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Original Research

Analysis of the Causal Relationship between the Spatial Change of Cultivated Land Conversion and Economic Development in North China, Using Hohhot City in Inner Mongolia as an Example

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Abstract

In order to achieve the "win-win" situation of development and food, we must solve the contradiction between economic development and cultivated land conversion. This paper provides a reference basis for effective protection of cultivated land resources and minimizing the amount of cultivated land conversion. The land use data of Hohhot in 2010, 2015 and 2020 are used to analyze the spatial distribution characteristics of cultivated land conversion in Hohhot. In addition, Granger causality analysis is used to study the relationship between the cultivated land conversion area, urbanization rate and GDP in Hohhot from 2010 to 2020, and master the causal relationship between the cultivated land conversion and economic development in Hohhot. Research conclusions: (1) The banner counties of Hohhot's high cultivated land conversion area are mainly distributed in the northeastern urban built-up areas, and the overall level of cultivated land conversion in Hohhot presents a spatial distribution pattern of high in the northeast and low in the southwest. (2) GDP and urbanization level are the direct reasons for cultivated land conversion in Hohhot, while cultivated land conversion is the indirect reason for the improvement of urbanization level, but not the reason for GDP growth.

Keywords: cultivated land conversion, spatial variation, granger causality, economic development, Hohhot City

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Introduction

The country is based on the people, the people depend on food, and food for the source of grain [1]. Cultivated land is an indispensable basic resource and foundation for people. In September 1994, Lester Brown, Director of the World Watch Institute in the United States, published a report titled "Who will feed China?" in which he pointed out that China was changing from an agricultural society to an industrial society at an extremely "dangerous" rate, and its farmland was shrinking just when it needed to expand most. In the end, Brown concluded that China has the greatest impact on world grain supply and demand in the future, and the shortage of grain in China is also the shortage of grain in the world [2, 3]. In the 21st Century, With the development of social economy and the acceleration of industrialization and urbanization in China, the living standard of the people is improving, and the demand for construction land is becoming more and more urgent. Cultivated land is gradually occupied by non-agricultural construction, which leads to the increase of non-agricultural area of cultivated land [4, 5]. In recent years, both China's economic growth rate and total economic quantity are among the top in the world [6, 7], The evolution process of cultivated land conversion under economic growth is advancing rapidly, and the contradiction between economic growth and cultivated land conversion is gradually significant [8]. Most of the growth of China's construction land is caused by the conversion of different types of cultivated land, leading to the cultivated land conversion as one of the main reasons for the reduction of cultivated land [9, 10]. The transfer of cultivated land from agricultural sector to non-agricultural industry sector, on the one hand, provides spatial support for urbanization development and plays an important role in economic growth. However, on the other hand, cultivated land conversion has caused a large loss of cultivated land resources in our country, resulting in human-land contradiction problems such as food security and ecological environment degradation [11, 12]. Therefore, food security will be the most serious challenge facing mankind in the 21st century. Based on a large number of relevant literature at home and abroad, researches on cultivated land conversion mainly focus on the spatio-temporal evolution characteristics and rules of cultivated land conversion [13, 14], the influence factors of cultivated land conversion from the aspects of social economy and ecological environment [15, 16], the driving force and driving mechanism [17-19], and the regulation at the technical level [20, 21]. In terms of research theories and methods, scholars mainly use qualitative methods, adopt a combination of qualitative and quantitative methods, study the driving mechanism of cultivated land conversion through mathematical statistics analysis, and combine remote sensing and GIS technology for dynamic monitoring and application of land use change. Such as entropy method, principal component analysis method, Geographic Information System spatial analysis method [22], geographical detector method [23], Geographically Weighted Regression model and Stochastic Impacts by Regression on Population, Affluence, and Technology model [24], etc. In terms of scale and scope of research, many scholars have focused on many elements of the system of cultivated land conversion and socio-economic development in the more economically developed regions at the macro-medium scale, but lack of research on micro-subjects. Therefore, it is necessary to strengthen the research on the micro-level such as county and township, so as to improve the pertinence and operability of research results on cultivated land conversion [25].

