

Identification and Characteristic Analysis of Urban Fringe of Resource Declining City: A Case Study of Tongchuan

Siqi Liu^{1,2,3,4}, Biao Peng^{3,4,5,*}

¹ Shaanxi Provincial Land Engineering Construction Group Co., Ltd. Xi'an 710075, China

² Institute of Land Engineering and Technology, Shaanxi Provincial Land Engineering Construction Group Co., Ltd. Xi'an 710075, China

³ Shaanxi Key Laboratory of Land Consolidation, Xi'an 710000, China

⁴ Key Laboratory of Degraded and Unused Land Consolidation Engineering, the Ministry of Natural Resources, Xi'an 710075, China

⁵ Land Engineering Technology Innovation Center, Ministry of Natural Resources, Xi'an 710075, China

Abstract

The research on the development of resource declining city is an important issue in the process of new urbanization. With the adjustment of industrial structure and the continuous improvement of people's material needs, there are more and more contradictions in the development of resource declining cities. The lack of endogenous impetus for economic development, the continuous loss of urban population, the disorderly and inefficient expansion of construction land, and the increasingly significant environmental problems have hindered the sustainable development of resource declining cities. In this study, Tongchuan city, Shaanxi province is taken as an example, and combined with multi-source remote sensing data (GF-2 and Landsat-7) in 2010 and 2020 respectively, the urban fringe area was identified. The results show that the urban fringe area of Tongchuan city is mainly composed of industrial and mining storage land, rural residential land and suburban farmland, with significant contradiction between people and land. The governance of the region will become the key to the transformation and development of resource declining cities.

Keywords

Urban Fringe; Resource Declining City; Remote Sensing; Land Use.

1. Introduction

The process of urbanization and industrialization has been rapidly promoted and the economy has developed at a high speed since the reform and opening up in China. China's urban space has continued to expand. The urban built-up areas has increased from 7438 km² in 1981 to 62420.5 km² in 2021, increased by 739.21%. Urban expansion occupies a large amount of land, more than half of which is cultivated land [2]. The demand for construction land and the non-agricultural conversion of a large amount of cultivated land have led to the continuous extension of urban fringe to rural areas. The urban fringe has become an important part of China's urban space [3], and it is also in the process of continuous high-speed and dynamic changes. Resource-based cities are the products of the industrialization period. They are mainly engaged in the mining and processing of mineral resources, with heavy industry as the pillar industry, and the economic development model of high energy consumption, high pollution and high emissions as the main. With the adjustment of the industrial structure, the limitations of the exploitation of non-renewable resources and the damage to the ecological environment

have become increasingly prominent. Cities relying on mineral resources have gradually lost their vitality and competition. In recent years, the construction of ecological civilization has been raised to a historic height. The concept of ecological civilization has become the guiding concept of urban and rural construction. China has gradually abandoned the old and low efficiency model of natural resource energy consumption, and explored a new sustainable development model [4].

Urban fringe is regarded as an urban construction positive area. Industrial related activities are the dominant factors that affect urban fringe development involving land, population and economic structure. Normally, the economic forms happened in urban fringe areas are stay at low-level stage, it is very difficult to make choices between economic development and environmental conservation. The problems of serious and complicated soil-water-air pollution, high dependence on non-renewable energy, lack of ecological restoration measures are prominent. Eventually it causes the decrease of living environment quality [5]. Therefore, the ecological problems in urban fringe areas have become the main obstacle factors for China to implement the new urbanization and rural revitalization strategy, promote the poverty alleviation strategy and improve the coordinated development of urban and rural areas. It has become the focus of the transformation and development of resource declining cities.

Compared with the southeast coastal region, the northwest region has a slower urbanization speed, relatively a more backward economy, and more prominent ecological and environmental problems. The National Sustainable Development Plan for Resource based Cities (2013-2020) issued by the State Council divides resource-based cities into four types including growth type, maturity type, decline type and regeneration type. At present, the total energy production of Shaanxi Province is in a slow rising stage, and the rising speed has decreased significantly compared with the previous years. In 2020, the total energy production will be 591.68 million tons of standard coal, and the total energy consumption will be 135.12 million tons of standard coal [6] (Figure 1).

