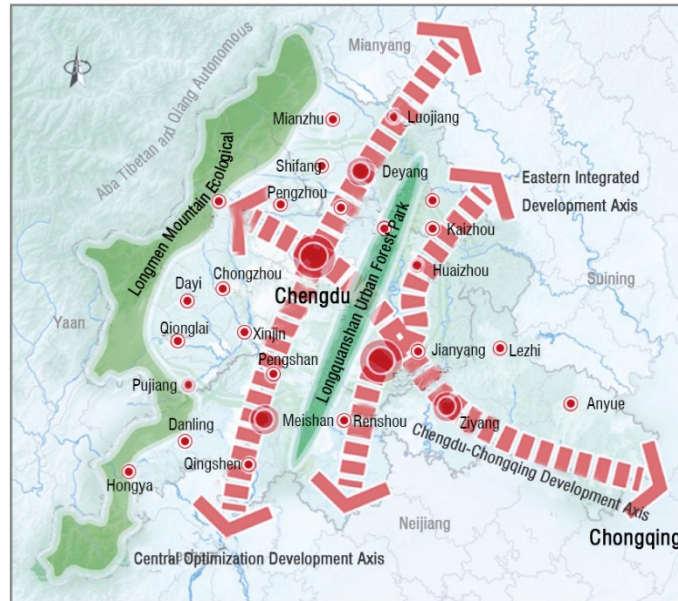


Fig. 4. Spatial structure of Chengdu metropolitan area.

3.3. Demographic Characteristics of Chengdu Metropolitan Area

3.3.1. Population Agglomeration

The core-periphery divergence in population agglomeration and urbanization rate is obvious, and the area is in the stage of core city polarization. Chengdu city's resident population accounted for 64.7% of the metropolitan area's resident population in 2019, and the city is home to 93% of the new resident population of the metropolitan area and 73% of its new urban population (Fig. 1). In 2019, Chengdu city's resident population urbanization rate was 74.4%, ranking first in the province, while most counties in Ziyang had urbanization rates below 50%.

3.3.2. Population flow characteristics

The population is steadily growing but represents a small proportion of the regional population. There is population outflow from the peripheral districts and counties (Fig. 5). In 2019, the Chengdu metropolitan area had a resident population of 25.64 million, accounting for 30.6% of the province's population which was increased from 30% in 2012. However, there was still a significant gap with the regional share of 43.6% held by the Shanghai metropolitan area. Approximately one-third of the household population in the peripheral districts and counties of the metropolitan area emigrated.

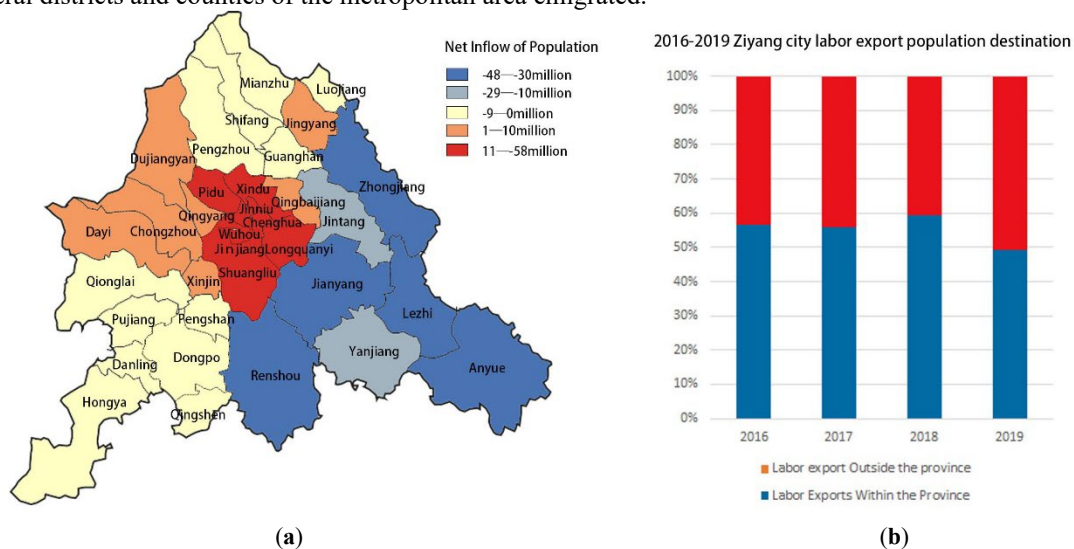


Fig. 5. Net Inflow of Population by District and County in Chengdu Metropolitan Area (a) and Destination of Population Export in Ziyang City (b).

