Driving Forces of Land Use/Cover Change and Urban Construction Land Conversion: A Case Study of Tianjin

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Driving Forces of Land Use/Cover Change and Urban Construction Land Conversion: A Case Study of Tianjin

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Abstract. The proportion of Land Use/Cover Change（LUCC） and urban construction land can reflect the development and construction of the city to a certain extent, and provide valuable reference data for decision makers. Based on the data of Tianjin from 2005 to 2014, this paper studies the distribution of LUCC, and analyses the driving force based on the annual change value of the urban population, economic level, and contemporaneous policies of Tianjin. According to the research, the main driving forces affecting the development of urban LUCC and the conversion of construction land in Tianjin are obtained. This research method and conclusions are equally applicable to other cities and can be promoted. At the same time, the results of this study also provide data support and decision-making direction for the future development of land in Tianjin.

1. Introduction
Land use/cover change (LUCC) is an important component of global environmental and climate change research. It is the most direct manifestation of human activities on the changes of the global land surface, and also the link between human social economic activities and natural ecological processes [1]. LUCC can reflect the construction, economy and urbanization level of the research area to a certain extent. At the same time, these factors are also important driving factors affecting LUCC. Through the analysis of LUCC by means of RS and GIS, and comparing various driving factors in the same section of the study area, the factors driving the development of the city can be obtained. On this basis, the future expansion of the study area in advance can be predicted and planed, reasonable planning suggestions for urban development can also be provided.

Tianjin is an important port city in China and an important city in the Beijing-Tianjin-Hebei metropolitan area. It is in the historical window of the construction of a free trade pilot zone, the construction of a national independent innovation demonstration zone, the development and opening up of Binhai New Area, and the "Belt and Road". This paper will take the Tianjin area as the research object and attribute the driving force of urban development through the LUCC monitoring and analysis of the research area.

2. Data and processing

2.1. Study Area
Tianjin is located in the East 8th District of the International Time Zone, between 38° 34′ and 40° 15′ north latitude, 116° 48′ to 118° 04′ east longitude, in the middle of the Bohai Bay in the north eastern part of the North China Plain, and Yanshan in the north. Bohai. Agricultural land accounts for about 60%, and construction land accounts for about 35%. The unused land exceeds 800 square kilometers, accounting for 7%, which provides space for the future development of Tianjin.

2.2. Data processing
The remote sensing image used in this paper is remote sensing image data collected by landsat7 satellite, and data pre-processing is performed using ENVI, ArcGIS and ArcMap software. The Tianjin LUCC map was obtained by image registration correction, splicing, mask processing, and remote sensing image classification. After extracting urban land, the map for urban construction in Tianjin area is obtained (Figure 1).
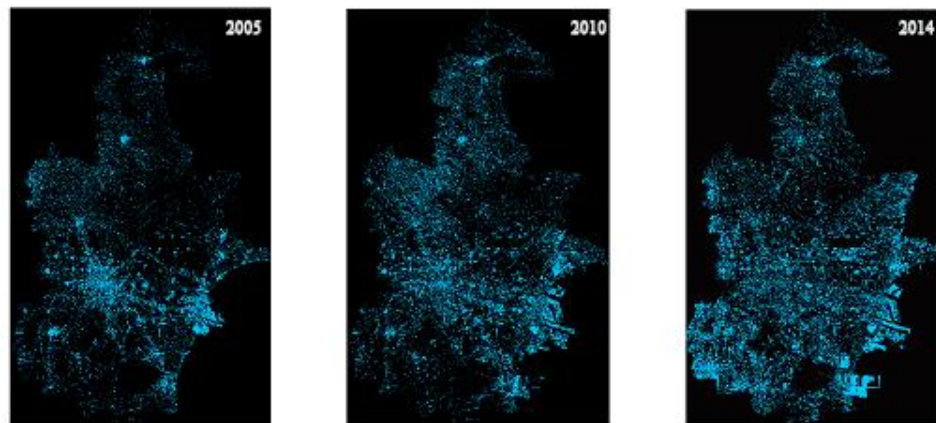

Figure1. Map of urban construction in Tianjin in 2005, 2010 and 2014.

3. Methodology
The annual change rate formula is used to calculate the rate of change of land use type in the study area. The formula is as follows:

$$K = \left\{ \sum_{ij}^{n} \left(\frac{\Delta S_{ij}}{S_i} \right) \right\} \times \frac{1}{t} \times 100\%$$

Among them, ΔS_{ij} is the sum of the area of mutual conversion between construction land and other types of land use in the study area during the monitoring period; S_i is the total area of construction land at the start of monitoring; t is the time period from the beginning to the end of monitoring; annual change rate of construction land K reflects the rate of change of construction land in the study area corresponding to the t-time period [2]. Through the annual change rate of land types, the development of urban land types can be reflected. Comparing the development of various factors in the same period, the driving factors of urban development can be calculated.