In terms of the causal relationship between cultivated land conversion and economic development, predecessors have conducted relevant research and found that economic growth is one of the important reasons to accelerate the cultivated land conversion. For example, Morns [26] believes that with the rapid advancement of economic development, the continuous expansion of urban area leads to the rise of land value around cities, and the expanding demand for construction land encroaches on agricultural land. Anders [2] studied the relationship between economic development and land use change in Norway by using the fixed-effect model analysis method, and found that there was a reverse change between economic growth and the decline of wasteland quantity. Bao B.Y. [27] took the time series data of Anhui province from 1990 to 2009 as an example, studied the co-integration relationship between cultivated land area and agricultural economic growth variables with the method of co-collation and ECM model, and believed that there was a reverse dynamic linear relationship between the cultivated land conversion and the change of agricultural output value in Anhui Province.

As an important transportation and advanced manufacturing base in northern region of China, North China is also an important economic hinterland of the Beijing-Tianjin-Hebei economic circle. Both the economic aggregate and the level of economic development in the north of China are in the first square matrix, but the economic development of this region also has a certain imbalance, with Beijing, Tianjin and the Bohai Rim Beijing-Tianjin-Hebei having a high level of economic development, such as Hebei, Shaanxi, Inner Mongolia and other areas of the overall level of economic development needs to be further improved. Hohhot is one of the constituent cities of the "Golden Triangle" area of the Hu-Baoe urban agglomeration in Inner Mongolia, and is now in a period of rapid economic development [28]. Due to the rapid economic development and the increase of the total population, the demand for construction land is increasing. Therefore, the main contradiction between the total amount of cultivated land and economic development is

becoming increasingly prominent, and the phenomenon of cultivated land conversion is becoming more and more serious. Hohhot has good quality plain cultivated land resources. In the face of limited cultivated land resources, it is of great significance for the comprehensive development of Hohhot to make good use of, protect and improve cultivated land [29, 30]. Therefore, this paper takes Hohhot as the research object, analyzes the spatial and temporal distribution characteristics of non-agricultural land in Hohhot in 2010, 2015 and 2020, and uses Granger causality analysis method to study the relationship between the cultivated land conversion area, urbanization rate and total GDP of Hohhot from 2010 to 2020. To express the causal relationship between Hohhot's cultivated land conversion and economic development.

Material and Methods

Study Area

Hohhot is located in the south of DaQing Mountain in central Inner Mongolia, between latitudes 40°51'N~41°8'N and longitudes 110°46'E~112°10'E. The total land area of Hohhot is 17,200 square kilometers. It is adjacent to Baotou City and Ordos City in the west, Ulanqab City in the east and Shanxi Province in the south. Hohhot is the political, economic and cultural center of Inner Mongolia Autonomous region. It is an important central city in the northern border region and the core city of the Hu-Baoe urban agglomeration (Fig. 1). In 2020, the city's cultivated land area is 556185.45 hm^2, of which 179.88 hm^2 is paddy field, accounting for 0.03%. 348722.24 hm^2 of irrigated land, accounting for 62.70%. Dry land accounted for 37.27% of 20783.33 hm^2. Among them, Wuchuan County has the most cultivated land distribution, with an area of 14.4436×10^4 hm^2, accounting for 25.96% of the city's cultivated land. From the secondary class distribution, the dry land is mainly distributed in Wuchuan County, Qingshuihe County and Helinger County, with 8.70×10^4 hm^2, 5.64×10^4 hm^2 and 4.7×10^4 hm^2 respectively, accounting for 91.78% of the total dry land area. The area of paddy field and irrigated land was the most distributed in Tumote zuo Banner, with an area of 110.79 hm^2 and 113403.72 hm^2 respectively, accounting for 61.59% of paddy field and 32.52% of irrigated land of the city [31]. By 2021, the city's permanent resident population is 3444200, with a GDP of 2800.68 billion yuan and a per capita GDP of 81656 yuan, with an urbanization rate of 70.45%.

Measure Method and Data Processing

Cultivated Land Conversion Index

The index of cultivated land conversion is to measure the level of cultivated land conversion in each banner and county,using the relative value of cultivated land conversion area and actual cultivated land area.

