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A Dynamic Performance and Differentiation Management Policy for Urban Construction Land Use Change in Gansu, China

Yajun Ma ¹, Ping Zhang ^{2,3}, Kaixu Zhao ⁴ , Yong Zhou ⁵ and Sidong Zhao ^{6,7,*}

- ¹ New District Branch, Lanzhou Urban and Rural Planning and Design Institute, Lanzhou 730030, China; myj13018333@163.com
- ² College of Civil Engineering and Architecture, Jiaying University, Jiaying 314001, China; ppqzhangp@zjxu.edu.cn
- ³ College of Architecture and Urban Planning, Lanzhou Jiaotong University, Lanzhou 730070, China
- ⁴ College of Urban and Environmental Science, Northwest University, Xi'an 710127, China; zhaokaixu@stumail.nwu.edu.cn
- ⁵ Graduate Institute of National Development, National Taiwan University, Taipei 10617, Taiwan; d07341002@ntu.edu.tw
- ⁶ School of Civil Engineering and Architecture, Guangxi University, Nanning 530004, China
- ⁷ School of Architecture, Southeast University, Nanjing 210096, China
- * Correspondence: 230189013@seu.edu.cn



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Abstract: Making efforts to promote rationalized urban construction land change, distribution, allocation, and its performance is the core task of territory spatial planning and a complex issue that the government must face and solve. Based on the Boston Consulting Group matrix, a decoupling model, and a GIS tool, this paper constructs a new tool that integrates “dynamic analysis + performance evaluation + policy design” for urban construction land. We reached the following findings from an empirical study of Gansu, China: (1) Urban construction land shows diversified changes, where expansion is dominant and shrink cannot be ignored. (2) Most cities are in the non-ideal state of LH (Low-High) and LL (Low-Low), with a small number in the state of HH (High-High) and HL (High-Low). (3) Urban construction land change and population growth, economic development, and income increase are in a discordant relationship, mostly in strong negative decoupling and expansive negative decoupling. (4) The spatial heterogeneity of urban construction land change and its performance are at a high level, and they show a slow upward trend. Additionally, the cold and the hot spots show obvious spatial clustering characteristics, and the spatial pattern of different indexes is different to some extent. (5) It is suggested that in territory spatial planning Gansu should divide the space into four policy areas—incremental, inventory, a reduction development policy area, and a transformation leading policy area—to implement differentiated management policies and to form a new spatial governance system of “control by zoning and management by class”. The change of urban construction land, characterized by dynamics and complexity, is a direct mapping of the urban growth process. The new tools constructed in this paper will help to reveal the laws of urban development and to improve the accuracy of territory spatial planning in the new era. They are of great theoretical significance and practical value for promoting high-quality and sustainable urban development.

Keywords: land use; territory spatial planning; urban expansion; performance evaluation; China

1. Introduction

1.1. Background

Urban construction land is the carrier of urban social, economic, political, and cultural activities, and it is also one of the most active and complex spatial phenomena in the region. Balancing the relationship between population growth, economic development, income

increase, and land resource consumption is the key to sustainable development in cities, and it is a hot research topic for planning, geography, urbanology, land science, and other sciences [1]. The scientific formulation of urban construction land scale and structure objectives, reasonable control of changes, and optimal distribution and allocation are the core elements of territory spatial planning and land use management, and they are also complex issues that the government must face and solve [2,3]. The change of urban construction land is a direct mapping of the urban growth process, and it has a comprehensive and a complex impact on regional economic growth, social development, ecological construction, and environmental protection [4]. For any city worldwide, land use change is a non-linear and a complex dynamic presentation that interacts with economic, social, cultural, political, and natural factors [5]. Therefore, it is of great theoretical significance and practical value to carry out research on the evolution characteristics of urban construction land and its effects, as it will help to reveal the laws of urban spatial change and to provide a basis for territory spatial planning [6].

Along with urbanization and industrialization, China has seen a rapid expansion in urban building land, characterized by both positive and negative effects, making it a key to spatial planning and governance and a typical representative in the world. Data from China's National Bureau of Statistics show that China's urban construction land area has increased from 6720 km² in 1981 to 58,355 km² in 2020, an increase of more than eight times with an average annual growth of nearly 6%, showing a trend of rapid expansion. The expansion of urban construction land is a double-edged sword, which on the one hand boosts the rapid development of regional economies and societies and on the other hand brings huge ecological and environmental pressure, leading to land degradation and waste and posing a great threat to cultivated land protection and food security [7,8]. How to control the change of urban construction land, improve the efficiency of the regional allocation of land resources and achieve a balance between the quantity and the structure of land supply and demand is a problem that the Chinese government and scholars are trying to solve. Therefore, an analysis of change characteristics, the evolution trend, the performance of urban construction land, and the formulation of precise management policies will facilitate revealing the law of urban spatial development in China and provide a decision-making basis for China's territory spatial planning in the new era, which is of great research value [9].

1.2. Aim and Question

As large-scale arable land is transformed into urban construction land during rapid urbanization and industrialization, how to meet the demand for land for healthy urban development while strictly adhering to the "red line" of cultivated land protection has become a daunting task and a major challenge for local governments. The coupling match of urban construction land change with population growth, economic development, and income increase is an essential prerequisite for the sound development of cities and also the core goal of territory spatial planning and land use management policies. However, current land mismatches [10], land use conflict [11], and the spatial misallocation of land supply [12] have become common in the regional allocation of land resources and in the formulation and the implementation of territory spatial planning.

China's central and local governments have implemented a series of urban construction land management policies and spatial plans in recent years, proposing targets for controlling the total amount and the change of urban construction land. However, a variety of factors such as policy precision, environmental complexity, the executive ability of actors, and the game intensity of stakeholders have led to unsatisfactory results in planning and policy implementation. Urban land expansion and spatial spread in most cities have not been put under effective control until now, so the government is in urgent need of a new tool that can provide a basis for the design of urban construction land change management policies.

This paper conducts an empirical study of Gansu based on a combination of GIS tools and the Boston Consulting Group matrix, and decoupling models, mainly focusing on the following questions: (1) What are the changing characteristics and evolution trends of urban construction land in Gansu? (2) What is the decoupling state (which of the eight decoupling types) between the change of urban construction land and population growth, economic development, and income increase in Gansu? (3) How to construct a differentiated land use management policy for Gansu based on a dynamic performance analysis of urban construction land, and to apply it to the preparation and the implementation of territory spatial planning? This paper attempts to reveal the spatio-temporal evolution pattern of urban construction land in Gansu through the study of the above issues and to build a new method that can integrate the “dynamic analysis–performance evaluation–policy design” of urban construction land, so as to provide new tools for territory spatial planning and differential land use management policy design in the new era.

2. Literature Review

2.1. Research Method and Model

With the increasing abundance of research methods and models as well as their rising technical complexity and application difficulty, the cross-application of multiple methods has been a new trend [13].

The use of GIS and remote sensing tools to analyze land use change is the most common approach [14,15]. For example, Arefin [16], Aal [17], Rahman [18], Suribabu [19], Zadbagher [20], Obeidat [21], Enoguanbhor [22], and Abuelaish [23] conducted critical analysis, respectively, of land use change in Rajshahi in Bangladesh, Najran City in Saudi Arabia, Delhi and Tiruchirapalli City in Bangladesh, Seyhan Basin in Turkey, Yarmouk River Basin in Jordan, Abuja City-Region in Nigeria, and Gaza Strip in Palestine, identifying the changing trends in different types of land such as urban construction land, cultivated land, and green space. Toure [24] analyzed the patterns of land use change in the Ghana metropolitan area. Halpern [25] analyzed the characteristics, causes, and consequences of land use change in Swaziland. Cabanillas [26] analyzed the impact of demographic and of economic changes on the border zone between Spain and Portugal. Gibas [27] analyzed the characteristics of land use change and its influencing factors in Europe from 2012 to 2018 from a sustainable development perspective. Lubowski [28] analyzed the driving forces of land use change in the U.S., using a spatial econometric model. Terama [29] found that demographic structure and dynamics are key factors driving urban land use change in Europe.

Machine learning, especially hybrid machine learning models, has become a new technique in the field of land use change prediction. Abijith [30], Khwarahm [31], Fita-wok [32], Nasiri [33], Nath [34], and Al-sharif [35] evaluated the uncertainty of cellular automata–Markov chain approach modeling, and they predicted and analyzed land use change in the northern coastal region of Tamil Nadu in India, Bahir Dar City in Ethiopia, Arasbaran region in Iran, and Tripoli Metropolitan City in Lebanon, depending on the approach. ZiaeeVafaeyan [36], Gounaridis [37], Levy [38], and Abdullahi [39] conducted a multi-scenario analysis of land use change by leveraging the cellular automata-random forest model, bee colony optimization, random forest-cellular automata modeling, and Bayes theory. Mustafa [40], Mustafa [41], and Samie [42] simulated land use change using a logistic regression model, the Time Monte Carlo method, and a Land System model.

The mixed use of multiple methods and comparative studies are emphasized, and there is an increasing number of research papers applying complex theories and multi-agent techniques. Rahnama [43] predicted the land use change of Melbourne from 2014 to 2050 based on the combination of Multilayer Perceptron neural networks and Markov chain model in ArcGIS and TerrSet software. Kumar [44] analyzed the long-term spatio-temporal evolution characteristics of land use in the United States from 1850 to 2000 by Nonlinear Bi-analytical mode. Models based on different paradigms are known to produce very different results, but these are not always equivalent or attributable to particular assumptions [45].

Avashia [46] captured the evaluation of different classification techniques: hybrid, unsupervised, decision tree classification, and object-based image analysis. Karimi [47] argued that land use change modeling is complex, dynamic and nonlinear, and they proposed to use a mixture of geographic information systems, remote sensing, fuzzy logic, cellular automata and multi-criteria decision analysis for analyzing land use change. Basse [48] integrated a variety of methods and tools such as cellular automata, geographic information system, and decision tree learning, and they developed a hybrid model for analyzing land use change and its drivers. Kocabas [49] constructed a complex theory-based land use change model relying on Bayesian networks and agent-based modeling. Wang [50] conducted a comparative analysis of logistic regression and survival analysis and found that the latter outperforms the former for spatial prediction of land use change. Ralha [51], Jjumba [52], and Schwarz [53] proposed a multi-agent model system and ABMLand (agent-based models land) tool for land use change simulation, and they analyzed the application with the examples of the Brazilian region of Cerrado and the City of Chilliwack in Canada.

Traditional research methods still have very strong vitality and they should not be neglected. Pullanikkatil [54] and Palmer [55] analyzed land use change and its drivers in Malawi and South Africa by the driver-pressure-state-impact-response approach. Okten [56] analyzed the relationship between residential land use change and urban sprawl in Turkey in 2010 and 2018 by hierarchical analysis. Mohammady analyzed land use change in Ramian County, Iran by the conversion of land use and its effects using model and hierarchical analysis, and they proposed an optimization proposal [57]. Based on grounded theory, Coral [58] explained land use change in Mindo, Ecuador and in the western foothills of Pichincha, Ecuador. Buya [59] developed a land use change analysis model by leveraging binary and multinomial logistic regression. Wilson [60] constructed a socio-geospatial approach to simulate the impact of civil war on land use change.

To sum up, the current research methods are becoming more and more diversified and complicated, and cross-disciplinary and multi-method research are increasing. However, it is difficult to transform and to apply the emerging methods, and the traditional methods have a weak direct guiding role in policy design and planning. The different models and methods adopt fundamentally different modeling paradigms, leading to a large variation in the results of analyses. The same methods and models, with different parameter settings, lead to different study findings, resulting in increased difficulties in comparing and integrating analyses between the findings of different papers. Of note is that high-tech research methods such as cellular automata, the Bayesian method, and multi-agent need special software, and they also require users to have better professional knowledge and skills. In reality, government employees and territory spatial planners often do not have such highly technical and complex knowledge, making it increasingly difficult to translate these research methods and their findings into practical work in territory spatial planning and land use management. The driver-pressure-state-impact-response approach, grounded theory, logistic regression, and other traditional methods have low technical difficulty, but they are more inclined to the description and the explanation of land use change phenomena, thus making them difficult to directly guide the practice of territory spatial planning and land management policy design. Overall, the available methods generally focus on urban land use change characterization, index measurement, performance evaluation, and trend simulation. Due to their gap, to a certain extent, in the preparation, implementation, and evaluation of territory spatial planning, there is an urgent need for new methods that can be directly applied to the planning process [61].