4. Result and discussion

4.1. Analysis of the LUCC in Tianjin from 2005-2014

According to the remote sensing image analysis and calculation, combined with the statistical data of Tianjin Statistical Yearbook, the land classification of Tianjin in 2005, 2010 and 2014 was obtained (Table 1, Figure2). In this decade, the area and proportion of urban construction land increased, from 3,462.84 square kilometers in 2005 to 4,054.41 square kilometers in 2014. This is in line with the reality of Tianjin's industrialization modernization in the past decade. The types of land used for arable land, grassland, and unused land are planned to be used for construction. From the LUCC state analysis, the proportion of conversion of cultivated land to construction land by land type is the most prominent.

Table 1. Area of land in Tianjin in 2005, 2010 and 2014.

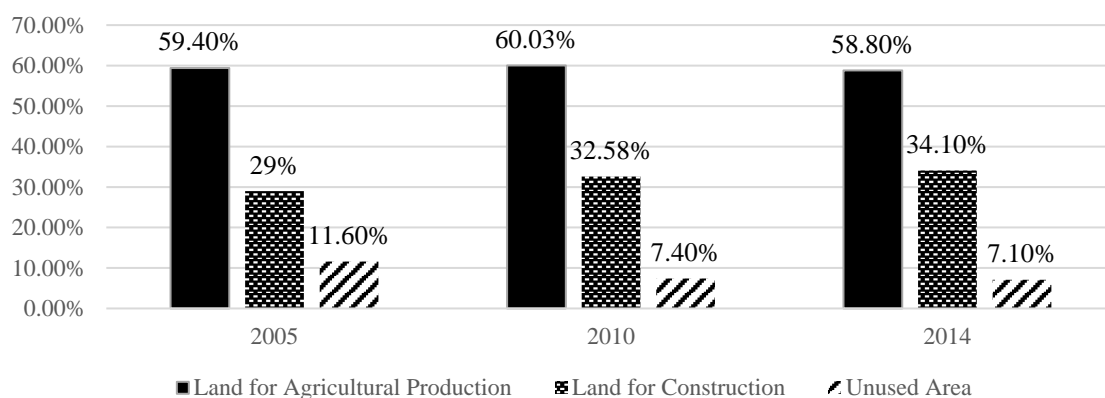|	2005		2010		2014	
	Area (sq. km)	Percentage to Total Area (%)	Area (sq. km)	Percentage to Total Area (%)	Area (sq. km)	Percentage to Total Area (%)
Total Land Area	**1191937.00**	**100.00**	**11916.88**	**100.00**	**11916.85**	**100.00**
Land for Agricultural Production	**7075.00**	**59.40**	**7153.29**	**60.03**	**7009.56**	**58.80**
Cultivated Land	4455.14	37.40	4437.04	37.23	4383.10	36.80
Garden Plot	371.01	3.10	312.28	2.62	303.98	2.60
Afforested Land	366.31	3.10	561.80	4.71	552.62	4.60
Others	1876.50	15.70	1842.17	15.46	1769.86	14.80
Land for Construction	**3462.84**	**29.00**	**3881.94**	**32.58**	**4059.41**	**34.10**
Land for Residents and Industry	2625.16	22.00	3110.58	26.10	3251.75	27.30
Land for Transportation	183.95	1.50	238.04	2.00	274.29	2.30
Land for Water Conservancy	653.73	5.50	533.32	4.48	533.37	4.50
Unused Area	**1381.86**	**11.60**	**881.65**	**7.40**	**847.88**	**7.10**
Unused Soil	406.92	3.40	837.26	7.03	162.93	1.40
Other Land	974.95	8.20	44.39	0.37	684.95	5.70

Figure2. Proportion of land type classification in Tianjin in 2005, 2010 and 2014.

4.2. Analysis of the driving force of urban development in Tianjin

The development and change of cities are influenced and influenced by natural, social, economic, cultural, political, legal and other factors at different time and space scales. Through the integration analysis of the city's LUCC and other statistical data at the same time (Table 2), it can be analysed that LUCC changes, urban construction land conversion rules and driving mechanisms can be used to control and plan the development and expansion of the city more purposefully. According to the analysis, the driving force of urban development and urban construction land conversion in Tianjin can be summarized as natural environmental factors, social economic factors and policy factors.

Table 2.Comparison of population, economy, trade data and construction land in Tianjin in 2005, 2010 and 2014.

Year	Land for Construction (sq. km)	Permanent Population (10 000 persons)	Natural Population Growth Rate (‰)	Total Value of Imports and Exports in Tianjin Port Calculated by USD (USD 100 million)			GDP Per Capita (yuan)
				Imports &Exports	Exports	Imports	
2005	3462.84	1043.00	1.43	819.29	446.83	372.46	37796
2010	3881.94	1299.29	2.60	1641.10	794.41	846.69	72994
2014	4059.41	1516.81	2.14	2285.04	1097.98	1187.06	105231

4.2.1Natural environmental factors

Natural environmental conditions have a certain leading role to a certain extent, which determines the macroscopic pattern and spatial evolution of urban land expansion. Tianjin has a complex topography, mainly plains and depressions, and low hills in the north, but the plains account for the total 93% of the area, flat terrain is conducive to the development of construction land, and has a positive role in promoting the development of construction land in Tianjin. The east of Tianjin is closed to the Bohai Sea, which limits the expansion of urban land use. However, with the development of advanced technologies such as river diversion and land reclamation, natural environmental factors are no longer the main factors affecting the development of construction land.