The formula for calculating the Cultivated land conversion index:

$$P_i = \frac{F_i}{S_i} \tag{1}$$

In Formula (1), where P_i is the cultivated land conversion index of the i administrative region, F_i is the

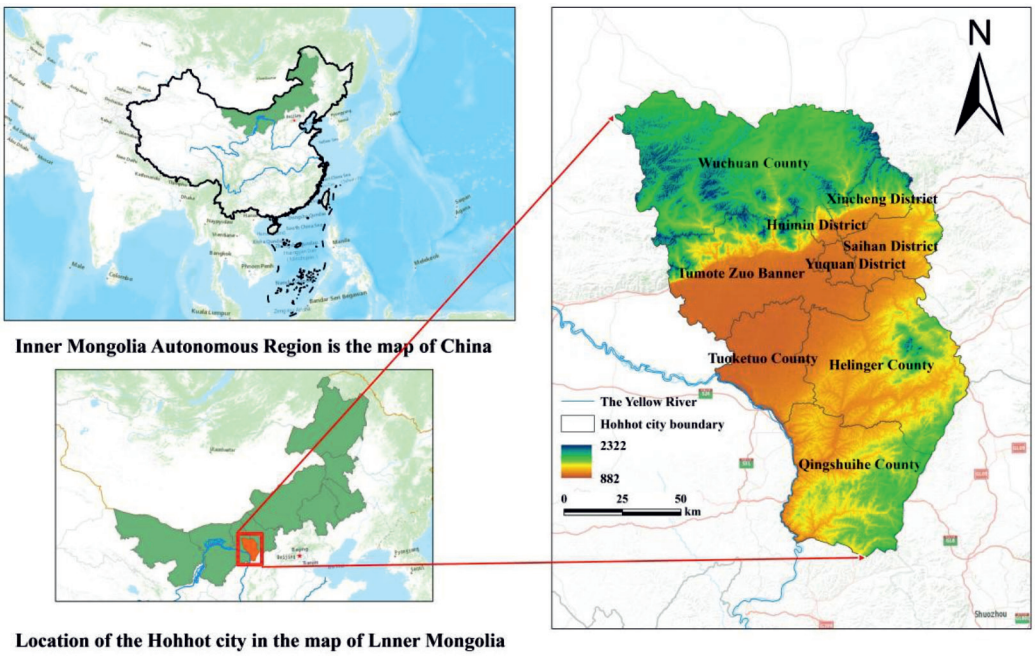

Fig. 1. Schematic diagram of the Study Area.

cultivated land conversion area of the *i* administrative region, and S_i is for the cultivated land area of the *i* administrative region. According to the calculation results of farmland non-agricultural index, the spatial distribution pattern of cultivated land conversion in Hohhot can be divided into 6 categories: $P_i = 0$ is No cultivated land conversion Area, $P_i \in (0,0.05]$ is Low cultivated land conversion Area, $P_i \in (0.05, 0.15)$ is Mild cultivated land conversion Area, and $P_i \in (0.15, 0.25)$ is Medium cultivated land conversion Area. $P_i \in (0.25, 0.35]$ refers to heavy cultivated land conversion Area, while $P_i \in (0.35, 1.00]$ refers to Extremely cultivated land conversion Area.

Granger Causality Test

The Granger causality test [32, 33] is an econometric method used to determine whether there is a causal relationship between economic variables and the direction of influence. The test idea is: whether a set of time series x is the cause of the change of another set of time series y. It is based on the autoregressive model in regression analysis. Regression analysis can only obtain the correlation between different variables at the same time, while autoregressive model can only obtain the correlation before and after the same variable [34]. Before Granger causality test, it must be proved that the random variable isa stationary series, so the ADF test is first conducted on the time series. The ADF test requires the sequence to be stable, so the sequence stationarity is the premise of Granger.

The ADF test [35] is to test whether there is unit root in the sequence, and the existence of unit root means non-stationary time series. The unit root refers to the unit root process, If the unit root process exists in the sequence, it is an unstable time series, which will lead to the existence of pseudo regression in the regression analysis. Therefore, if the original time series is not stationary, the next test of time series can be conducted in the case of the same order, which is the EG co-integration test (Engle-Granger) [36].

The EG two-step method [37] is another method of co-integration test. It is OLS regression for two variables of the same order, and unit root test for the obtained residual sequence etc. If the residual sequence passes the unit root test, the sequence is stable, that is, the two variables are considered to be co-integrated and there is a long-term equilibrium variation relationship [38].