2.2. Response Planning and Policy

It is well known that land use change is in a complex interactive relationship with territory spatial planning and government management policies, and it has long received high attention from planners, policy makers, and researchers.

The studies focus on the interactions of land use change with territory spatial planning and government management policies. Spalding [62] analyzed the connection between

development processes and land policies in Latin America. Pareglio [63] argued that the lack of rational land use policy design has led to irregular and disorderly urban spatial development and a trend of decentralization. Sanchez [64] analyzed the impact of planning laws on the implementation of land use plans by comparing two planning models in Spain and in the Netherlands. Li [65] argued that policy is the main force driving land use change. Qu [66] analyzed the interaction between urban construction land expansion and land use policies. Vu [67] found that land development policies influenced changes in land use patterns. Sims [68] analyzed the impact of local regulations on land use change.

Land use change and its integrated impacts are incorporated into models, plans, and policies. Models built to analyze land use change, such as Markov chain, logistic regression, generalized additive models, and survival analysis, can help us accurately identify its characteristics, trends, causes, and impacts, and provide evidence for the formulation of territory spatial planning and land use policy design so that potential negative consequences can be eliminated or mitigated to the greatest extent [69]. Huber [70,71] proposed the formulation of cross-sectoral development policies and spatial planning. Koomen [72] applied the land use change model to regional spatial planning in the Netherlands. Schmidt [73] analyzed the evolution of land use planning tools and institutions in Germany, and they found a large gap between the strategic objectives of spatial governance and the actual dynamics of land use change in local and in regional planning. Milhorance [74] called for driving a shift from a policy mix to policy networks through an analysis of the interaction between land use policies and climate change in Brazil.

Studies focus on the subfields of industrial and agricultural land, with a small number of papers analyzing green space and woodland areas. Danilo [75] analyzed the evolution of Chicago's industrial land use policy and revealed how the relationship between land use planning and manufacturing has shaped the city. Dai [76] established a life cycle management of industrial land model for China. Teka [77] argued that the agricultural development policy of Ethiopia is the main driving force of land use change, directly affecting watershed land change and indirectly driving urban construction land change. Li [78] analyzed the change of agricultural land and its policy basis in Chongqing, China, and they found that a lower policy management level would result in a higher degree of uneven spatial distribution of agricultural land deagrarianization. Song [79] analyzed the cultivated land use change in China from 1999 to 2007, and they suggested the development of multifunctional land management policies based on regional differences to promote the sound development of cultivated land protection. Balikci [80] found a disconnect between realistic trends in urban land use change and urban green space policies through an analysis of the urban green space policies and compact urban development policies of Amsterdam and Brussels.

In summary, the research on land use change and its policies is rich in content and diverse in perspective; yet, there are still some limitations in the current research on how to integrate land use change and its performance evaluation into territory spatial planning and land use management policies [81]. First, less attention is paid to the analysis of the spatial effects of urban land use change. Although Adhikari [82] and Ganguly [83] proposed a spatial statistical model of land use change, Sidharthan [84] proposed the incorporation of spatial dynamics and spatial dependence into land use change models, and Jimenez-Moreno [85] compared and analyzed spatial methods that can detect urban land use change, there is still no land use management model available for integrating land use change dynamics, performance, and policy. Second, there is no technical tool for the design of differentiated urban construction land policies. Wang [86] argued that China has experienced large-scale land development and degradation, and land use benefits and change trends vary significantly in different regions, so differentiated policies should be developed. Since the scale of construction land development, utilization, and transformation modes vary markedly among different cities, a uniform management model would lead to land resource mismatch and efficiency loss. Differentiated management is to develop and to implement differentiated urban construction land use and management

policies based on the development stage and the resource endowment of a city so as to achieve a more rational and intensive use and a more refined and effective management of its land resources. However, as an exploratory study, it does not give a solution system regarding the scientific basis, realization path, and governance direction for carrying out differentiated policy design. Third, current studies mainly focus on industrial land and agricultural land, while there are few specialized studies on urban construction land, and some conclusions are in conflict, making them impossible to be applied in territory spatial planning. For example, Zhu [87] argued that construction land and population are in a weak decoupling, but Cao [88] found that population agglomeration is the first cause to drive the expansion of urban construction land. Urbanization and industrialization have generated a large demand for urban construction land, leading to a continuous increase in land supply pressure, but at the same time inefficient and idle urban construction land is widely found, with a coexistence of both “shortage and waste”. Therefore, it is necessary to study the characteristics, trends, patterns, and performance of urban construction land changes and their response policies under different scenarios of population growth, economic development, and income increase.

3. Research Design

3.1. Study Area: Gansu Province, China

The study area is Gansu, China, including 12 prefecture-level cities and 69 county-level cities (Figure 1). Gansu is an underdeveloped region in western China, located at the intersection of Loess Plateau, Qinghai-Tibet Plateau, and Inner Mongolia Plateau, crisscrossed by mountain ranges with complex and diverse landforms, long and narrow in its topography. In 2020, Gansu had a total population of 25,019,800, and it was at the stage of rapid urbanization development, with an urbanization rate of 52.23%. Gansu currently lags behind the national average in urbanization by 11.7%, and approximately 4% behind neighboring provinces and autonomous regions. Furthermore, with a GDP per capita of US\$5217 (about RMB 6.8996), it is in the medium stage of industrialization. In addition, there are large differences between Gansu’s cities in urbanization and industrialization development stages, and most cities are in the rapid urbanization development stage or pre- and mid-industrialization stage (Figure 2). Therefore, with an improvement in urbanization and industrialization, Gansu will see a higher urbanization rate in the future, resulting in a huge demand for urban construction land supply.

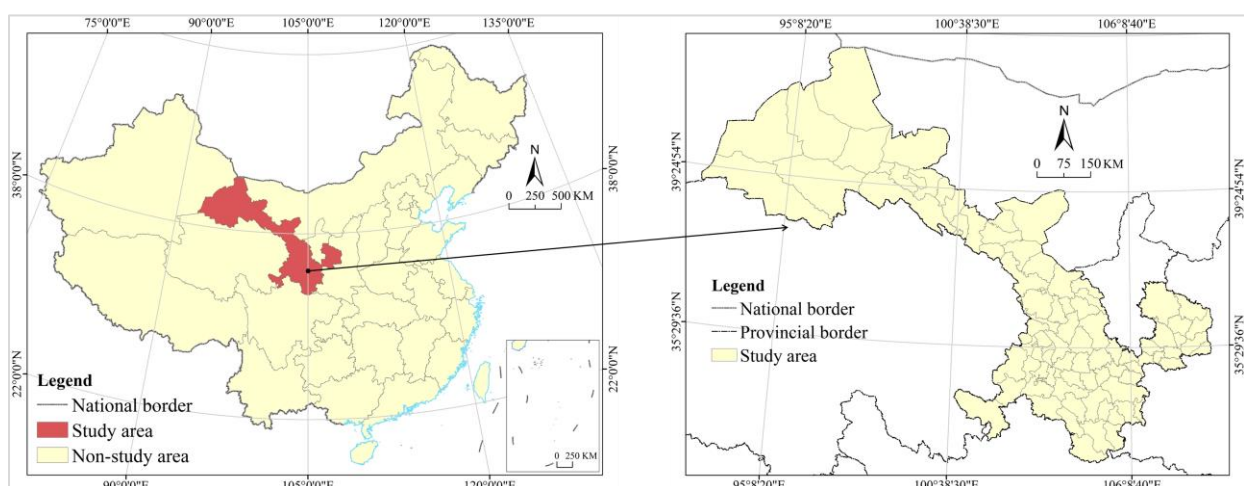


Figure 1. Study area.

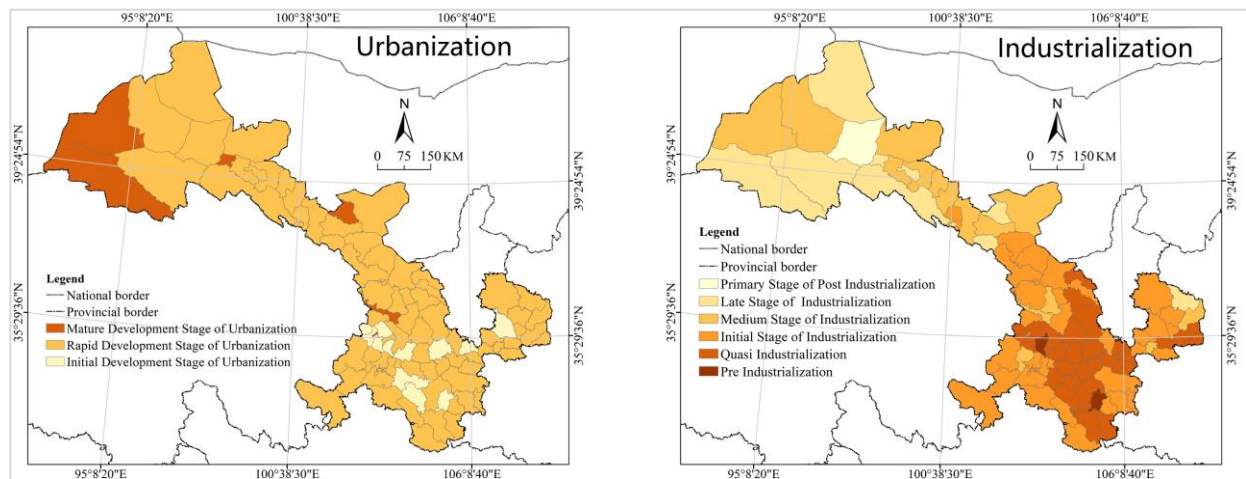


Figure 2. Analysis on the development stage of cities in Gansu province. Note: The thresholds for the classification of urbanization stages are 30% and 70%. In the industrialization stage, Chenery's standard was adopted, and per capita GDP was used as the indicator. The conversion of 1970 and 2020 US dollars is calculated according to the GDP deflator, and the index value is 5.25. Pre-industrialization <735 \$; quasi-industrialization <1470 \$, initial stage of industrialization <2940 \$, medium stage of industrialization <5880 \$, late stage of industrialization, 11,025 \$, primary stage of post industrialization <17,640 \$.

3.2. Index Selection and Data Sources

In view of data accessibility and comparability, this paper uses six indexes of urban construction land, added value of non-agricultural industries, per capita GDP, urban population, government revenue, and resident income. The research period is 2016–2020; the smallest spatial statistical units of the data is county-level city; and the data was collected on 2 March 2022. Economic development, especially industrialization, is a deep-seated driver of urban construction land expansion and change, and it is an essential standard to measure the level of quality development [89]. China is the largest developing country in the world, while Gansu is one of the most typical inland underdeveloped regions in China. Therefore, this paper chooses the added value of non-agricultural industries to represent the total economic output created by urban construction land inputs [90,91] and per capita GDP to represent the support of urban construction land investments for industrialization [92]. Besides, income increase is the core goal of urban construction land input in China, especially in Gansu, so this paper chooses government revenue and resident income to represent the government and the residents' income. The former shows the government's dependence on land finance, while the latter reflects the driving force of the consumption of land resources to the improvement of residents' living standards. Land finance refers to the case where governments at all levels are, to varying degrees, overly dependent on land resource-related revenues for revenue and expenditure, and it is a major display of the capitalization and the financialization of land resources [93,94]. In addition, against the background of increasingly intense human–land conflict, promoting the decoupling of urban population growth from urban construction land change is an essential prerequisite for the construction of new urbanization and an important measure of the harmony of the human–land relationship [95,96]. The data of urban construction land come from the *China Urban Construction Statistical Yearbook* published by the Ministry of Housing and Construction of China, and the statistical caliber is consistent with the *Code for Classification of Urban Land Use and Planning Standards of Development Land* (GB50137-2011) [97]. The other indexes are mainly from the *China City Statistical Yearbook*, and some missing data are from the *Gansu Provincial Statistical Yearbook* as well as the statistical yearbooks and statistical bulletins of cities.