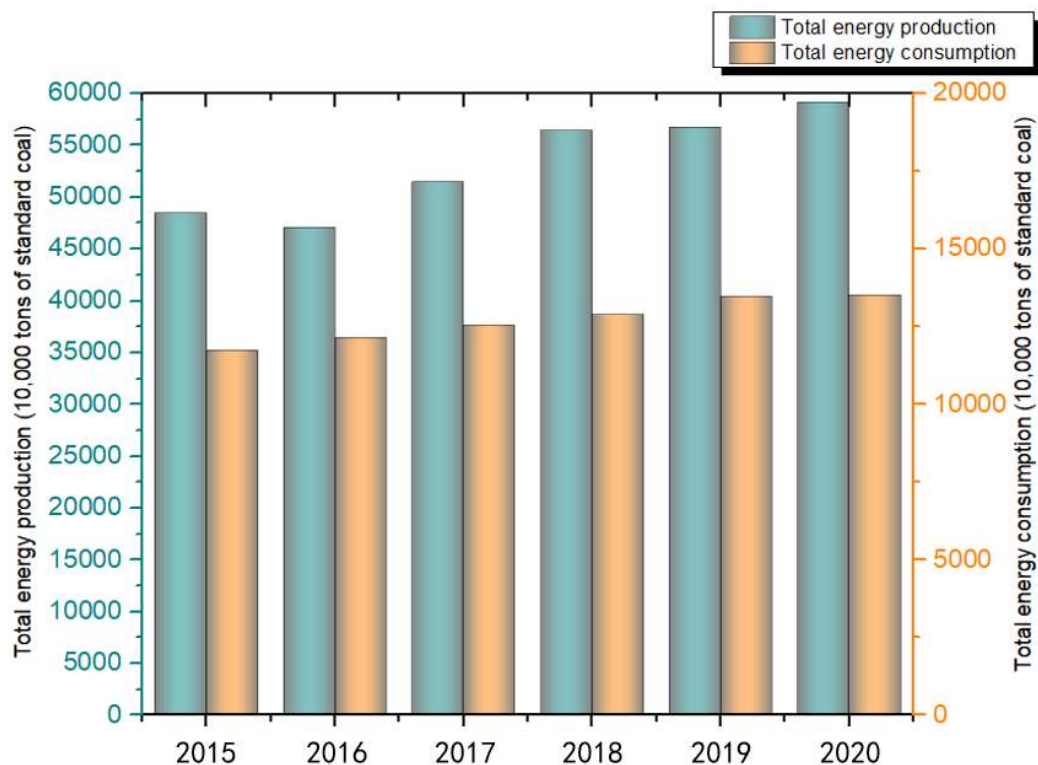


Figure 1. Total energy production and consumption of Shaanxi from 2015 to 2020

2. Research Areas

Tongchuan is an important part of the Guanzhong economic belt, with its total area is about 3882 km². The terrain is high in the northwest and low in the southeast. The topographic features are complex and diverse, with rivers crisscross, mainly distributed in Shichuan River and Luohe River. Tongchuan is rich in natural resources, especially coal, oil shale and petroleum, with large reserves and good quality. As one of the first industrial cities born after the founding of the People's Republic of China (PRC), Tongchuan is an important energy and building materials base in Shaanxi and northwest China. After more than 60 years of development, Tongchuan has formed four traditional industries including coal, electricity, aluminum and cement. The gross domestic product (GDP) of the secondary industry increased from 11.577 billion yuan in 2015 to 18.001 billion yuan in 2021, with a growth rate of 55.49%. The industrial output value increased from 10.226 billion yuan to 15.726 billion yuan, with a growth rate of 53.78%. In recent years, the total population of Tongchuan city has been declining, showing the characteristics of slow outflow. In 2017, the total population was 825800, while in 2021, the total population was 779500. However, the urbanization rate shows a slow rising trend, and the urbanization rate will be 64.20% in 2021 [7].