Selection of Variables

In this paper, three variable factors are selected to study the causal relationship between Hohhot's economic development and cultivated land conversion (Table 1). The area of newly increased cultivated land occupied by construction land each year from 2010 to 2020 in Hohhot was selected as the index to measure the change of cultivated land conversion (F), and the per capita GDP index was selected to measure the economic growth (G). In order to avoid the influence of some population factors on the estimation of GDP level, compared with the total GDP, per capita GDP can better represent the economic growth of the whole city [39]. Urbanization rate (R) is selected to represent urbanization level. Because the two variables of economic growth and urbanization level can reflect the economic development of Hohhot.

In this paper, the land use data of the study area in 2010, 2015 and 2020 (from Data Center for Resources and Environment, Chinese Academy of Sciences https://www.resdc.cn/) and the vector map of administrative boundary with administrative districts and counties

Table 1. Cultivated land conversion area and economic development of Hohhot City from 2010 to 2020.

Year	Factor		
	Urbanization rate (%)	Per capita GDP (yuan)	Cultivated land conversion area (hm^2)
2010	62.46	44095	2132.25
2011	64.83	48875	1506.82
2012	67.20	52034	1801.58
2013	69.49	56948	1945.98
2014	70.77	60028	777.90
2015	72.28	65671	1504.65
2016	74.14	68932	1390.06
2017	75.58	73680	1136.22
2018	76.72	77744	775.23
2019	77.95	82475	318.71
2020	79.15	81656	3470.35

as spatial units are used. The data was imported into ArcGIS 10.5 operating software, and the cultivated land data of various administrative regions of Hohhot in different years and cultivated land non-agricultural conversion data in different periods were obtained by means of extraction and spatial overlay analysis and other tools. In addition, all the statistical data used in this paper are from the Statistical Yearbook of Inner Mongolia and the Statistical Yearbook of Hohhot in each year.

Results and Analysis

Spatial Distribution Pattern of Cultivated Land Conversion

The topography of Hohhot is mainly mountainous and plain, and the cultivated land resources are mainly concentrated in the northwest and central plain areas. According to the statistics of Inner Mongolia Statistical Yearbook in 2020, the total area of cultivated land in Hohhot is 558,372.56 hm^2, accounting for 32.77% of the city's land area [31]. It is mainly distributed in 6 banner counties, including Tumote Zuo Banner, Wuchuan County, Toketuo County, Helinger County, Qingshuihe County and Saihan District. The total amount of cultivated land in these 6 regions accounts for 71.72% of the total amount of cultivated land in the city, especially Toketuo County and Tumote Zuo Banner are important grain production bases in the city.

With the social and economic development of Hohhot, the demand for national key construction projects, infrastructure, urban and rural residential construction land has increased rapidly, the urban scale has been expanding outward, and a large amount of farmland has been occupied by non-agricultural construction [40]. In order to better grasp the spatial change rules of cultivated land non-agricultural conversion in Hohhot, the Natural Breaks classification method is adopted to classify the cultivated land conversion area in each banner county and district of Hohhot from 2010-2015 and 2015-2020, so as to analyze the spatial distribution of cultivated land conversion, as shown in Fig. 2. As can be seen from the figure, Yuquan District and Saihan District had the highest concentration of cultivated land conversion area in Hohhot during 2010-2015, and the cultivated land conversion area was between 20.47-48.35 km^2. However, from 2015 to 2020, Wuchuan County and Helinger County are the most concentrated areas of cultivated land conversion, with the cultivated land conversion area ranging from 79.5-115.4 km^2. In 2010-2015, there were two administrative districts with more than 22.75 km^2 of cultivated land conversion area, while in 2015-2020, there were six counties. During 2010-2015, the amount of cultivated land conversion in southwest China (Toketuo County and Qingshuihe County) was the least, and the area was less than 3.52 km^2, while the area was 22.75~44.65 km^2 during 2015-2020, with a big difference between the two periods. Therefore, it can be seen that there are great differences in the spatial areas of cultivated land conversion of different cultivated land in different periods.