3.4. Economic Characteristics of Chengdu Metropolitan Area

3.4.1. Industrial Characteristics

All four cities proposed industries for electronics, information technology, equipment manufacturing, biomedicine, advanced materials, trade and logistics, cultural tourism, and food and beverage in the leading industrial development system. The four cities have a large scale of industrial cluster development in special equipment, automobiles, Chinese medicine, food and beverage, and so on. This suggests that the overlap of individual enterprises and products in the “industrial chain” is not competitive in the supply chain, making benefit distribution coordination more difficult [9,10].

3.4.2. Characteristics of Economic Linkages

The concept of gravity serves as an inspiration for the study of inter-city economic connectivity and logistics, and it is thought that regional economic linkage follows a law of gravitation. Experts and academics in the world have advanced ideas and techniques such as the diffusion potential, integrated scale, and basic gravitational model [11,12]. The following is an equation for determining the economic interdependence of two cities [13].

$$R_{ij} = k \frac{\sqrt{P_i * V_i} * \sqrt{P_j * V_j}}{D_{ij}^2} \quad (1)$$

where R_{ij} is the intensity of economic ties between cities i and j , P_i and P_j is the total population of cities i and j , V_i and V_j is the GDP of cities i and j , and D_{ij}^2 is the square of the shortest travel distance between the two cities.

It is discovered that there are poor demographic and economic ties in the Chengdu metropolitan area. Chengdu is the focal point of more than 60% of the metropolitan area’s investment connections and 46% of cross-regional population flows (Fig. 6).

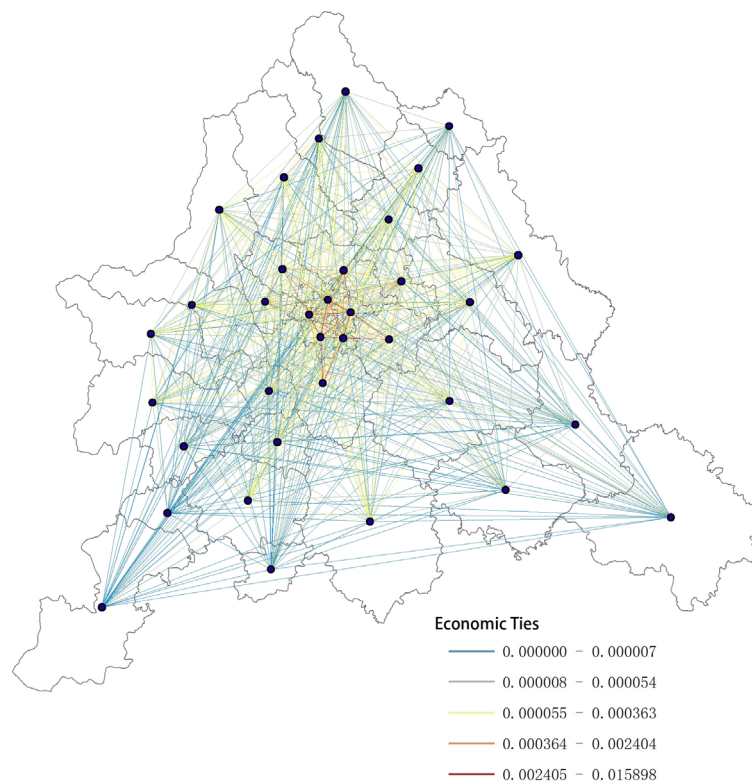


Fig. 6. Economic links between cities in the Chengdu metropolitan area.

3.5. Traffic Characteristics of Chengdu Metropolitan Area

For the development of the Chengdu-Deyang-Meishan-Ziyang co-city, Chengdu Municipality prioritizes the concept of traffic and pushes urban integrated development of Chengdu-Deyang-Meishan-Ziyang with the transportation development of the collocation of Chengdu-Deyang-Meishan-Ziyang. Traffic homogeneity has begun to show its results after nearly two years of work on the Chengdu-Deyang-Meishan-Ziyang traffic link into a circle.