4.2.2Socioeconomic factors

4.2.2.1Population factor

Population is the most important factor in social and economic factors, and it is also the driving force for the most dynamic urban land use change. The rapid growth of population directly or indirectly leads to urbanization. The increasing population of the city has led to an increase in the demand for objective living space, driving the increase in urban construction land, and the LUCC classification has changed [3].

It can be seen from Figure3 that the urban population growth and the growth trend of construction land are basically the same. The correlation analysis between the construction land and the urban population in Tianjin is made by using SPSS, and the conclusions that are significantly related to the two are obtained. The urban population has a significant effect on the driving force of construction land.

Figure3. Comparison of land for construction and Permanent Population in Tianjin from 2005 to 2014.

4.2.2.2 Economic development factor

The urbanization and industrialization process in Tianjin directly led to the expansion of urban construction land. In recent years, Tianjin's GDP has grown rapidly, trade has increased, and economic development has been growing rapidly. Economic development has changed the structure and spatial layout of land use. Economic development affects the flow of talents and attracts people to enter the city, thus affecting the demand for residential land. Economic development attracts more investment, which affects the demand for types of transportation land, leading to further expansion of urban construction land.

It can be seen from Figure4 that the per capita GDP and the growth trend of construction land are basically the same. The correlation analysis between the construction land and the per capita GDP of Tianjin is made by using SPSS, and the conclusions that are significantly related to the two are obtained. The per capita GDP is driven by the construction land. The force is obvious.
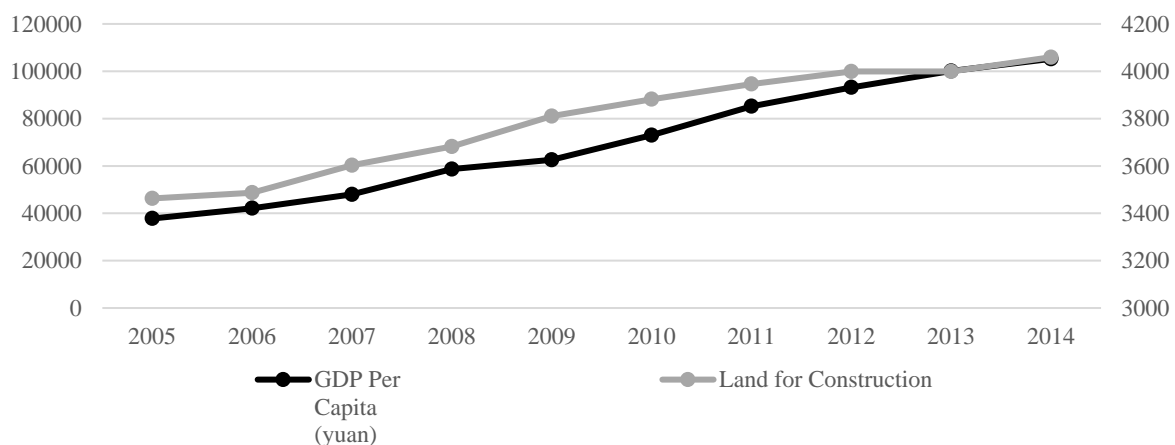

Figure4. Comparison of the land for construction land and per capita GDP in Tianjin from 2005 to 2014.

4.2.3 Policy factor

Policy is the guiding factor of land use change. The role of policy plays an important role in the process of urbanization. It has the most direct impact on land use change. From the perspective of the conversion of agricultural land to non-agricultural construction land, it is deeply affected by national

policies [4]. In March 1994, Tianjin decided to "build a new coastal area in a ten-year period on the basis of the Tianjin Economic and Technological Development Zone and the Tianjin Port Free Trade Zone". After more than 10 years of independent development in Tianjin, Binhai New Area began to be included in the "Eleventh Five-Year Plan" in 2005 and incorporated into the national development strategy, becoming a national-level new district with national key support for development and opening up. After being approved as a national-level new district, Tianjin Binhai New Area has attracted a large amount of foreign investment, especially high-tech industries, and the expansion of urban land has experienced extraordinary high-speed growth [5]. As one of the important cities of the Beijing-Tianjin-Hebei urban agglomeration, the policy tilts to promote the development of the economic industry and drive population movement.

5. Conclusion

In short, for Tianjin, natural environmental factors determine the basic conditions for urban development, but in the later stages of urban development, the impact on the proportion of LUCC and urban construction land is not too large. The socio-economic factors represented by factors such as population and economy have played a vital role in the driving force of urban development. The policy factor is the vane to promote urban development, especially the importance that the country attaches to the development of Tianjin in recent years. The tilt of Tianjin's economic construction and urban development is leading the urban development orientation of Tianjin. The driving factors are equally applicable in the development of other cities and have a general promotion.

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