3.3. Research Methods

3.3.1. Spatial Heterogeneity and Agglomeration Methods: CV, GI, CR, HHI

The coefficient of variation (CV), Gini index (GI), concentration rate (CR), Herfindahl–Hirschman index (HHI), Theil index, and entropy index as well as range and standard deviation [98] are common approaches to measure the dispersion and the concentration of variables, and this paper employs GI and CR to measure the spatial heterogeneity and agglomeration of urban construction land in Gansu and their changing trends [99]. GI has no dimension, and a larger value represents a greater inter-city gap and a higher level of spatial heterogeneity of urban construction land in Gansu. CR is expressed as a percentage, and a larger value indicates a higher degree of the spatial agglomeration and concentration of urban construction land in Gansu, reflecting the greater dominance and influence of large cities on the regional urban system. GI and CR are calculated as follows:

$$GI = 1 - \frac{1}{m} \left(2 \sum_{i=1}^{m-1} W_i + 1 \right) \quad (1)$$

$$CR = \frac{\sum_{i=1}^k X_i}{\sum_{i=1}^n X_i} \times 100\% \quad (2)$$

where n represents the number of cities in the study area, m represents the number of city groups, k represents the top k cities, and X_i represents the observed value of an indicator for the city i . It should be noted that the calculation of GI is complex, and it is calculated mainly by the following steps. In the first step, the raw data (without negative values) are arranged in ascending order; in the second step, the study area is divided into m groups with an equal number of cities; in the third step, W_i is calculated, i.e., the cumulative value of the city variable from group 1 to group i as a proportion of the total cumulative value of this variable; in the fourth step, GI is defined using definite integration, and the integration of the Lorenz curve is divided into the sum of the areas of m trapezoids with equal height; in the fifth step, the Lorenz curve is plotted, the upper and the lower areas of the curve are calculated; and the final value of GI is obtained by calculating the proportion of the upper area to the area of the triangle. Based on the GI and the CR values and the findings of available studies, this paper classifies spatial heterogeneity into three grades and concentration into six grades. According to the research protocols of scholars such as Zhao [100], Miyamoto [101], Bain [102], and Li [103] and the classification criteria of the United Nations Development Program, a classification criterion for spatial differentiation and concentration are proposed in this paper (Table 1).

Table 1. Classification standards of spatial heterogeneity and agglomeration.

Indicator	Grade	Parameter Value Range	
Gini Index (GI)	Strong	GI < 0.4	
	Medium	0.6 > GI ≥ 0.4	
	Weak	GI ≥ 0.6	
Concentration Rate (CR)	Oligopoly type I	CR ₄ ≥ 85%	
	Oligopoly type II	85% > CR ₄ ≥ 75%	CR ₈ ≥ 75%
	Oligopoly type III	75% > CR ₄ ≥ 50%	85% > CR ₈ ≥ 75%
	Oligopoly type IV	50% > CR ₄ ≥ 35%	75% > CR ₈ ≥ 45%
	Oligopoly type V	35% > CR ₄ ≥ 30%	45% > CR ₈ ≥ 40%
	Competitive type	CR ₄ < 30%	CR ₈ < 40%

3.3.2. Evolution Model Analysis Method: Boston Consulting Group Matrix (BCG)

Created by the Boston Consulting Group in the 1970s, BCG is a method for analyzing and optimizing existing business portfolios that is mainly applied in the fields of business management and economics. BCG is essentially a method for planning business portfolios, and it is introduced in this paper for land use change research to analyze land use change

trends and evolution patterns. In this paper, the combination of two indicators of relative share (*RS*) and growth rate (*GR*) is used to show the change trend and the evolution pattern of urban construction land in cities of Gansu. *RS* and *GR* are calculated as follows:

$$RS = \frac{X_i}{X_{max}} \quad (3)$$

$$GR = \left(\sqrt[t]{\frac{X_i}{X_i^b}} - 1 \right) \times 100\% \quad (4)$$

where *t* represents time, *X_{max}* represents the maximum value of urban built-up land area in the study area, *X_{i+t}* represents the value of urban built-up land area in city *i* in the base period, and other parameters have the same meanings as above. To eliminate the interference of human factors, this paper divides the cities in the study area into four types: HH (High-High), LH (Low-High), HL (High-Low), and LL (Low-Low) (corresponding to the stars, question, cow, and dog in the BCG model prototype) based on the mean of *RS* and *GR* as the limit. HH-type cities have high *RS* and *GR* for urban building land. They hold an important place in the region; they are well-developed with great development potential and opportunities; and expansionary strategies are suitable for them in future developments. HL-type cities have very high *RS* but low *GR* for urban construction land. They currently have a strong radiation and influence in the region, but they are in maturity or even decline. Harvesting strategies are suitable for them in future developments by controlling land input resources. LH-type cities have very low *RS* but high *GR* for urban construction land. They are currently not prominent in the region, but they have great development potential. LH-type cities have uncertain directions and uncertain futures, so they should be approached cautiously in the future. Selective strategies are suitable for them based on an in-depth analysis of each city. LL-type cities have low *RS* and *GR* for urban construction land and they are weak in development strength and potential. They are inefficient spaces that affect the sustainable development of the region, and they must be promoted through policy interventions to transform their development.

3.3.3. Performance Evaluation Method: Decoupling Model

Decoupling is essentially a process of dematerialization and depollution during urban economic development [104]. Depending on the level and the stage of economic development, the dependence of economic growth on land resource consumption is characterized by a tendency to grow first and then decline. Decoupling means a shift from a high dependence on incremental construction land for urban economic growth to the efficient development and intensive use of land resources. This paper analyzes the economic and the social effects of changes in urban construction land based on a decoupling model so as to determine whether land consumption is associated with population growth, economic development, and income increase, with simultaneous or asynchronous changes. The decoupling index is calculated by two methods, OECD [105] and Tapio [106], and the latter is used in this paper by the following equation:

$$\gamma = \frac{\Delta\alpha}{\Delta\beta} \quad (5)$$

$$\Delta\alpha = \frac{X_{i+t} - X_i}{X_i} \quad (6)$$

$$\Delta\beta = \frac{Y_{i+t} - Y_i}{Y_i} \quad (7)$$

where γ represents the decoupling index, $\Delta\alpha$ represents the growth rate of urban construction land in the urban agglomeration, X_i and X_{i+t} are the values of urban construction land area of the city *i* in the base period and at the end of the period, respectively, $\Delta\beta$ represents the growth rate of urban social and economic development-related indicators, Y_i and Y_{i+t}

are the values of social and economic development-related indexes of the city i in the base period and at the end of the period, respectively, t represents the study time period, and $t = 4$ in this paper. Based on the positivity and the negativity of $\Delta\alpha$ and $\Delta\beta$, the decoupling types are classified into three categories and eight subcategories with 0.8 and 1.2 as the classification threshold for γ (Figure 3) [107,108].

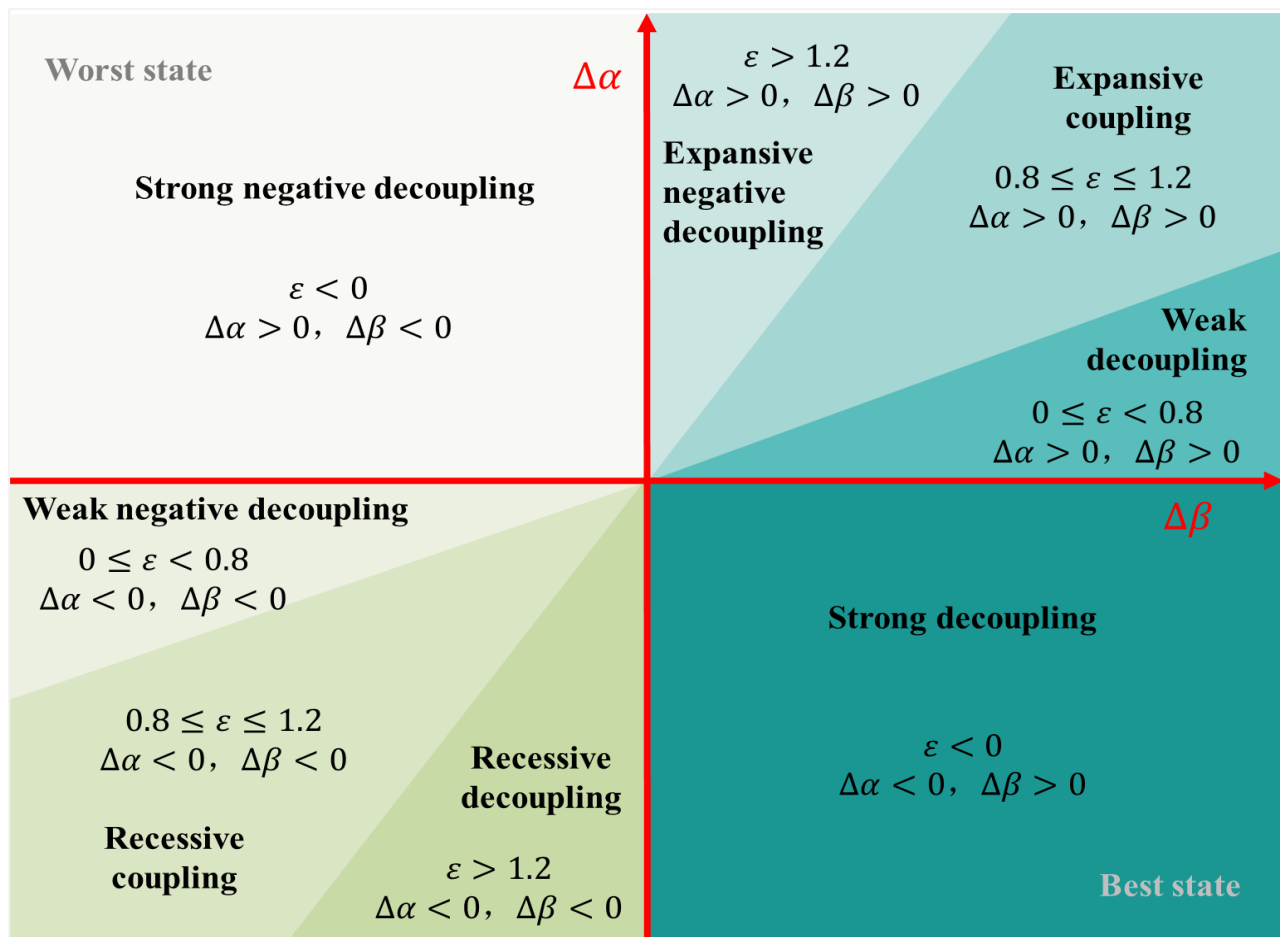


Figure 3. Decoupling type and Decoupling indicator range.

For example, strong decoupling is the best state and strong negative decoupling is the worst state for the decoupling relationship between urban construction land supply change and economic growth. The former indicates that the city has been in the development stage of land loss and economic growth, as the benchmark of regional high-quality development, while the latter indicates that the city is in the development stage of land increase and economic decrease, where the supply of urban construction land is misallocated and fails to fulfill its value, making the city a diseased space in the region. Weak decoupling, expansive coupling, and expansive negative decoupling indicate that both urban construction land and economic development are in growth, but the land use intensification is getting lower, representing efficient incremental development, inefficient incremental development, and extensive incremental development, respectively. Weak decoupling indicates that both urban construction land change and economic development in urban agglomerations are on the rise, with economic growth faster than land consumption growth, and that the cities are in a state with an increase in both quantity and quality, characterized by high value-added land output and high land use intensification. Weak decoupling is still not the optimal state. Weak negative decoupling, recessive coupling, and recessive decoupling indicate that urban construction land and economic development are in negative growth, and land use

intensification is getting successively higher, representing extensive reduction development, inefficient reduction development, and efficient reduction development, respectively.

3.4. Research Steps

The first step is data collection and processing, that is, to collect the raw data of urban construction land, population, income, economic and social indexes in Gansu and cities for 2016–2020, and to organize, analyze, and proofread the data. The second step is dynamic analysis, that is, to measure GI, CR, and Moran's I by leveraging Python, ArcGIS, and GeoDa tools, and further analyzing the spatial heterogeneity, agglomeration, correlation, and evolution patterns of urban construction land in Gansu using BCG and ESDA methods to summarize and to refine the changing characteristics of urban construction land in the study area. The third step is performance evaluation, that is, to analyze the relationship between the change of urban construction land and the growth of added value of non-agricultural industries, per capita GDP, urban population, government revenue, and resident income in the cities of Gansu based on the decoupling model to evaluate the performance level of urban land resource consumption in the study area. The fourth step is the term spatial planning application research—differentiation management policy, that is, to propose the direction of differential management policy design based on the decoupling state and the changing trend of urban construction land to provide a decision-making reference for the formulation and the implementation of territory spatial planning (Figure 4).