In contrast to the established metropolitan centers in the east, the Chengdu metropolitan area’s existing transportation system undoubtedly still has issues. According to the separation between stations and the city center, all stations are grouped into 4 circles, and the distribution ratio of stations in each circle is analyzed. The findings indicate that the current Chengdu rail transit still primarily meets the city’s internal transportation needs and that the connectivity with the suburbs and other cities in the metropolitan area needs to be improved [14]. The results also show that the number of stations in the first two circles exceeds 90%, and the stations outside 20 km are scarcely distributed (Fig. 7).

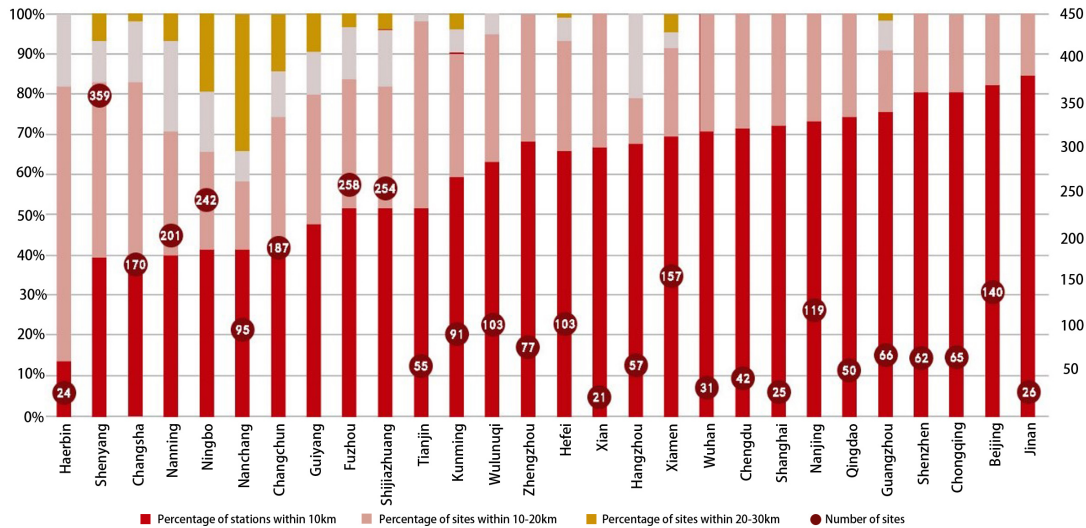


Fig. 7. Total number of stations in each city and their distribution in different circles.

3.6. Ecological Characteristics of Chengdu Metropolitan Area

3.6.1. Ecological Base

Located in the upper reaches of the Yangtze River, the Chengdu metropolitan region has a diverse topography and landforms. The Chengdu Plain and the eastern hills are separated by Longquan Mountain to the east. Three important water systems of the Minjiang, Tuo, and Ful rivers, and the Dujiangyan irrigation area’s main coverage are well-developed as water systems in the region. One of the separating lines between the first and second rungs of the Chinese ladder is located in the west between the Longmen Mountains and the Qionglai Mountains (Fig. 8).

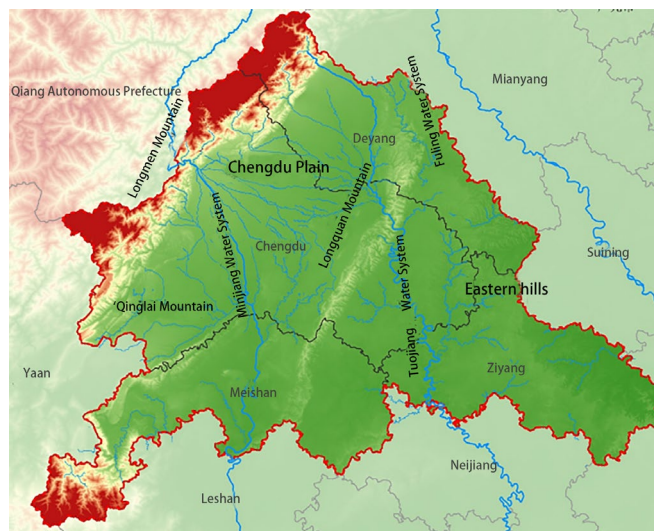


Fig. 8. Chengdu metropolitan area ecological base.