In order to show the endowment of cultivated land resources in each banner and county, and objectively

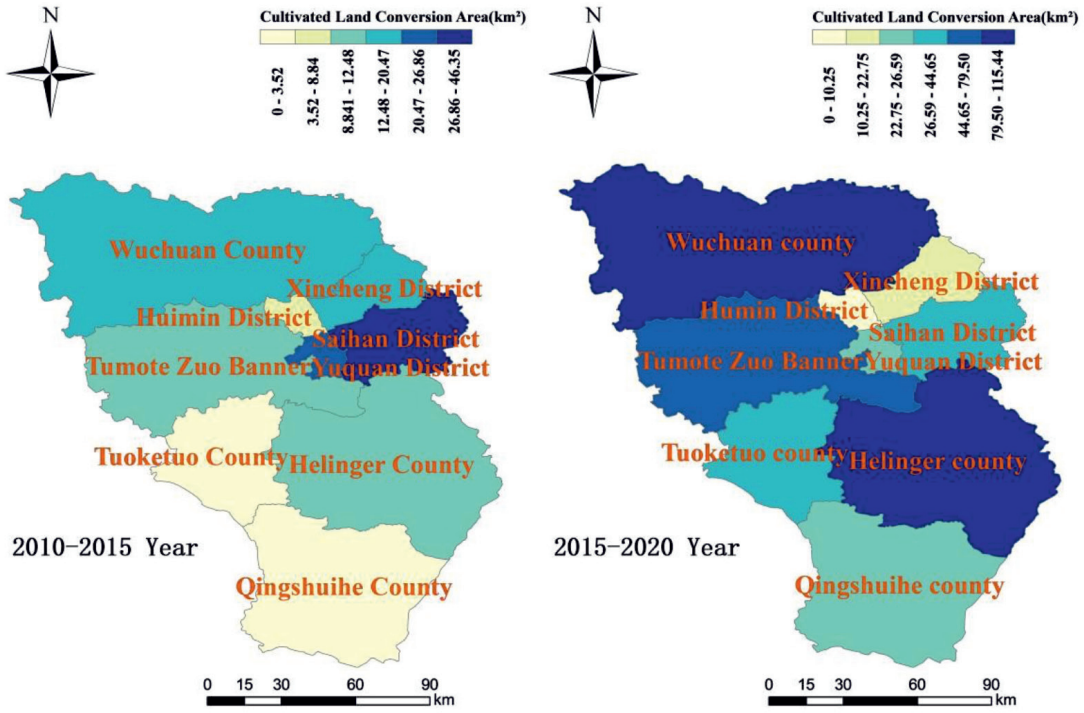

Fig. 2. Spatial distribution and classification of cultivated land conversion area in Hohhot from 2010 to 2020.

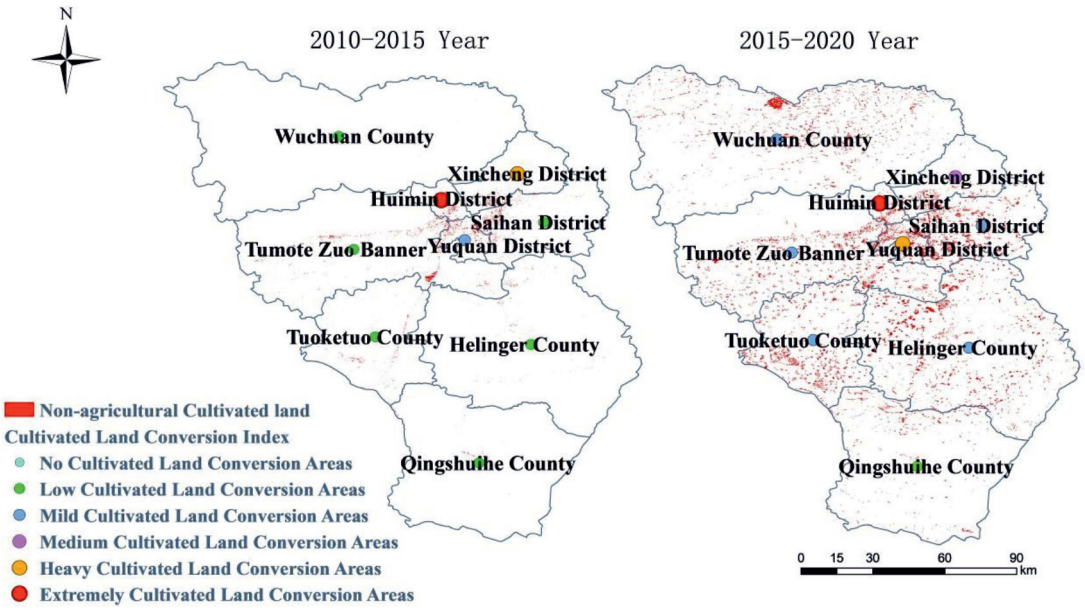

Fig. 3. Spatial distribution pattern of cultivated land conversion in Hohhot from 2010 to 2020.