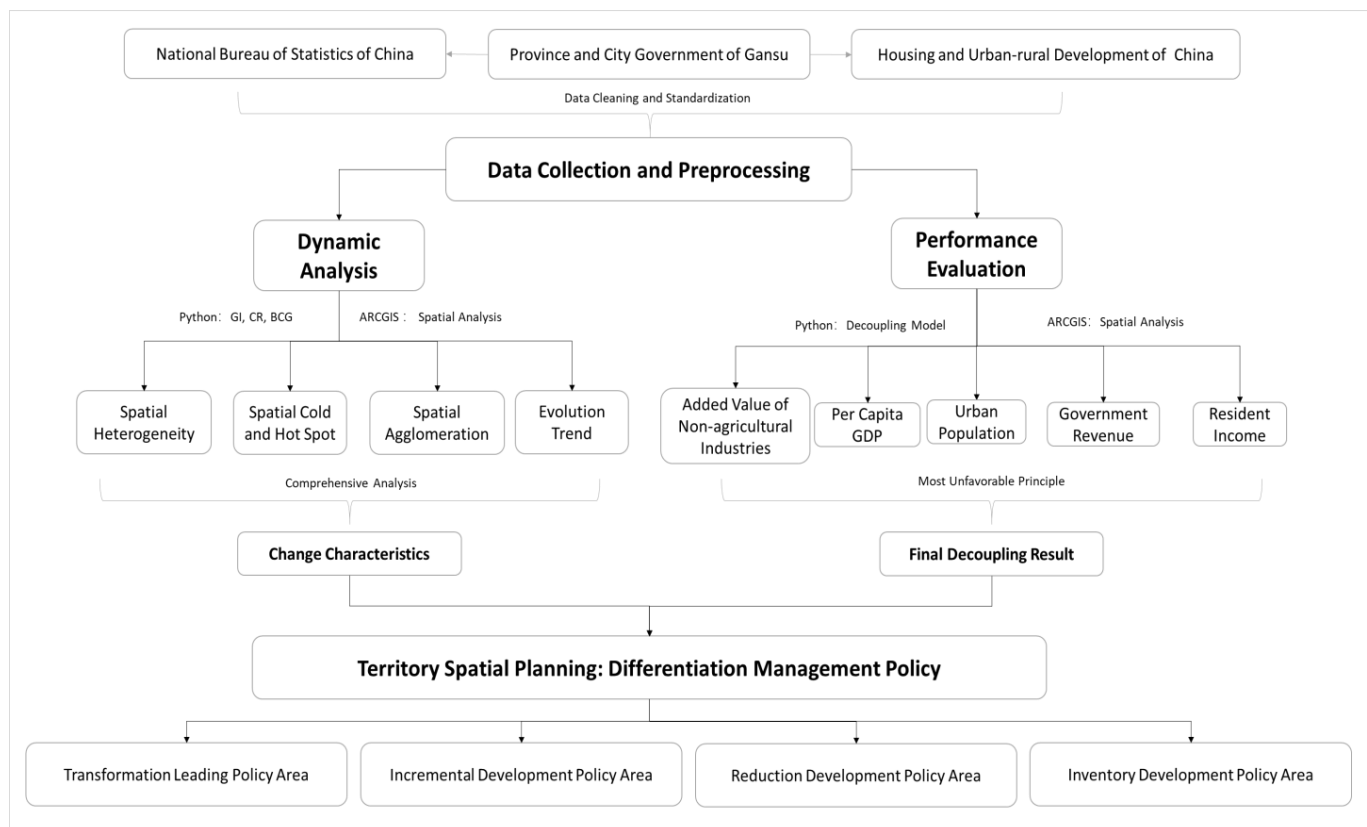


Figure 4. Research steps.

4. Results

4.1. Dynamic of Urban Construction Land

4.1.1. Change Characteristics

There is a huge gap between cities in Gansu Province in urban construction land, with a high level of spatial heterogeneity, and it shows a tendency of slow increase. In 2016, the maximum value was 308.43 km² (Lanzhou) and the minimum value was 1.42 km² (Subei),

with an average of 15.31 km^2 . GI was 0.6055, higher than 0.6, indicating a great spatial difference. In 2020, the maximum value was 332.35 km^2 (Lanzhou) and the minimum value was 1.75 km^2 (Luqu), with an average of 17.01 km^2 , slightly higher than in 2016. In addition, GI increased to 0.6116, indicating a trend of slow rise in spatial heterogeneity. To minimize the influence of human factors, this paper carries out a cluster analysis of the spatial pattern of urban construction land in Gansu based on natural break using the ArcGIS tool, and it divides it into five classes of higher, high, medium, low, and lower levels (Figure 5). The natural break method is a statistical method for grading and classifying classes according to the numerical statistical distribution law, which maximizes the difference between classes. The analysis results show that higher and high cities are clustered in the Yellow River and Longhai Railway economic belts, while low and lower cities are distributed in the peripheral area of Gansu or the transition zone of central cities. Furthermore, the pattern of spatial differentiation generally stays stable in 2016 and 2020, with changes only in some places for specific classes. For example, Guazhou County and Minqin County were in the medium class in 2016, but changed to the lower class in 2020.

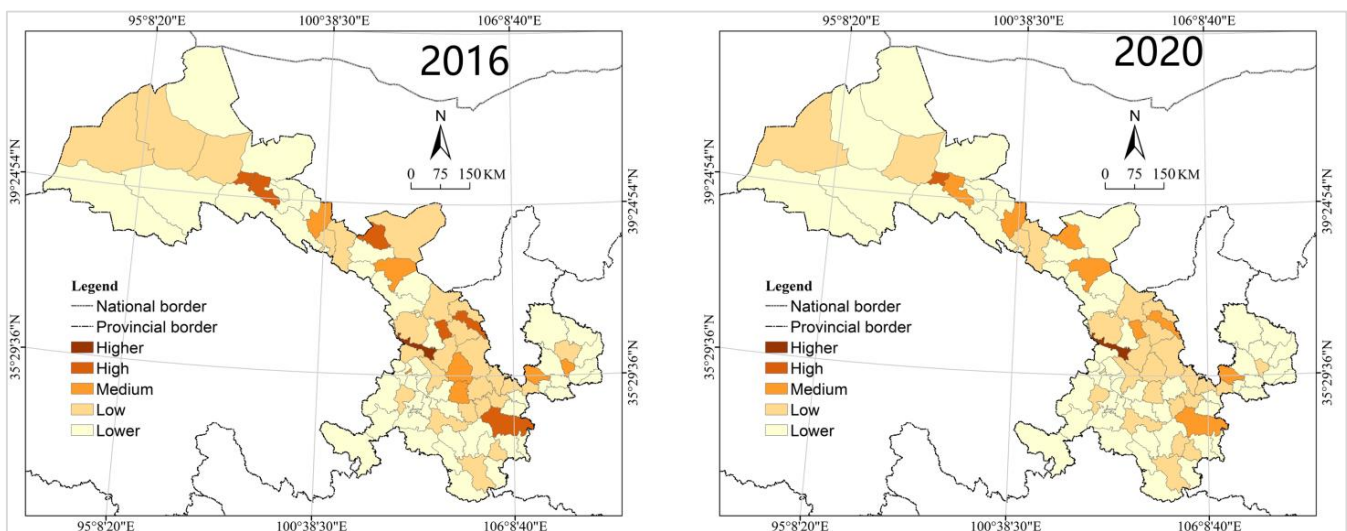


Figure 5. Analysis on the spatial clustering of urban construction land scale in Gansu.

The spatial concentration and correlation of urban construction land in Gansu are at a low level. In 2016, CR_4 and CR_8 were 39.78% and 53.00%, respectively, and they increased to 41.17% and 54.19% in 2020—always of Oligopoly type IV—indicating a certain spatial agglomeration but a low level of concentration for the geographical distribution of urban construction land. The tool of cold/hot spot analysis is to identify areas with statistically significant clustering, as it indicates that urban construction land change is being influenced by some spatial process factors and there is spatial correlation. The hot and the cold spots represent areas or locations where cities with high or low values of urban construction land are clustered spatially. The results of the analysis conducted by the ArcGIS tool for the spatial cold and hot spot method show that both hot and cold spot areas of urban construction land were clustered together in 2016 and 2020, with cold spot areas distributed in a solid pattern but the hot spot areas clustered in different geographical regions. The cold spot areas have long been clustered in the ethnic autonomous region of Longnan. The hot spot areas were clustered in the metropolitan area of the provincial capital in 2016, covering a large geographical area, and the spatial coverage contracted significantly in 2020, only distributed in the northern side of the metropolitan area (Figure 6).

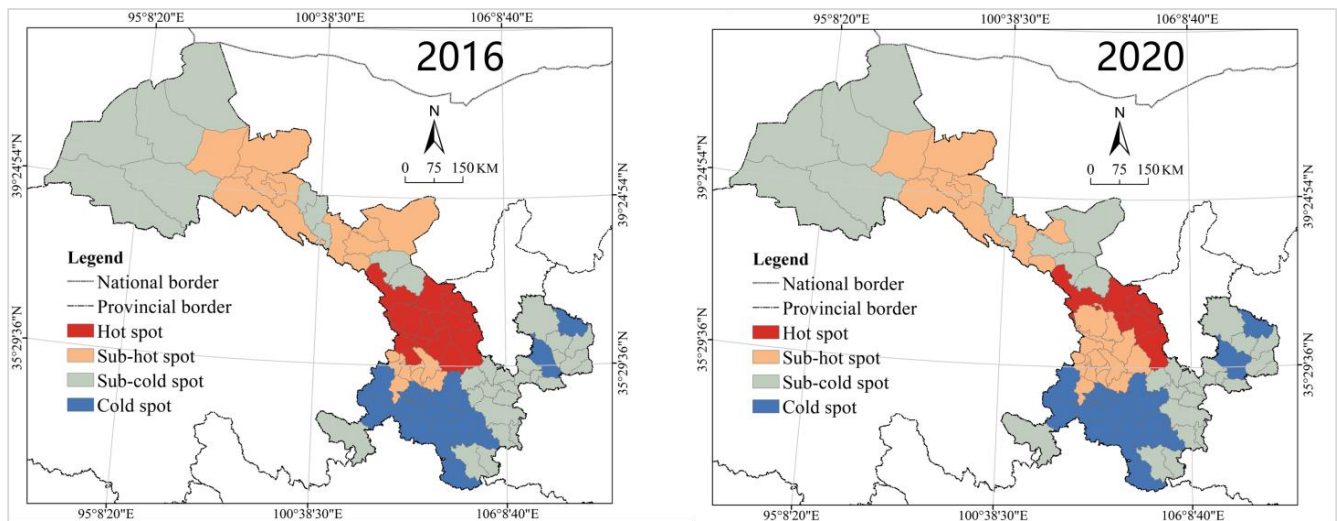


Figure 6. Analysis on the spatial cold and hot spot of urban construction land scale in Gansu.

The change of urban construction land in Gansu is dominated by growth, with the change trends of growth and decline remaining unchanged. The maximum change of urban construction land from 2016 to 2020 was 34.97 km² (Jiayuguan) and the minimum was −1.87 km² (L), with an average of 1.70 km². Expansion is the dominant trend in urban construction land change, with a total of 63 cities in the study area showing an increase in land area, accounting for more than 77.78%. The shrink cannot be ignored, with a total of 11 cities in the study area experiencing negative growth in urban construction land, accounting for 13.58%. In addition, there are seven cities where construction land remains largely unchanged and is in a state of stock development. From the spatial distribution of urban construction land changes, reduced-cities are scattered in the northern and the southern regions of Gansu, while invariable-cities are scattered in Longnan. Most of the hot spot cities with urban construction land change are clustered along the town belt of the Hexi Corridor, sub-hot spot cities are clustered in the metropolitan area of the provincial capital, cold spot cities are distributed in the town belt in the southeast of Gansu, and sub-cold spot cities are distributed in clusters in the Jinchang-Wuweï and in the Dingxi-Linxia regions (Figure 7).