Due to its flat topography, abundant water system, and high-quality agricultural land, the plain area between the two mountains has a large concentration of towns. On the west side of Longquan Mountain, Chengdu-Deyang-Ziyang-Meishan demonstrates a

continuous development of towns. The topographic restrictions have limited Ziyang City's development continuously. The environment in Chengdu's plain area, which has the limited atmospheric capacity, is degrading due to ongoing urbanization, whereas the hilly area in the east, which has strong development potential, has low development intensity (Fig. 9). It is necessary to better align the ecological background and overall spatial growth pattern.

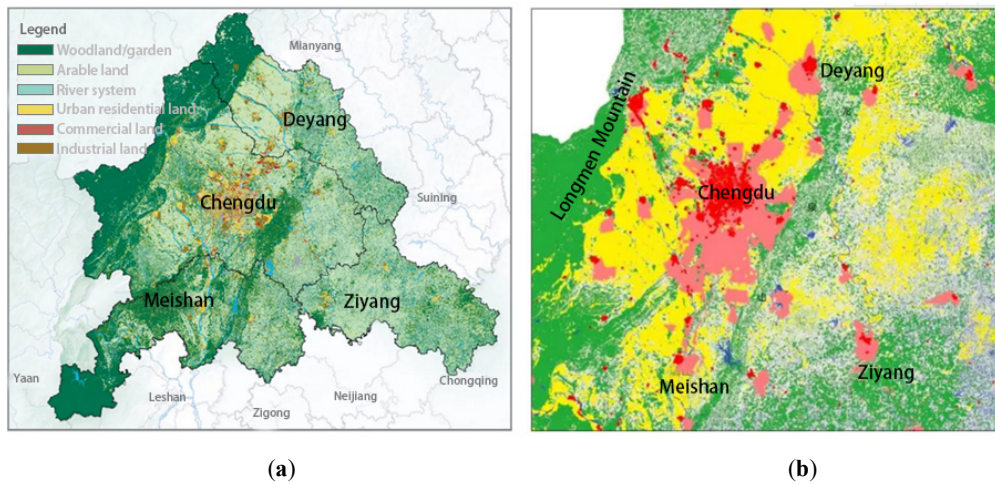


Fig. 9. Status of land use in Chengdu metropolitan area 2020 (a) and gradual contiguous trend of land use in Chengdu-Deyang-Meishan (b).

3.6.2. Evaluation of Ecological Environment Quality

There is a significant geographic disparity in the ecological environment quality, which exhibits a modest negative tendency overall in the metropolitan area [15]. According to the results of the comprehensive development index of urbanized ecological environment quality, the ecological environment quality of Chengdu is significantly higher than that of other cities, and the changes are more temporary with an overall decreasing trend, whereas the ecological environment quality of peripheral cities in the metropolitan area is lower, and the changes are less pronounced.

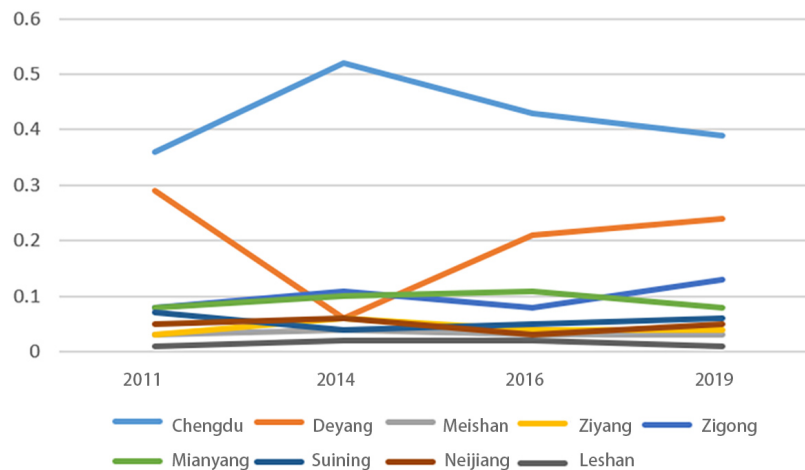


Fig. 10. Comprehensive development index of ecological quality.