reflect the degree of cultivated land conversion in Hohhot, the index of cultivated land conversion was constructed. According to the calculation results of the cultivated land conversion index, the spatial distribution pattern of cultivated land conversion in various regions of Hohhot during 2010-2020 was classified, as shown in Fig. 3. It can be clearly seen from Fig. 3 that from 2010 to 2020, the high cultivated land conversion index area in Hohhot is mainly concentrated in 4 urban areas, among which the Huimin District is the most serious cultivated land conversion index area, followed by Yuquan District. In the past ten years, more than 90% of the cultivated land occupied by the municipal district has been for the construction of development zones, infrastructure, large transportation facilities and industrial and mining land in towns and villages due to urbanization and economic development. As can be seen from the figure, due to the growth of urbanization level, Suburban Banner county has changed from a Low cultivated land conversion area during 2010-2015 to a Mild cultivated land conversion area during 2015-2020. The only region with no change in the index of cultivated land conversion purposes that no change between2010 to 2020 was Qingshuihe County, mainly because Qingshuihe County is the most backward area in the economic development of Hohhot City, and its construction land occupies the least area of cultivated land [41]. It can be seen from the figure that from 2010 to 2020, the extreme and heavy cultivated land conversion areas of all banner counties in Hohhot are mainly concentrated in the built-up Urban construction area in the northeast. Therefore, the overall level of cultivated land conversion in the whole city presents a spatial distribution pattern of high in the northeast and low in the southwest. Due to the influence of location condition and transportation convenience, each banner county has different ways in the urban expansion. Therefore, in recent years, Hohhot City cultivated land conversion status is more obvious. In conclusion, the regional difference of cultivated land conversion is the result of location, nature and social and economic factors.

Analysis of Granger Causality between Cultivated Land Conversion and Economic Development

ADF Unit Root Test

In order to ensure the stability of the data, Eviews10.0 was used to conduct ADF unit root test for the three sequences of cultivated land conversion area, per capita GDP and urbanization level from 2010 to 2020. The test results show that the ADF test values of cultivated land conversion (F), per capita GDP (G) and urbanization level (R) are at least one critical value greater than the significant level of 5%, as shown in Table 2. The unit root of the undifferentiated sequence of these three variables does not have stationarity and fails to pass the test. Therefore, the ADF first-order difference test was carried out for the three variables. First-order difference series test results show that the ADF values of the three variables are all less than the significant level of 5%, indicating that the three variables have stabilized. It can be seen that the three sequences are of the first order, namely I(1), as shown in Table 3.

Co-Integration Test

The unit root test shows that if the sequences are all integrations of the same order, we can investigate whether there is a co-integration relationship between

Table 2. ADF test of undifferentiated series of variables in Hohhot from 2010 to 2020.

Variables	ADF test	Level of significance	Above critical level	Results of test
Per capita GDP	-2.8809	1%	-5.2954	Non stationary
		5%	-4.0082	
		10%	-3.4608	
Cultivated land conversion	-2.7948	1%	-5.5219	Non stationary
		5%	-4.1078	
		10%	-3.5150	
Urbanization rate	-1.7388	1%	-5.2954	Non stationary
		5%	-4.0082	
		10%	-3.4608	

Table 3. ADF test of the log-first difference series of each variable in Hohhot City from 2010 to 2020.

Variables	ADF test	Level of significance	Above critical level	Results of test
Per capita GDP	-3.4471	1%	-4.42060	Stable
		5%	-3.2598	
		10%	-2.7711	
Cultivated land conversion	-2.7948	1%	-2.8473	Stable
		5%	-1.9882	
		10%	-1.6001	
Urbanization rate	-2.7362	1%	-2.8473	Stable
		5%	-1.9882	
		10%	-1.6001	

Table 4. ADF test of et1 and et2of residual series.

Variables	ADF test	1% critical value	5% critical value	10% critical value	Results of test
et_1	-4.5623	-5.1059	-3.9544	-3.4635	Stable
et_2	-4.3610	-5.1059	-3.9544	-3.4635	Stable

them. Avoid the phenomenon of pseudo regression. In this paper, the traditional process test in the Engle Granger co-integration test is used to investigate the co-integration relationship between the amount of cultivated land conversion and the level of economic development. Specifically, in EViews software, the co-integration relationship is judged by checking whether the residual error of the co-integration regression is stable.