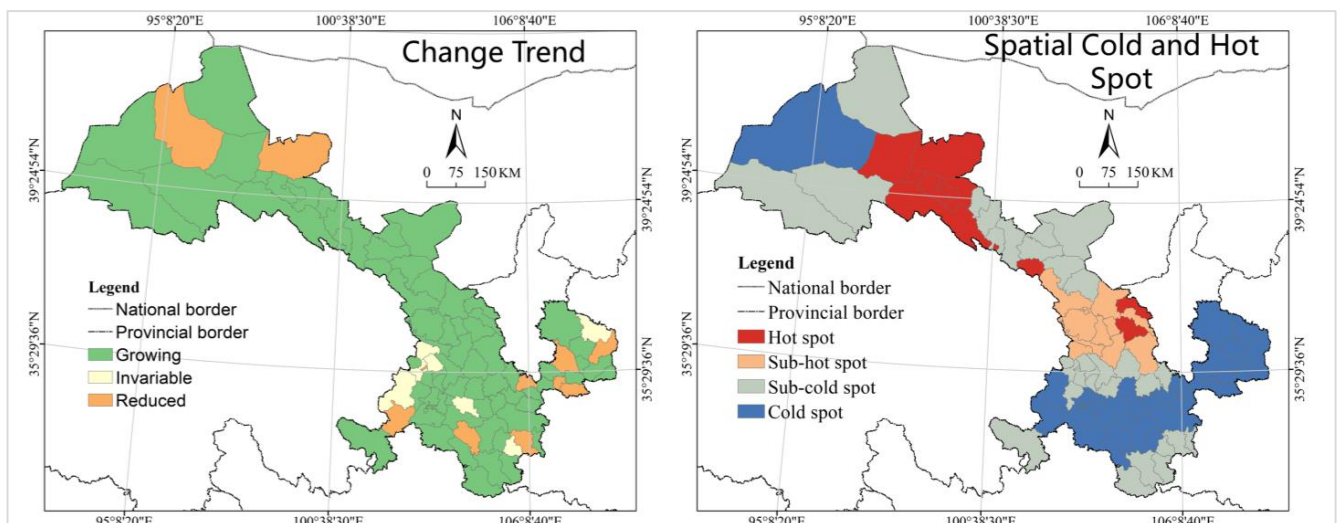


Figure 7. Analysis on the urban construction land change of Gansu.

4.1.2. Evolution Trend

HH- and HL-type cities account for a small proportion, while most cities are in a non-ideal development trend, so there is an urgent need to strengthen spatial planning management, formulate and implement targeted spatial governance policies, and promote urban transformation and development. The average value of the relative share (RS) of urban construction land in Gansu in 2020 was 0.05, and the growth average (GR) of urban construction land for 2016–2020 was 2.46%. Taking them as thresholds, we divided 81 cities into 4 classes of HH, LH, HL, and LL by means of the BCG model. HH- and HL-type cities are small in number, accounting for approximately 16% in total. There are a large number of LH- and LL-type cities, together accounting for approximately 84%. From the perspective of spatial distribution characteristics, HH- and HL-type cities are scattered along the Yellow River, LH-type cities are mostly concentrated along the town belt of Hexi Corridor and in the east of the provincial capital metropolitan area, and LL-type cities are mostly concentrated along the town belt in the southeast of Gansu and in the west of the provincial capital metropolitan area (Figure 8).

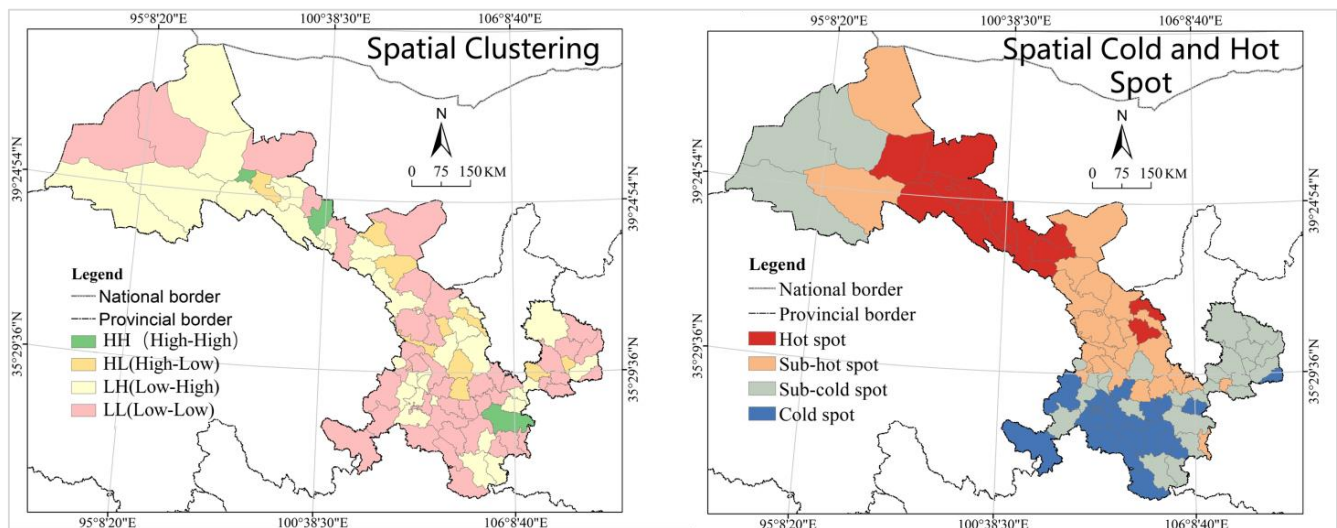


Figure 8. Analysis on the evolution trend of urban construction land in Gansu.

HH-type cities are the least in number, and there are only three prefecture-level cities: Jiayuguan, Tianshui, and Zhangye. In recent years, urban construction land in Jiayuguan, Tianshui, and Zhangye has grown rapidly in area on a large scale, and it has been in the best rapid growth stage in the whole life cycle. Additionally, as the central cities in the town belt of Hexi Corridor and the town belt of Longdong South, they have a high driving force and influence on urban agglomeration development.

LL-type cities are the most numerous, with 43 county-level cities in total, including Yongdeng, Gaolan, Gulang, Lingtai, Dunhuang, Linxia, Xiahe, and Luqu. In recent years, they have experienced a small share of urban construction land and a very low growth, or even negative growth, and now they are at risk of being marginalized in the urbanization development in Gansu. Now LL-type cities may generally encounter some insurmountable development difficulties and thus have to be in a state of “depression” or even “decline”.

There are 10 HL-type cities, including Lanzhou, Jinchang, Baiyin, Wuwei, Pingliang, Jiuquan, Qingyang, Dingxi, Longxi, and Linxia, and they are mostly prefecture-level cities or cities where autonomous prefecture governments are located. In recent years, HL-type cities have witnessed a very low growth of urban construction land area, but their status in regional development as well as their influence and radiation should still not be underestimated due to their rich history and high relative share. HL-type cities are at a mature stage of urban development throughout their life cycle, suggesting a high probability of future decline without proper planning and policy intervention.

There are 25 LH-type cities, including Yuzhong, Yongchang, Jingyuan, Huining, Qingshui, Zhangjiachuan, Tianzhu, Sunan, Minle, Gaotai, Huating, Subei, Aksay, Yumen, and other county-level cities, and many are resource-based cities or ethnic autonomous cities. Supported by national and Gansu's special support policies for new urbanization, poverty alleviation and poverty eradication, common prosperity, ethnic areas and resource-based cities, the construction land area of LH-type cities has enjoyed rapid growth in recent years. However, due to their weak development base and their chronically small-town size, their relative share in the region remains low at present. In general, LH-type cities have great development potential as new forces emerging in the process of reconstructing the regional town system, while their future development capacity is still highly uncertain due to the constraints of historical accumulation and basic conditions.

4.2. Performance of Urban Construction Land Change

4.2.1. Different Dimensions Analysis

Added Value of Non-Agricultural Industries

In terms of quantitative structure, cities in the state of strong negative decoupling are the most numerous, followed by those in weak decoupling and strong decoupling, with no cities in recessive coupling, and there are a small number of cities in other states (Figure 9). More than 40% of the cities are in strong and weak decoupling, and they are in or near to the best condition as benchmarks for regional sustainable development; more than 55% of the cities are in expansive negative decoupling, recessive decoupling, weak negative decoupling, strong negative decoupling, are they are in a bad or even the worst state as problematic cities that prevent the region from achieving sustainable development. From the perspective of spatial distribution, cities in strong decoupling and strong negative decoupling show zonal agglomeration; hot, sub-hot, and sub-cold spot cities are distributed in clusters; and other types of cities show a random and a scattered distribution (Figure 10).

Per Capita GDP

In terms of quantitative structure, cities in weak decoupling are the most numerous, followed by those in strong decoupling. There are no cities in recessive decoupling, recessive coupling, or weak negative decoupling states, and there are few cities in other states (Figure 9). More than 79% of cities are in strong and weak decoupling in or near to the optimal condition and they have been benchmark cities for regional sustainability, while 16% are in expansive negative decoupling and strong negative decoupling in a poor or even worse condition, and they have been problematic cities that prevent the region from achieving sustainable development. In terms of spatial distribution, cities in weak decoupling and strong negative decoupling are concentrated; hot, sub-hot, and sub-cold spot cities are distributed in clusters; and other types of cities show a random and a scattered distribution (Figure 11).

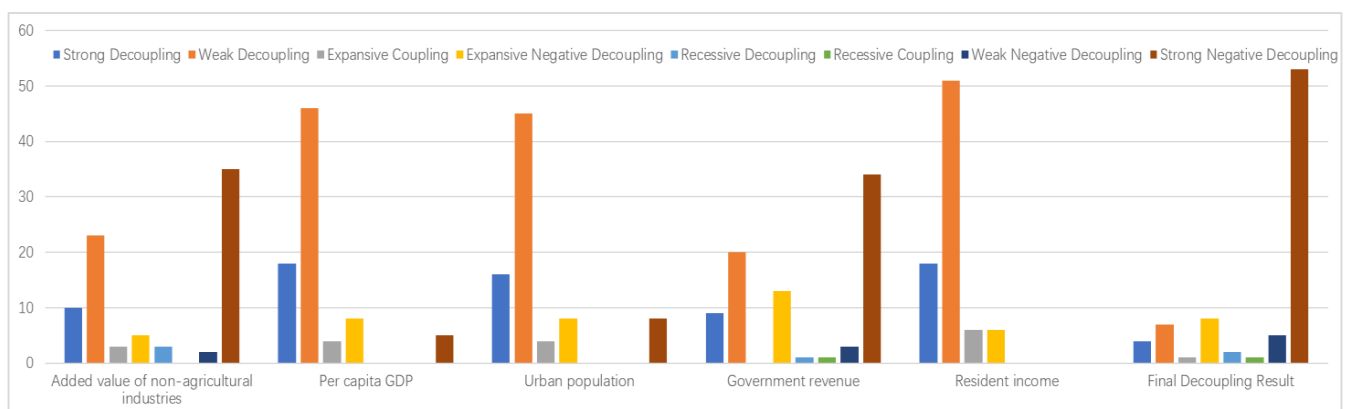


Figure 9. Statistical analysis of decoupling results in Gansu.

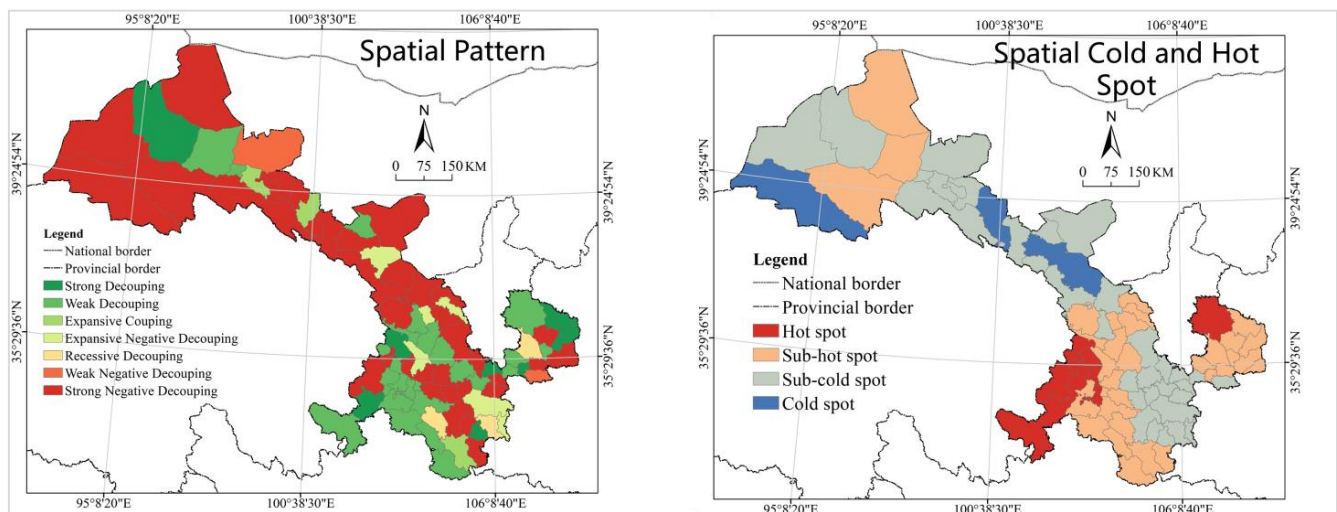


Figure 10. Spatial analysis on the decoupling relationship between urban construction land and added value of non-agricultural industries in Gansu.