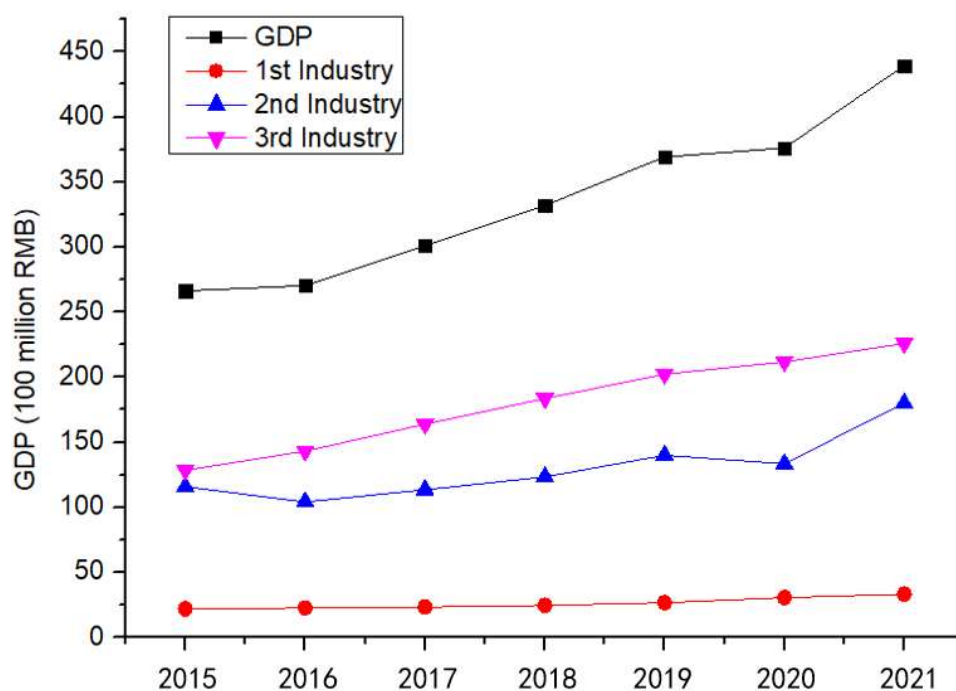


Figure 2. GDP changes of different industries of Tongchuan from 2015 to 2021

Tongchuan city, Shaanxi province, is recognized as a declining city, and its urban resources tend to be exhausted. At the same time, the urban space expansion and industrial development of Tongchuan city rely on the mining and smelting of coal and gold. The excessive exploitation of resources has led to soil pollution and ecological environment degradation. Urban fringe is a characteristic area reflecting environmental problems, urban development and industrial structure. Faced with the national strategic needs, it is imperative to solidly promote the multidisciplinary integration research on the comprehensive renovation of resource-based cities in China. It is urgent to carry out research on the identification, division, pollution investigation and evaluation of the urban fringe in resource declining cities, so as to realize the mode integration and path optimization of the ecological construction of resource-based cities.

3. Materials and Methods

In this study, multi-source data sets are used for spatial identification and evolution dynamic analysis, including GF-2, Landsat-7 remote sensing data and wordtop population data set. The spatial resolution of the data set is 100m, which is based on the night light data, land use data, distance factors and elevation information of various land use types. The weight layer of population distribution is estimated through the random forest model, and then the population is spatialized by using the density mapping of the subarea. The specific information of the data required for this study is shown in Table 1.

Table 1. Data source and statistics

Study Area	Year	Data	resolution	Date
Yaozhou District, Tongchuan	2010	Landsat-7	30m	2010/12/05
		Woldpop	100m	2010/12
	2020	GF-2	1m	2020/07/30
		Woldpop	100m	2020/07

In this research, three factors closely related to urban development, namely, landscape disorder, impervious surface coverage and population density, were selected to establish an urban fringe identification index system, and the extraction range of urban fringe was identified with sliding T-test. The recognition range of the urban fringe of Yaozhou district, Tongchuan city is finally obtained.