First, EViews10.0 was used to perform OLS regression on the area of cultivated land conversion and per capita GDP to obtain the residual sequence et_1, which was tested by ADF. After the unit root test of residual et_1, the critical value or P value in EViews cannot be directly applied to judge whether the residual is stable. The corresponding critical value should be calculated according to the critical value table for judgment.

As shown in Table 4, if the critical value a = 0.05 is given, the corresponding critical value is -3.9544 according to the critical value calculation table, and the t statistic of the residual et_1 unit root test is -4.5623, which is less than the critical value at the 5% test level. Therefore, the residual et_1 has no unit root, that is, the residual et_1 is a stationary sequence. This indicates that there is a co-integration relationship between regional cultivated land conversion area and per capita GDP. In the same way, OLS regression was performed on the cultivated land conversion and urbanization rates of regional cultivated land to obtain the residual sequence et_2, and unit root test was performed on et_2 to obtain the t statistic of -4.3610. Below the critical

value of 5%, the residual et_2 has no unit root, that is, the residual et_2 is a stationary sequence. Therefore, there is a co-integration relationship between cultivated land conversion and urbanization rate. On the whole, there is a long-term equilibrium relationship between the amount of cultivated land conversion and economic development in Hohhot.

Granger Causality Test Results

According to the results of Granger causality test (Table 5), when the lag order is 1 and 2, the confidence level of per capita GDP is 66% and 62%, which is the Granger cause of cultivated land conversion. When the lag order is 3, it is also the Granger cause of cultivated land conversion at 92% confidence. For the null hypothesis that cultivated land conversion is not the Granger cause of per capita GDP, when the lag order is 1 and 2, the probability is 18% and 31% respectively, indicating that the null hypothesis is not rejected. Therefore, the cultivated land conversion is not the Granger cause of per capita GDP.

When the lag order is 1 and 2, the urbanization rate is the Granger cause of cultivated land conversion at the confidence level of 76% and 95% respectively. when the lag order is 2 and 3, the cultivated land conversion is the Granger cause of urbanization at the confidence level of 84% and 89% respectively, In other words, the cultivated land conversion at lags orders 2 and 3 is a Granger cause of urbanization.

Analysis of the Causal Relationship between Cultivated Land Conversion and Economic Development

The results show that per capita GDP is the one-way Granger cause of cultivated land conversion, but not the Granger cause of per capita GDP growth. During 2010-2020, Hohhot vigorously promoted the reform of state-owned enterprises, continuously improved the level of economic development, and basically established the dominant position of enterprises in the market, resulting in a large number of new construction land occupied arable land. Cultivated land conversion can not only increase fiscal revenue for the central government but also provide capital for national urbanization construction [42,43]. Thus, the expansion of the development zone in Hohhot and the overheating of the real estate sector resulted in the existence of negligible factors that made the per capita GDP change. On the contrary, the reduction of cultivated land area in Hohhot during 2010-2020 cannot contribute to the economic growth. Since 2010, there have been problems such as extensive utilization of construction land, stockpiling and idling of construction land in Hohhot [44]. The way of cultivated land conversion is not only due to the occupation of new construction land, but also the adjustment of agricultural structure, the destruction of disasters and the return of ecological farmland. Moreover, when the economy grows to a certain level, the economic structure will be transformed from the "two, one and three" industries to the "three, two and one" industries. With the rapid development of high-tech industry, the demand for urban construction land reduces the pressure on cultivated land, thus slowing down the non-agricultural conversion of cultivated land [45].

The results show that urbanization and cultivated land conversion are two-way Granger causes of each other. Due to the continuous expansion of the urban scale of Hohhot, some high-quality farmland in the suburbs of the city is occupied by new construction land. Urbanization level is the general embodiment of economic development level. With the rapid development level of regional economy, the external expansion of urban scale is also faster. Due to the gap between the price of cultivated land and the stock of construction land, land use units turn their attention to new construction land [46]. Therefore, the level of urbanization has a more obvious impact on cultivated land conversion than GDP.