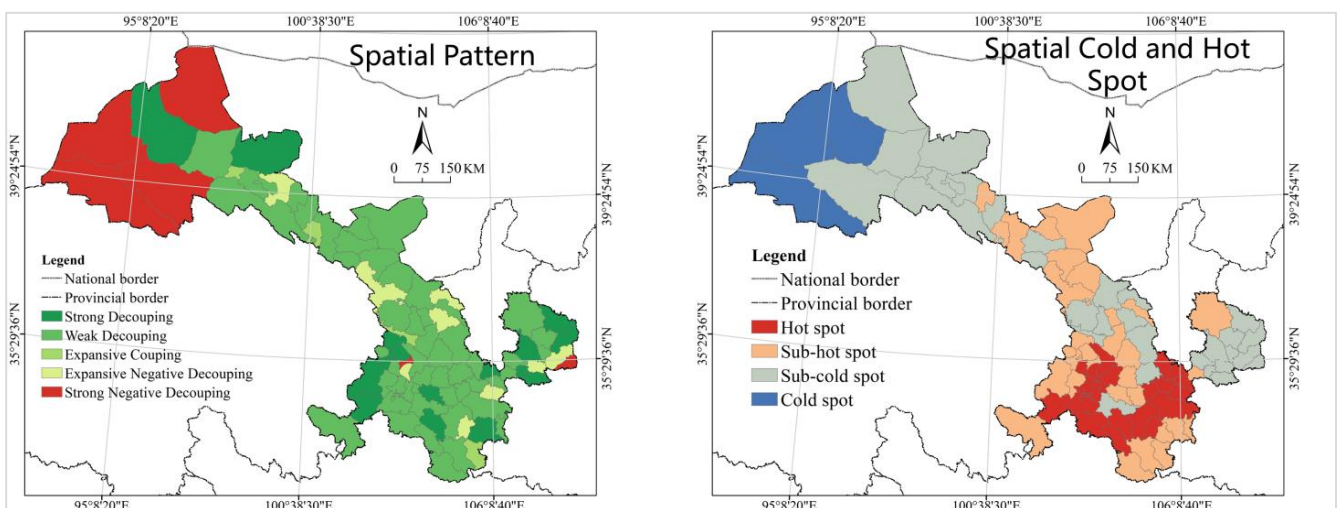


Figure 11. Spatial analysis on the decoupling relationship between urban construction land and per capita GDP in Gansu.

Urban Population

In terms of quantitative structure, cities in weak decoupling are the most numerous, followed by those in strong decoupling. There are no cities in recessive decoupling, recessive coupling, or weak negative decoupling states, and there are few cities in other states (Figure 9). More than 75% of cities are in or near to the optimal condition, while approximately 20% are still in poor or even worse condition as problematic cities that prevent the region from achieving sustainable development. In terms of spatial distribution, cities in weak decoupling are distributed in contiguous clusters; hot, cold, and sub-cold spot cities are distributed in clusters; and other types of cities are randomly distributed and scattered (Figure 12).

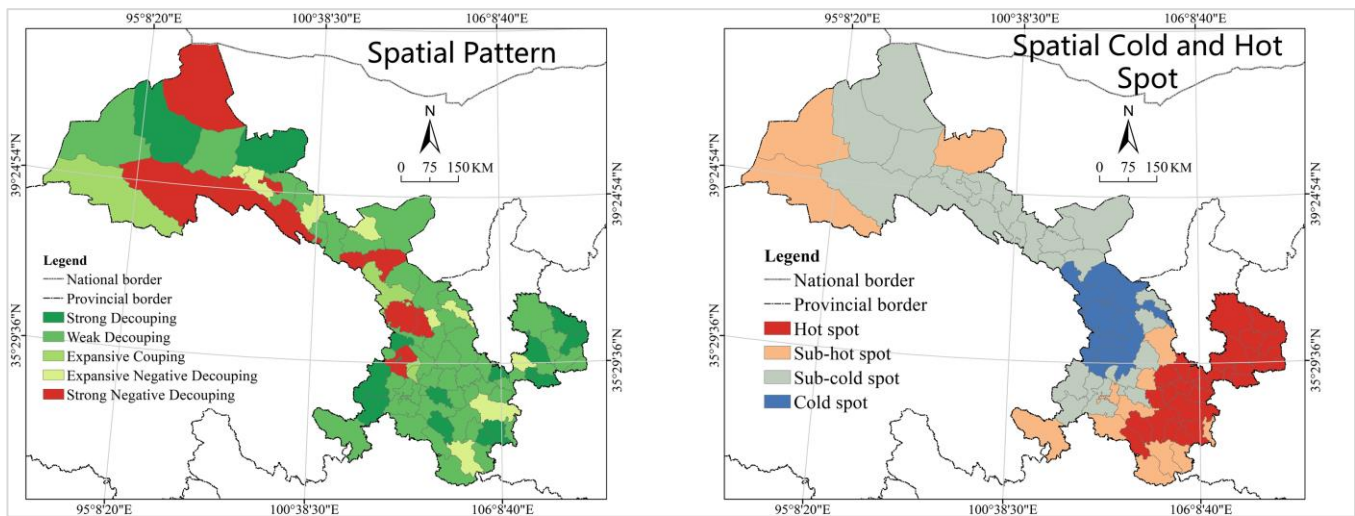


Figure 12. Spatial analysis on the decoupling relationship between urban construction land and urban population in Gansu.

Government Revenue

In terms of quantitative structure, cities in strong negative decoupling are the most numerous, followed by those in weak decoupling, there are also many cities in expansive negative decoupling and strong decoupling, no cities in expansive coupling are found, and a small number of cities are in other states (Figure 9). Only approximately 35% of cities fall into the type of strong and weak decoupling in or near to the optimal condition, while more than 64% fall into the type of expansive negative decoupling and strong negative decoupling in poor or even worse condition as problematic cities that prevent the region from achieving sustainable development. In terms of the spatial distribution of different decoupling types, the cities are generally decentralized, and those in strong negative decoupling present a relative agglomeration in the town belt of Hexi Corridor and Longnan region. In terms of the pattern of spatial cold and hot spots, the cities show marked clustering characteristics. Hot spot cities are concentrated in the northeast corner of Gansu, cold spot cities are concentrated in the town belt of Hexi Corridor, sub-cold spot cities are mostly concentrated in Longnan, and sub-hot spot cities are relatively concentrated in the northeast end of Gansu (Figure 13).

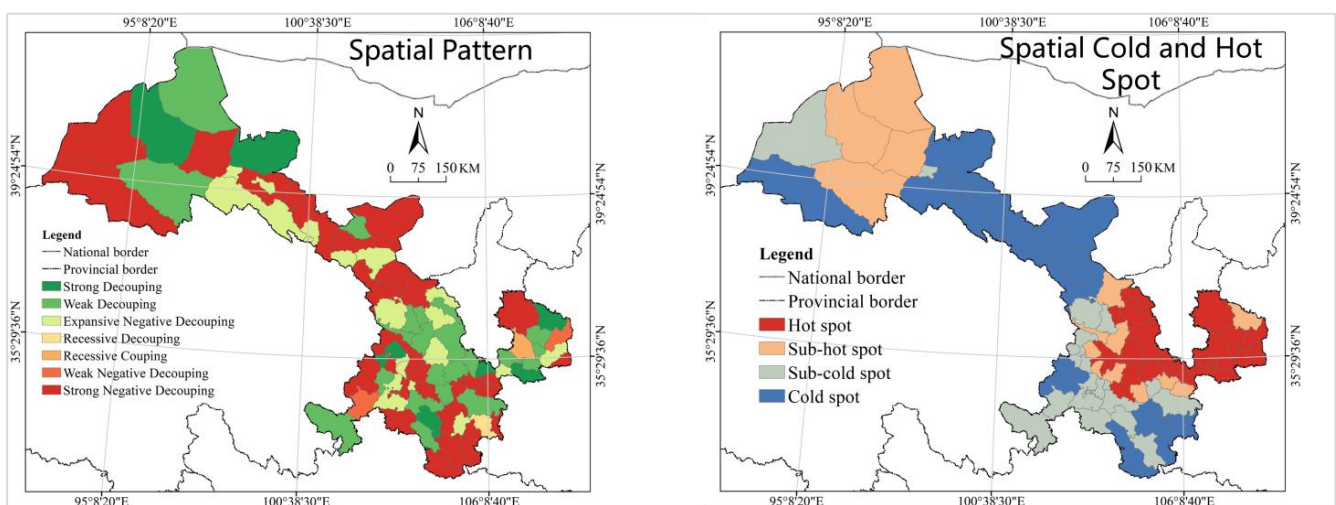


Figure 13. Spatial analysis on the decoupling relationship between urban construction land and government revenue in Gansu.

Resident Income

In terms of quantitative structure, cities in weak decoupling are the most numerous, followed by those in strong decoupling state, and there are a small number of cities in expansive coupling and expansive negative decoupling, with no cities in other states found (Figure 9). More than 85% of cities are in the strong and weak decoupling, which are in or near to the optimal condition and grow into benchmarks for regional sustainable development; less than 10% are in the poor expansive negative decoupling and become problematic cities hindering regional sustainable development. From the spatial distribution of different decoupling types of cities, cities in strong and weak decouplings are distributed in contiguous clusters, while those in other decoupling types are randomly distributed and scattered. From the spatial cold/hot spot analysis, hot spot cities are clustered in the northeast corner of Gansu, sub-hot spot cities are clustered in the southwest corner of Gansu, cold spot cities are mostly clustered in the town belt of Hexi Corridor, sub-cold spot cities are clustered in Longnan (Figure 14).

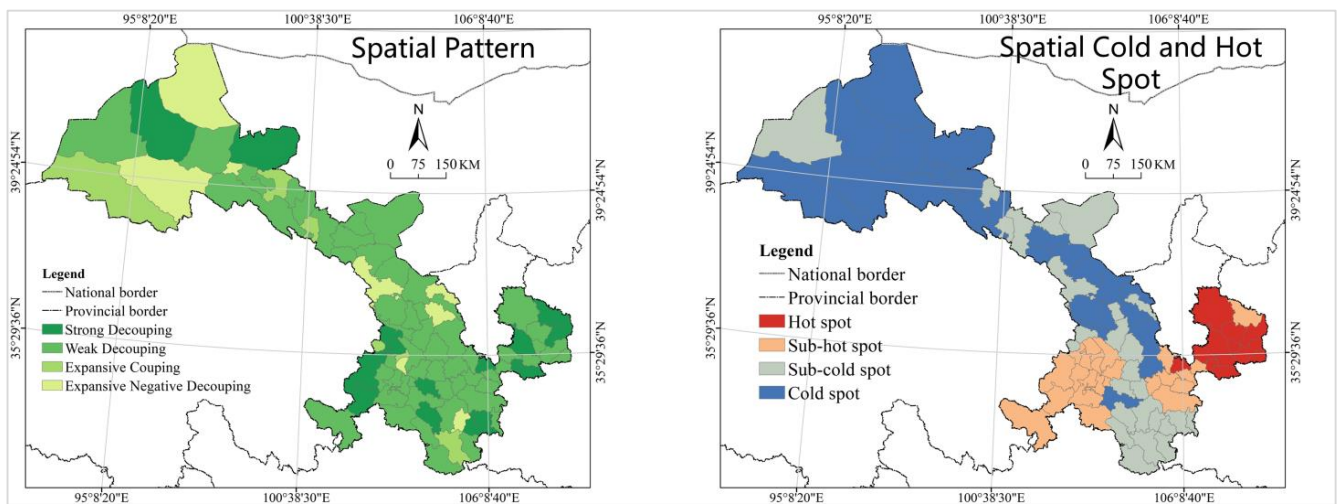


Figure 14. Spatial analysis on the decoupling relationship between urban construction land and resident income in Gansu.