4. Development Positioning of Ziyang City in the Context of the Chengdu Metropolitan Area

4.1. Opportunities and Challenges

4.1.1. Advantages in Location

Since ancient times, Ziyang has been an important transportation hub on the ancient post road of Chengdu and Chongqing [16]. It is located on the connection line between Chengdu and Chongqing in the southeast of Chengdu metropolitan area, 85 km away from the center of Chengdu, welcoming Chengdu in the west and connecting Chongqing in the east. It is the only city in the province

that connects Chengdu and Chongqing “double core” at the same time. Ziyang has been integrated into Chengdu and Chongqing in one-hour economic circles, which continues to drive the growth of people, logistics, capital flow, and information flow.

4.1.2. Development Opportunities

The multiple policy opportunities for building the economic circle of the twin city continue to exist, and the first breakthrough occurs in three areas. To begin, it coincides with the construction of major transportation projects such as the Chengdu-Zigong-Yibin high-speed railway, the Chengdu-Dazhou-Wanzhou high-speed railway, and the Chengdu-Chongqing mid-line high-speed railway to solidify the foundation of co-city. Second, the industrial ecology of Chengdu and Chongqing is concentrated in terms of industrial interaction to jointly construct the advanced manufacturing industry cluster on the east side of Longquan Mountain. There are also the Ziyang-Dazu cultural tourism integration and development demonstration area and an industrial clustering demonstration area in central Chongqing. Third, relying on Chengdu East New District and Tianfu International Airport, the construction of Chengdu East New District Ziyang Synergy Zone, Chengdu-Ziyang Airline Economic Industrial Zone, Tuojiang Green Economic Development Zone are accelerated, linking Chengdu to create a comprehensively integrated zone and logistics center with other special customs supervision areas and promote the development of Chengdu-Ziyang co-city.

4.1.3. Regional Competition Challenges

Inadequate regional economic development is the first challenge to overcome. On the one hand, Ziyang’s all-around strength is insufficient. Ziyang has a small population in comparison to the “co-city” region. On the other hand, Ziyang’s development pace is slow. The growth rate of most indicators of Ziyang’s GDP such as secondary and tertiary production, investment, total retail sales of consumer goods, and residents’ income in 2019 is lower than the provincial average and is also slower than the “crosstown” region (Table 1). The level of industrial development is low, and so is the proportion of high-tech industry output. Overall, there is still a lot of room for improvement in the integration of adult capital.

Table 1. Comparison of the industrial structure of the “crosstown” region in 2019.

	The proportion of added value of the third output value to GDP		Local general public budget revenue as a percentage of GDP		The proportion of operating income of industrial profits above the scale		Financial deposit and loan ratio	
	Number of completion (%)	Ranking	Number of completion (%)	Ranking	Number of completion (%)	Ranking	Number of completion (%)	Ranking
Chengdu	1483	1	11,693.2	1	7478.4	3	39828	1
Deyang	125	4	3451.8	4	907.7	1	2924.8	2
Meishan	110.8	3	1513.4	2	548.7	4	2325.6	4
Ziyang	53.1	2	609.4	3	416.3	2	1470.4	3
Total	1771.8	-	17,267.8	-	9351	-	46,548.8	-

4.2. Analysis of Ziyang’s Functional Positioning from the Spatial Structure of the Chengdu Metropolitan Area

From the standpoint of the Chengdu metropolitan area’s overall development trend, Chengdu is entering a concentrated period of industrial emigration and diffusion, which is also critical for neighboring cities to undertake industrial transfer, optimize the local economic system, and integrate into the Chengdu metropolitan area. Furthermore, Chengdu’s new industries require regional collaboration, and it is a critical time for neighboring cities to capitalize on various opportunities for industrial upgrading in Chengdu. As a result, analyzing Ziyang’s functional positioning and industrial development is necessary from the perspective of the spatial structure of industrial function development in the Chengdu metropolitan area and Ziyang to determine the main functions in the future.