4. Results and Discussion

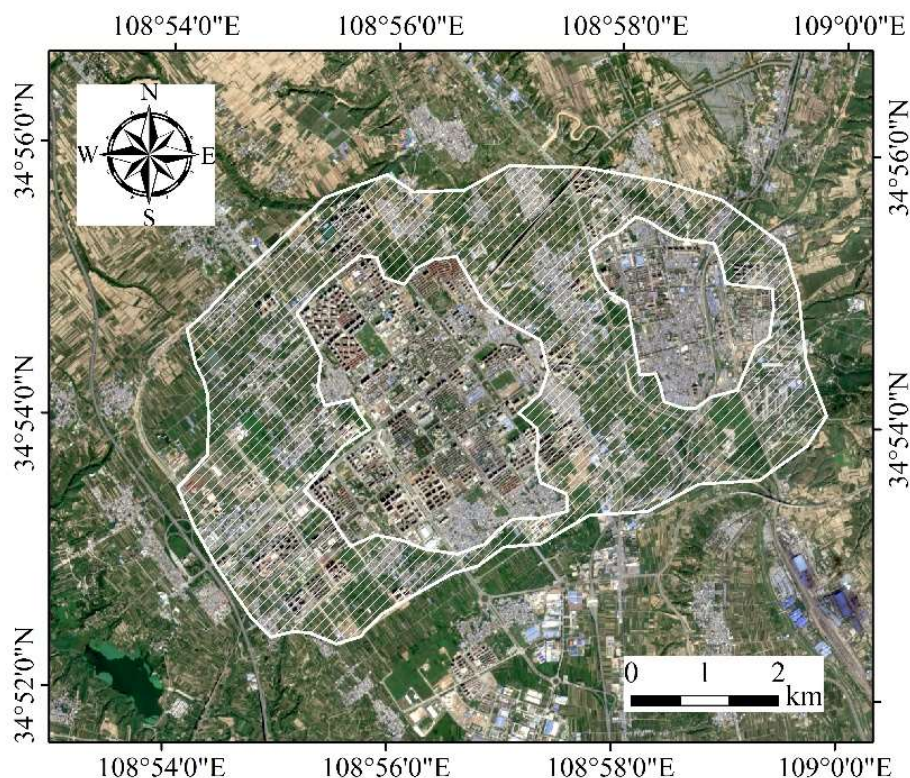


Figure 3. Urban fringe scope of Yaozhou district, Tongchuan



(a) Industrial, mining and warehousing land

(b) Rural residential land

(c) Cultivated land

Figure 4. Main land use patterns of urban fringe of Yaozhou district, Tongchuan

According to the General Plan for Land Use of Yaozhou District, Tongchuan City (2006-2020), the total scale of construction land in 2010 was 9958.75 hectares, including 8093.92 hectares of urban and rural construction land. By 2020, the total scale of construction land will be adjusted to 11846.67 hectares, including 9866.67 hectares of urban and rural construction land. Combined with the identification results of the urban fringe, Yaozhou District, Tongchuan City has a prominent contradiction between people and land. Urban and rural construction land is mostly distributed in the southern tableland area, and high-quality farmland is also distributed in this area, where the population is also concentrated, resulting in a prominent contradiction between population and farmland protection. Through remote sensing image recognition, it can be found that land use in urban fringe mainly includes industrial and mining storage land, rural residential land and suburban farmland (Figure 4). Rural residential land is extensive, with a per capita land area of 276.20 square meters, which is 135.20 km² higher than the national land standard. In addition, there is no reasonable and scientific planning for rural residential areas, the internal structure is loose, the layout is disordered, the land idle rate is high, and the overall land use efficiency is low.

5. Conclusion

Resource declining cities need to better coordinate the balance between social development and ecological protection. Compared with other cities, the pressure of economic transformation and environmental pollution in resource declining cities is greater, the endogenous power is insufficient, and the external pressure continues to increase, resulting in the stagnation of urban development, or even regression. The expansion of cities and the loss of urban population show the contradictions in urban development. The urban fringe belongs to the urban expansion zone, and the population and land change are complex and rapid. Many resource-based industrial, mining and storage enterprises are also located in this area, resulting in greater pollution risks and governance difficulties in the urban fringe. Therefore, the development of resource declining cities should be based on the ecological environment, taking land purification as the basic means, optimizing the land use mode, and comprehensively improving the quality of human settlements.

Acknowledgments

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