4.2.2. Final Decoupling Result

Since the analysis results of different indexes vary greatly, to better identify and to judge the final decoupling type of each city, this paper integrates the decoupling analysis results of the three dimensions in accordance with the least favorable principle. The so-called least favorable principle is to select the worst analysis result among the 5 indexes as the final result. This approach can help to obtain the real results in the most stringent situation, and it can effectively diagnose the actual state of urban construction land change performance in Gansu, avoiding missing the worst state in some areas of the management process and providing greater flexibility for spatial planning and policy design.

In terms of quantitative structure, cities in strong negative decoupling are the most numerous, including Yongdeng, Gaolan, Yongchang, Jingyuan, Huining, Jingtai, Qingshui, Qin'an, and Gangu, accounting for more than 65%. Cities in expansive negative decoupling are in the second tier, including Jiayuguan, Jinchang, Baiyin, Tianshui, Pingliang, Huating, and Dingxi, accounting for nearly 10%. Chongxin, Zhuanglang, Guazhou, and Huachi are in strong decoupling; Yuzhong, Qingyang, Tongwei, Minxian, Hezuo, Zhouqu, and Maqu are in weak decoupling; Lingtai, Jinta, Heshui, Linxia, and Luqu are in weak negative decoupling, accounting for 5%~10%, respectively. Lanzhou is in expansive coupling, Hui County and Dangchang are in recessive decoupling, and Zhen Yuan is in recessive coupling. Overall, only 13.58% of the cities are in strong and weak decouplings, which are already in or near to the optimal condition and grow into benchmarks for regional sustainable development; more than 85% are in expansive negative decoupling and strong negative

decoupling, which are in a bad or even worse state as problematic cities that prevent the region from achieving sustainable development (Figure 9).

In terms of spatial distribution, cities in strong negative decoupling are characterized by continuous agglomeration and are mainly distributed along the Yellow River and major roads, while other types of cities are scattered in patches. Hot spot cities are mostly clustered in the northeast corner of Gansu, sub-hot spot cities cluster in the northeast and northwest corner of Gansu, cold spot cities are clustered in the town belt of Hexi Corridor, and sub-cold spot cities are mostly clustered in the Gannan and Longnan (Figure 15).

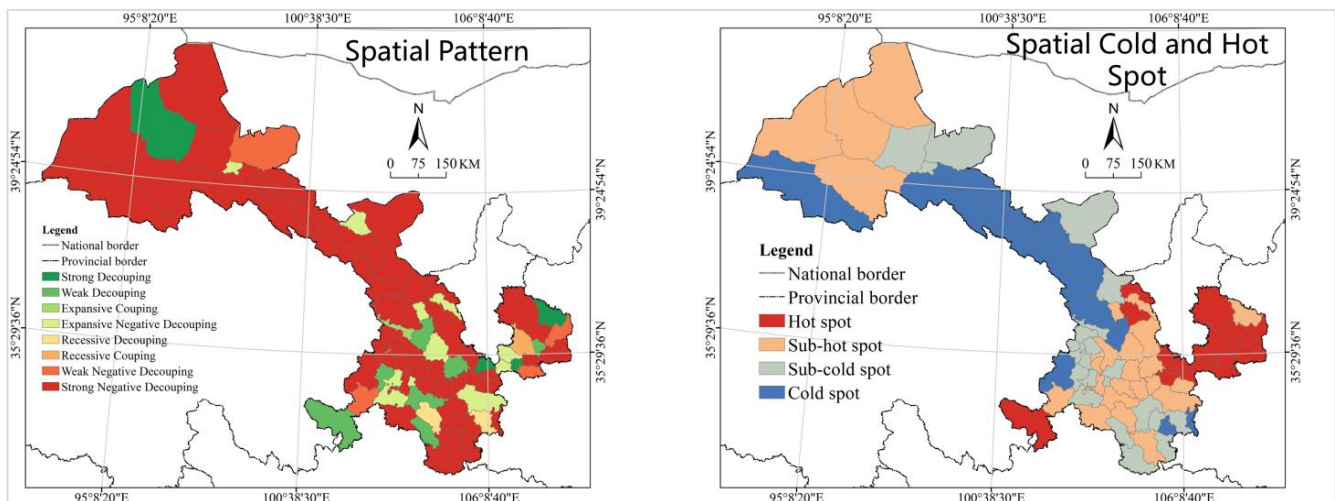


Figure 15. Spatial analysis on the decoupling relationship between urban construction land and final decoupling result in Gansu.

5. Discussion

5.1. Extended Thinking

5.1.1. Comparison with Other Regions in China

This paper also finds significant spatial heterogeneity in urban construction land change in urban agglomerations, a finding that is largely consistent with the conclusions of Li [109,110], Xue [111], Ren [112], Zhang [113], and Ouyang [114], who found there is a significant gap in both the scale and change trends of urban construction land between cities in the study area. At the same time, some of the findings in this paper are not identical to those of available papers on other regions of China. First, MA [115] found that the GI of urban construction land in the Central Plains City Cluster fluctuates within 0.2~0.3, at a reasonable level; however, the case study on Gansu shows that CI has been greater than 0.6 for a long time, quite unreasonable. Second, Tang [116] found that there is a big gap in urban construction land between cities within urban agglomerations, but it is shrinking by day. The conclusion is different from the analysis result of the case study on Gansu in this paper, as the latter argues that the spatial heterogeneity in Gansu is indeed at a high level with a trend of increasing rather than decreasing. Third, this paper finds that the decoupling relationship between urban construction land change and population growth, economic development, and income increase in Gansu is dominated by expansive negative decoupling. However, Liu [117] found that urban construction land expansion and the change in the number of migrant workers in Hubei Province are in expansive negative decoupling and weak decoupling, Li [118] found that population growth and urban construction land change in Hebei Province are generally in weak decoupling, and Wang [119] found that they are in generally in negative decoupling in Hubei Province. This discrepancy arises mainly from differences in the scope of the study area and in the choice of indexes for analysis. Additionally, it is also closely related to the differences in the development stage, basic conditions, resource endowment, and strategic objectives of the studies subjects.

5.1.2. Comparison with Other Countries in the World

This paper further verifies the research conclusions of some international scholars by analyzing the characteristics, evolutionary trends, and performance levels of urban construction land changes in Gansu. First, Sperandelli [120], Asabere [121], and Cutsinger [122] pointed out that urban building land expansion and spread are still the most dominant urban spatial changes, and this paper finds that more than 75% of cities in Gansu have positive growth in urban building land. Second, Zhang [123] analyzed the spatial pattern of land use in the coastal region of Vietnam using the landscape index and clustering algorithm, and divided the bay space into five types of management zones according to the intensity and the pattern of construction land development based on an underlying logic largely coinciding with the idea of differentiated management proposed in this paper. It is noteworthy that, unlike their Chinese counterparts, international scholars mainly focus on agricultural capitalization, food (grain) production, and ecological effects in their research on land use decoupling relationships [124,125]. For example, Acs [126] and Serra [127] analyzed the decoupling of agricultural land from agricultural income and farm crop structure; De Molina [128] and Millones [129] analyzed the decoupling of land use from food (grain) production; Pikaar [130] and Velado-Alonso [131] further refined it to the decoupling of land use from livestock production; Nelson [132] and Smart [133] took attention to the decoupling of land use from ecological change.

They have markedly different concerns from Chinese scholars, who place more focus on construction land than agricultural land, and more on economic effects than ecological effects. The fact that China and Europe are at different stages of development and adopt different development models is probably the biggest reason for the aforementioned differences. For European and American countries, they are generally in the stage of post-industrial development as developed nations, and the ecological environment is the mainstream discourse of their society. On the contrary, China is the world's largest developing country, and, for it, development is the key to solving all problems. While agricultural land has a lower economic value, construction land is the core engine to promote the urban economy and how to efficiently use and scientifically manage urban construction land in the context of developmentalism to promote economic growth and residents' living improvement is the center of government work and scholars' research.

Despite the marked differences between the studies of international and Chinese scholars, they generally conduct their research on the same basis, with the same ultimate purpose. Specifically, all studies are based on sustainable development, with an attempt to promote innovation in the application of decoupling methods in the land field and to find a new generation of land use patterns and research models [134,135], thus promoting more scientific land use and management. As Azadi [136] argued, land use change and management are extraordinarily complex and no one paradigm or approach is adequate to address all issues. The study in this paper is conducted based on BCG and decoupling models, essentially in the paradigm of positivism. It is important to note that the results and the conclusions of this paper require a comparative analysis and cross-validation by more scholars using post-positivism, constructivism, participatory, and pragmatism approaches.

5.2. Territory Spatial Planning: Differentiation Management Policy

Spatial planning and land use policies play a key role in managing the supply and the change of land for urban construction, and they are also key tools for promoting cities toward high-quality and sustainable development. As mentioned above, there is a large gap in the scale of urban construction land between cities in Gansu, with high levels of spatial heterogeneity and large differences in evolutionary trends and development performance. In the new era of ecological civilization and high-quality development, promoting the optimization of the spatial layout and the regional configuration of urban construction land has become a complex issue that must be faced and solved for the government and for territory spatial planning [137,138]. To improve the accuracy and the effectiveness of spatial governance and land management policies, there is an urgent need to formulate and to

implement a differentiated urban construction land supply policy of “classified guidance, zoning management, and combination of maintaining and reducing expenditures” and to incorporate it into territory spatial planning in the new era.

In the design of territory spatial planning and land use policy, an expansionary strategy should be adopted for HH-type cities to support them to grow bigger and stronger. A retreat strategy should be adopted for LL-type cities to avoid blind investments and possible risks. The governments should adopt a harvesting strategy for HL-type cities; take the “smart growth” theory as a guide to strictly control the supply of new urban construction land; promote the renewal and the transformation of the stock of urban construction land; realize the shift of urban development from “quantitative expansion” to “quality improvement”; build quality regional center cities suitable for living, working, and traveling; and try their best to keep the urban development in a mature stage in the long run or promote the urban development into a new stage of high-quality development of revival/reprosperity. The governments should adopt a selective strategy for LH-type cities; implement class management by “one policy for one city”; scientifically guide the direction of urban development; formulate targeted and adaptive development positioning, goals and policies; and try to improve the sustainable development capacity of cities early.

According to Figure 3, the decoupling results are divided into four categories by quadrant. For cities in the first quadrant, both land and economy maintain positive growth with extensive or even wasteful land use, and they should optimize policies to increase the intensification and efficiency of land use. For cities in the second quadrant, since their positive land growth is accompanied by negative economic growth, and land inputs are not generating economic development, strong intervention policies must be implemented to change the tide. For cities in the third quadrant, both land and economic growth are negative, and they are also required to implement strong intervention policies to reverse the decline and contraction trends. For cities in the fourth quadrant, with negative land growth and positive economic growth, they are already in the most desirable state of development, and they should be committed to creating regional development benchmarks and development standards in the future. Based on the new classification results of decoupling analysis and the trend of urban construction land evolution, this paper divides Gansu into four types of policy areas and suggests that a differentiated management system be implemented accordingly in the formulation and the implementation of Gansu’s territory spatial planning (Figure 16).