With the Tianfu New Area of Chengdu on the left and the Liangjiang New Area of Chongqing on the right, Ziyang in the Chengdu metropolitan area as the “Chengdu-Chongqing gateway hub and the emerging city in the air,” stands at the intersection of the national strategy of “the construction of the twin-city economic circle of Chengdu and Chongqing.” Focusing on the “three comparative advantages” of the gateway hub, airside economy, and park city, the city proposes to adhere to the strategic support of Chengdu-Ziyang co-city, accelerate the construction of the gateway hub with airside economy and park city and leads to the rise of the central Chengdu-Chongqing region. It will be the first breakthrough area in city integration, leading to the rise of the central part of the Chengdu-Chongqing region, designating it as a “pioneer area of city integration, a gathering area of air traffic economy, and a demonstration area of park city”. The construction of a modern and international national air traffic economic zone and a

demonstration area of cultural and tourism integration development is accelerated, focusing on building a “China Dental Valley” to accelerate the development of the countermeasures of Ziyang in the context of the metropolitan area co-location.

5. Research on Countermeasures for Ziyang’s Development in the Urbanization of the Metropolitan Area

5.1. Interconnection and Interoperability to Establish an Eastern Chengdu Transportation Hub

Interconnection and interoperability are critical to the growth of the same city. The level and convenience of interconnection between Ziyang and other cities in the Chengdu metropolitan area need to be improved to facilitate labor mobility, guide the hierarchical and efficient organization of rail transportation, promote bus operation, and construct a rail-based metropolitan area. It is required to build a transportation hub in eastern Chengdu under the concept of “interconnection, seamless connection, same network and standard, one operation.”

5.2. Industrial Synergy and Active Integration into Chengdu’s Industrial Layout

Ziyang not only has a superior location, transportation, and labor resources, but also has many industrial development platforms with excellent functions such as the new airport industry city, “China Dental Valley,” Yanjiang Industrial Concentrated Development Zone, and Anyue and Lezhi Economic Development Zone. The city has been actively docking into Chengdu’s industrial layout with biomedicine, new materials, food processing, ICT, and other industries in the Chengdu metropolitan area and has been vigorously transferring industries, people, logistics, and information from Chengdu to Chongqing.

5.3. Linkage and Openness, Collaborate to form an Investment Attraction Alliance

Ziyang can learn from Chengdu’s experience to act for “comprehensive improvement of the business environment in the year,” collaborate to establish the Chengdu metropolitan area investment attraction alliance, specifically set up a Ziyang investment promotion branch in Chengdu, join to play the “metropolitan area” “co-city” brand, collaborate to carry out the reform of separation of economic zones and administrative districts, and promote regional cooperation. Through the “city circle” and “crosstownization”, the reform of the economic zone and the administrative district moderate separation can be carried out to promote regional cooperation benefit-sharing, cost-sharing, park co-construction by using the West Expo and other major activities to jointly plan and package project introduction.

5.4. Joint Prevention and Treatment Are Required to Effectively Address Transboundary Ecological Issues

It is demanded to match the regional spatial development pattern to the ecological background conditions and build development zoning around the ecological background conditions of Longmen Mountain, Chengdu Plain, Longquan Mountain, and Chuanzhong Hills. Ziyang is positioned as the eastern spanning area, a representative of the ecological civilization era with the topographic features of Fang Mountain and hills and moderate increment. The protection and utilization of the Tuo River water system need to be strengthened for embracing a networked and multi-centered organization. It is required to share monitoring data from the four “Chengde Meizi” cities’ atmosphere, water, and soil, as well as dealing with cross-border ecological and environmental issues.

5.5. Improving People’s Livelihood and Building a Public Service-sharing Platform

Ziyang needs to improve collaboration and share public services. In particular, in caring for the elderly, Chengdu’s high-quality elderly service enterprises need to be introduced to Ziyang layout development. In medical care, it is demanded to encourage provincial and Chengdu hospitals such as Sichuan University West China Hospital, Sichuan Provincial People’s Hospital, Chengdu Medical College, and Ziyang City to deepen medical cooperation and carry out close multi-modal medical association construction. Simultaneously, it is also needed to continue to promote the expansion and quality of medical insurance card settlement in other locations, as well as simplify the procedures for Ziyang citizens to travel to Chengdu for medical services. In terms of job security, we need to promote mutual recognition of work injury recognition and labor ability identification in Chengdu, Deyang, Meishan, and Ziyang as well as the development of a common employment information platform. In terms of vocational to compulsory education, we need to strengthen teacher training and upgrading in Ziyang, share high-quality educational resources, and promote the growth of industry-education integration.

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