To sum up, the variables GDP is the one-way Granger cause of cultivated land conversion in Hohhot, urbanization and cultivated land conversion are two-way Granger causes of each other.

Discussions

Under the influence of economic policies, the government will increase investment and the demand for construction land will also increase, which will promote the adjustment of agricultural structure. The demand for urban construction land is the greatest, and a large

Table 5. Test results of causality between cultivated land conversion, per capita GDP and urbanization.

Lag phase	Per capita GDP is not the Granger cause of Cultivated land conversion		Cultivated and conversion is not the Granger cause of per capita GDP		Urbanization is not the Granger cause of Cultivated land conversion		Cultivated land conversion is not the Granger cause of urbanization	
	Statistic of F	P values	Statistic of F	P values	Statistic of F	P values	Statistic of F	P values
1	1.0456	0.3406	0.0544	0.8223	1.6435	0.2407	0.2892	0.6074
2	1.2361	0.382	0.3973	0.696	6.6434	0.0535	2.9835	0.1611
3	81.7543	0.0811	2.0982	0.4604	1.577	0.516	41.4122	0.1136

amount of farmland is around the city, so a large amount of farmland is occupied by urban construction [47]. China is in a period of vigorous economic development, the accelerated urbanization and industrialization process has promoted the conversion of agricultural land, and the continuous expansion of construction land while the continuous decline of agricultural land. In particular, the drastic reduction of cultivated land has seriously threatened China's social security, economic security and ecological security [48-52]. Cultivated land conversion is a major strategic issue related to food security. In order to achieve the "win-win" situation of development and eating, the contradiction between economic development and cultivated land conversion must be solved. The authors analyse the spatial distribution characteristics of cultivated land conversion in Hohhot, and apply Granger causality analysis to reveal the causal relationship between economic development and cultivated land conversion. In this study, two comprehensive factors influencing economic development in Hohhot, GDP and the level of urbanisation, were selected, and the strength of their interaction varies in different stages of urbanisation development. This role, which varies with the stage of development, has a strong influence on the process of cultivated land conversion. The test results show that GDP is the one-way cause of cultivated land conversion in Hohhot, and urbanisation and cultivated land conversion are mutual two-way Granger causes. The effect of urbanisation on cultivated land conversion is not consistent with the effect of GDP on cultivated land conversion, and the effect of urbanisation on cultivated land conversion is more significant. To fundamentally resolve the contradiction between cultivated land conversion and economic development in Hohhot city, urbanisation must be used as an entry point.

Therefore, this study provides some theoretical and practical cases for the relevant authorities to solve the contradiction between the cultivated land conversion and the social and economic development, and to carry out the policy guidance, regulation and control measures on the utilization of specific cultivated land resources. However, the limitation of this paper is that it does not study the causes of cultivated land conversion in the study area. The problem of cultivated land conversion often involves many factors, which are closely related to social economy, resources and environment, population, policy and other factors. Therefore, determining the influencing factors and driving forces of the cultivated land conversion process in the study area will be the next research content of the authors.

Conclusions

This paper uses the cultivated land data of Hohhot in 2010, 2015 and 2020 to analyze the spatial distribution characteristics of cultivated land conversion, and uses the Granger causality analysis method to study the relationship between the cultivated land conversion area, urbanization rate and GDP of Hohhot from 2010 to 2020, so as to express the causal relationship between cultivated land conversion and economic development. The results showed that:

(1) The overall non-agricultural level of cultivated land in Hohhot showed a spatial distribution pattern of higher in the northeast and lower in the southwest. From the spatial distribution of cultivated land conversion in Hohhot, it can be seen that the spatial regions of cultivated land conversion in different periods have great differences. In Hohhot, the administrative villages in the cultivated land conversion area are mainly distributed in the urban built-up areas in the northeast, and the overall level of cultivated land conversion is higher in the northeast and lower in the southwest.

(2) GDP is the one-way Granger cause of cultivated land conversion in Hohhot, urbanization and cultivated land conversion are two-way Granger causes of each other. In this paper, Granger causality test is used to study the causal relationship between Hohhot's economic development and cultivated land conversion. The economic development is represented by the per capita GDP of Hohhot and the level of urbanization, and the cultivated land conversion is mainly represented by the newly increased construction land area of Hohhot. It can be seen from the research results that the two have a certain mutual influence.

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Conflicts of Interest

The authors declare no conflict of interest.

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