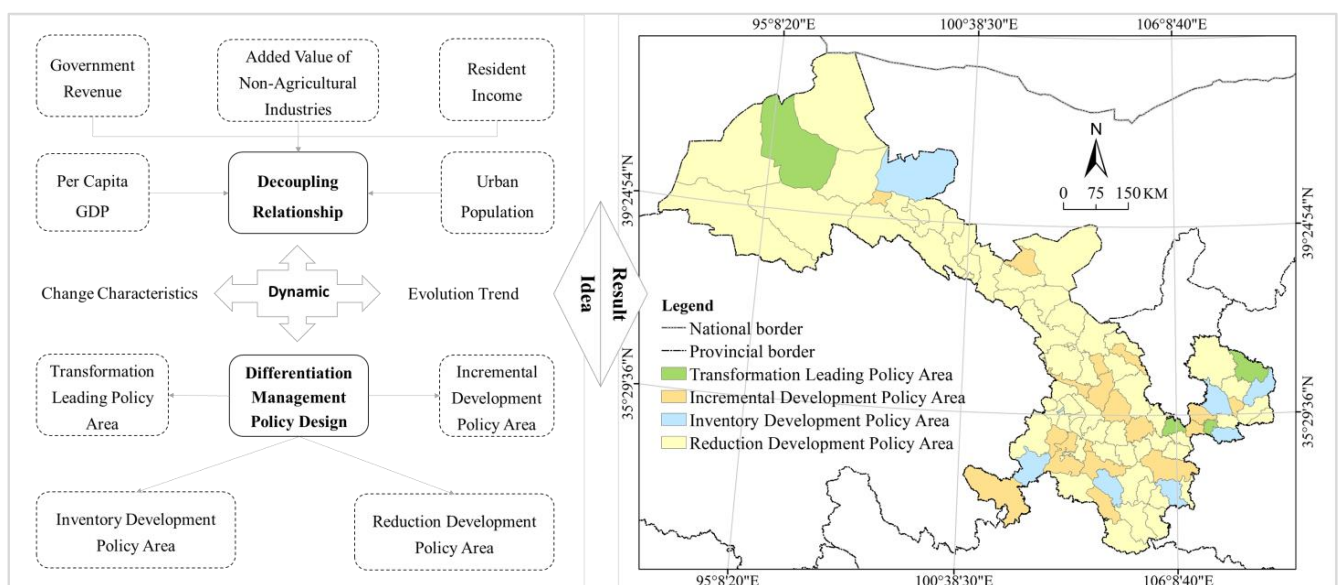


Figure 16. Analysis on the differentiated policy area in Gansu.

5.2.1. Transformation Leading Policy Area

The four small LL-type cities of Chongxin, Zhuanglang, Guazhou, and Huachi are in strong decoupling. The construction land in these cities has been steadily decreasing in recent years, while at the same time the population, economy, and income are all in positive growth, indicating that economic growth and social development are less dependent on urban construction land input, and the urban development momentum has shifted from relying on land resource factor input to driving by innovation factors. The cities in this policy area should be strictly controlled in the process of the spatial planning of national land and strictly controlled in the supply of new urban construction land to accelerate the transformation of land use. It is suggested that the national and the provincial governments increase investment in capital, technology, talent, and other innovation factors and optimize and reconfigure the combination and matching relationship between urban construction land and investment in capital, technology, talent and other factors [139]. On the one hand, efforts should be made to strengthen the supervision of urban construction land, fully implement the remediation and redevelopment of low-utility land, import high value-added industries, allocate innovative factors, and promote industrial upgrading and economic transformation. On the other hand, the government should adjust urban construction land use; supply standards and set norms for investment and the output intensity of urban construction land by level, industry, and function; introduce a directory of industries that meet the city's priority and preferential land supply; and force the transformation of investment attraction through the innovation of urban construction land supply standards to promote sustainable development of the urban economy.

5.2.2. Incremental Development Policy Area

The cities including Lanzhou, Yuzhong, Jiayuguan, Jinchang, Baiyin, Tianshui, Pingliang, Huating, Qingyang, Dingxi, Tongwei, and Hezuo are in weak decoupling, expansive coupling, and expansive negative decoupling. These cities have positive growth in urban construction land, population, economy and income, but their dependence of urban development on land resource consumption is at a high level and their land use intensification needs to be improved. It is worth noting that Lanzhou has a special situation and a unique position among all cities. Lanzhou is the core city of the provincial capital metropolitan area. In recent years, Gansu Province has been fully implementing the strategy of "strengthening the provincial capital". Driven by policy intervention and the market, Lanzhou's agglomeration of population, enterprises, and resources will be further enhanced. In the future, driven by Lanzhou New District, Lanzhou Science City, county towns, and industrial parks, the supply of urban construction land in Lanzhou will continue to maintain high growth. The first is to control the supply of urban construction land. The demand for land should be scientifically measured in territory spatial planning and annual land use planning, and a certain amount of urban construction land should be appropriately supplied to guarantee the demand for land for major production, living, and ecological projects. The second is to innovate the ways to supply urban construction land. It is suggested to collect more urban construction land indexes and to enrich the sources of urban construction land through regional trading of land indicators, redevelopment of inefficient use, and urban–rural land exchange. The third is to improve the effectiveness of land development. The focus should be on strengthening the supervision of land use in Jiayuguan, Jinchang, Baiyin, Tianshui, Pingliang, Huating, and other cities, regularly carrying out evaluations of the intensive use of urban construction land, accelerating the establishment of a mechanism linking land development performance to indicator allocation, and gradually reducing the dependence of urban development on land resource consumption and moving into strong decoupling [140,141].

5.2.3. Inventory Development Policy Area

The cities including Lingtai, Jinta, Heshui, Zhenyuan, Dangchang, Huixian, Linxia, and Luqu are in recessive decoupling, recessive coupling, and weak negative decoupling.

These cities are in a negative growth of urban construction land, population, economy, and income, as shrinking cities in the region. Priority should be given to promoting the transformation of cities from negative to positive growth to achieve an urban renaissance in the process of territory spatial planning and implementation. On the one hand, the existing urban construction land should be revitalized, optimized, exploited, and promoted around the goal of “determining the total, revitalizing the existing stock, and improving the quality,” and urban renewal and renovation planning, comprehensive environmental regulation planning, industrial upgrading and park integration planning, and land reconditioning, demolition and resettlement planning should be developed and implemented to gradually improve the population carrying capacity and increase economic added value of the unit area of land. On the other hand, under the guidance of national and Gansu provincial strategies and according to the development strategy needs of this city, new towns, industrial parks, science and technology cities, tourist attractions, and other emerging complexes should be planned to stimulate the vitality of urban development and to drive urban revival [142].

5.2.4. Reduction Development Policy Area

A total of 53 cities including Yongdeng, Gaolan, Yongchang, Jingyuan, Huining, Jingtai, Qingshui, Qin'an, Gangu, Wushan, Zhangjiachuan, and Wuwei are all in strong negative decoupling. Under the circumstances of population outflow and economic recession, the scale of urban construction land is still in a rapid growth, and there is a serious waste of land. Compared with regional central cities such as Zhangye, Wuwei, Jiuquan, Longxi, Yongdeng, Gaolan, Dunhuang, Jingyuan, and other key node cities of urban agglomerations, LL-type cities including Qin'an, Gangu, Wushan, Minqin, Gulang, Linze, Shandan, Jingchuan, Jingning, Lintao, and Linxia have less conflict between land supply and utilization performance, and they should adopt a small and moderate reduction development strategy in the future according to the strategic needs of new urbanization construction. For Zhangjiachuan, Tianzhu, Sunan, Minle, Gaotai, Subei, Aksay, Yumen, Jishiyama, and other LH-type cities, the supply of new urban construction land should be suspended in the future, and the total amount of urban construction land should be significantly reduced due to a large conflict between urban construction land supply and utilization performance, and unsatisfactory urban location conditions and development foundation. In formulating and implementing territory spatial planning, the following tasks should be emphasized: first, special studies should be conducted for the cities in this policy area to identify the cruxes and the obstacles that prevent the capitalization of urban construction land resources, formulate urban construction land reduction plans and lists, and incorporate them into the government performance assessment for wise shrinkage. Second, reclamation and greening actions should be implemented for idle and inefficient urban construction land for rural revitalization and park city construction needs to improve the human living environment [143,144]. Third, surplus urban construction land indicators should be sold through an intercity land indicator trading platform to reduce waste of land resources while providing funds for land remediation and urban development.

5.3. Innovation and Deficiency

One of the major innovations in this paper is the integrated use of the BCG model and decoupling models to build a new tool integrating “dynamic analysis + performance evaluation + policy design” for urban construction land, providing a quantitative decision basis for the formulation and the implementation of territory spatial planning in the new era. This paper also proposes a policy design methodology that can be used for the differential management of regional allocation of urban construction land, providing government officials and spatial planners with a set of scientific, objective, concise, and feasible technical frameworks that improve the precision, scientific, and adaptability of planning and management decisions. Although some scholars have applied decoupling models to land use research, their studies focus on analyzing the decoupling effect between

urban construction land change and population growth, and are devoted to the quantitative description of the decoupling relationship between the two, without directly applying it to the practice of territory spatial planning, which is also an innovative exploration of this paper.

Notably, the technical framework and research findings presented in this paper are not only applicable to China but also to other regions of China and other developing countries, especially India, Iran, Brazil, Russia, Egypt, and Indonesia by providing valuable references for decision making in urban construction land management and spatial planning. Along with urbanization and industrialization, cities in developing countries are witnessing rapid growth, and they are becoming a new challenge for territory spatial planning and governance. Xiao [145], Li [146], Hu [147], Zhao [148], and Rienow [149] studied, based on a coupled coordination degree model, the spatial Durbin model, spatial analysis method, and the spatial econometric model, and they found that urban construction land expansion is in a complex interactive driving relationship with population growth and economic development. By leveraging the new tools and technical methods in this paper, the empirical or case studies of the aforementioned countries will help to clarify the dynamic relationships between urban construction land changes and population growth, economic development, and income increase to identify their problems and challenges and to formulate and implement spatial planning and policy interventions in a timely manner to promote high-quality and sustainable urban development.

In addition, this paper also has some shortcomings. On the one hand, some indexes selected are not optimal due to the limitation of data accessibility. In China, government revenue includes value-added tax, consumption tax, corporate and personal income tax, resource tax, property tax, urban land use tax, land value-added tax, vehicle and boat tax, environmental protection tax, and non-tax revenue, etc. Land finance is an important part but not all of government revenue. However, due to the lack of data, the fiscal revenue index of cities is directly used as an alternative in this paper, which affects the accuracy of the analysis results to some extent. On the other hand, due to the complexity of the urban development mechanism and the urban construction land supply and demand system, this paper has only done empirical tests for Gansu, and due to the lack of comparative analysis of multiple cases, the generality of the results and the conclusions in this paper should be cross-checked by more empirical studies.

6. Conclusions

Promoting the synergistic evolution of urban construction land change with population growth, economic development, and income increase is one of the core objectives of territory spatial planning and a focus of research in multiple disciplines such as planning, land, geography, and economics. This paper has conducted an empirical study of Gansu, China and reached the following findings:

- (1) Urban construction land has a solid spatial pattern with large intercity differences, but the level of spatial heterogeneity is decreasing. The cold and the hot spots are significantly clustered, with the cold spot space remaining stable for a long time, and the hot spot space shrinking in spatial coverage;
- (2) The change of urban construction land is dominated by expansion, and there is a small number of cities in shrinking and stagnation stages. The change of urban construction land is characterized by clustering and agglomeration;
- (3) The unhealthy trend of urban construction land evolution and the large number of cities in the question and dog classes urgently require the strengthening of spatial planning management and the formulation and the implementation of targeted spatial governance policies. The spatial pattern of gradient change takes shape with the town belt of Hexi Corridor as the hot spot, the provincial capital metropolitan area as the sub-hot spot, and Longnan as the cold spot and sub-cold spot;
- (4) Urban construction land change is in an incongruous relationship with population growth, economic development, and income increase, and most cities are in strong

negative decoupling. It should be noted that the analysis results in different dimensions differ slightly in the dominant decoupling types and spatial distribution patterns, and in order to simplify the analysis this paper employs the equal-weighted superposition analysis method; however, in the practical application, the differentiated weighted superposition analysis method can be considered to calculate the final results so as to improve the accuracy of the analysis and the practicality of the results;

- (5) This paper puts forward the policy design method of differential management of urban construction land and takes the lead in applying it to territory spatial planning. Based on the decoupling relationship between urban construction land change and population and economic and income growth and in accordance with the trend of urban construction land evolution, the study area is divided into four types of study areas: incremental, inventory, reduction development policy area, and transformation leading policy area. For each type of city in the policy areas, this paper proposes a targeted policy design direction, forming a governance system of “control by zoning and management by class,” which significantly improves the accuracy of territory spatial planning.

Due to the high complexity of land use systems, we call for more scholars to conduct multi-case comparative studies in different locations in the world and at different stages of development in the future. At the same time, we will also invest our efforts in analyzing the trends of decoupling changes and the driving mechanisms behind them to provide more targeted and constructive reference information for governments and planners.

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