Forecasts of Urban Construction Land Scale based on Driving Force Analysis

Wang Yanjun，Li Liujun
College of Urban and Environmental Sciences，Northwest University, Xi'an 710127, China.
974702583@qq.com

Abstract：On the basis of summing up the evaluation and prediction methods of construction land scale, this paper explored a new method for forecasting construction land in small towns. Taking Fuping County as an example, correlation analysis was used to determine the driven factors of land expansion such as economy, population, construction investment and so on, and entropy method was used to determine the impacting weight of each driving factor. At last, this paper analyzed mechanism and characteristics of urban expansion, to forecast the scale of construction land using regression analysis, which will provide basis for urban construction and policy making.

Key-Words：Construction land scale; Correlational analysis; Entropy method

1. Introduction

Urban population accounted for 56.10% of the total population in the end of 2016 in China, a large number of rural labor force concentrated in large cities. However, with the industrial upgrading and transfer, jobs in large city can’t meet the demand of rural labor, and rural population can’t afford the expensive cost of living in large cities. Small-sized or medium-sized cities and small towns have a vital role in the development of urban and rural areas, the development priorities of urbanization gradually transferred from large cities to small towns. The scale of small towns continues to expand, and the demand for construction land is increasing day by day. Scientific prediction of construction land scale plays an important role in urban capacity prediction, industry selection, and other fundamental issues. It is an indispensable content that must be rationally controlled, and an effective measure to protect cultivated land resources and to realize the sustainable utilization of land resources.

At present, the domestic scholars have studied more about the prediction methods and models of land use scale, and these methods can be divided into two categories, direct prediction and indirect prediction. The basic idea of direct prediction is assuming that land use scale growth in the future in line with the historical trend, combined with the previous land use data and variation characteristics, to predict the future scale of land use through a variety of parameters in the model fitting, such as exponential growth model [1], grey system model [2], Markov Model [3]. The basic idea of indirect prediction is to using driving factors of construction land expansion to predict the future scale, such as per capita multivariate statistical regression model [4], neural network model and genetic support vector machine [5]. In addition, there are other models considering other driving factors in the part of the decision rules, such as CA and multi-agent method [6].

What these methods have in common is that they all need to be based on historical data. Direct prediction the takes time trend into consideration but ignores the comprehensive effect of driving factors. Models of indirect prediction are complex and difficult to calculate, this method tacitly holds that the most powerful model is the developing trend in the future, which doesn’t conform to the reality. This paper starts with the social and economic influence factors of construction land expansion instead of historical data, and constructs the target-oriented and multi-scale construction land scale prediction method.

2. Research Method

Changes of construction land is less affected by natural factors because the short time span, indicators from social and economic aspects are selected to establish a driving force model of construction land. The purpose of the model is to establish quantitative relationship between the scale of construction land and the influence factors, and to provide the basis for the prediction of construction land scale.

Based on summarizing the existing literature and fully consider the social and economic factors of construction land expansion, five indicators in three aspects are selected, that is city population size (total population and urban population), economic development (Gross Domestic Product) and construction investment (fixed asset investment and urban fixed asset investment) [7, 8]. There are four steps in the driving force model of construction land. First, correlation analysis method is used to judge the relationship between the influence factors and construction land, to exclude factors with little relevance; secondly, the model narrows the links between each influence factor through normalization, to ensure the independence of each factor; thirdly, the model uses entropy method to calculate the weights of modified factors; at last, the model analyzes the characteristics of construction land influenced by economic and social according to the calculation result of weights.

3. Study area

The study area, Fuping county, is subordinate to Weinan City, Shaanxi Province. It is located at 34°41'N latitude and 108°57'E longitude, and in the Loess Plateau area of Weibei Loess Plateau in the northeast of Guanzhong. East of Fuping County is Weinan City, west of it is Xianyang and Tongchuan City, south of it is Xi'an city. Fuping County is located in the core position of Guanzhong-Tianshui Economic Zone, and also the central position of the hinterland of China. Taking Fuping County as the research example is significant to regulate the construction land of small towns in northwest China. Five economic and social indicators in the central city of Fuping in the past 10 years are selected to establish the driving force model (Table 1).

Table 1 Construction land scale and its influencing factors of past years in Fuping

Year	Total population(10,000people)	Urban population (10,000people)	GDP （100 million）	Fixed asset investment (10,000 yuan)	Urban fixed assets investment (10,000 yuan)	Construction land scale (ha)
2000	10.06	3.71	17.29	1.79	0.64	810.91
2001	12.88	3.82	18.68	3.61	2.08	863.40
2002	12.93	3.86	20.34	3.59	2.38	881.80
2003	13.01	3.96	22.37	5.52	4.35	904.50
2004	13.72	4.74	22.18	6.15	5.02	949.60
2005	13.86	4.89	25.23	6.34	5.14	969.30
2006	14.04	4.85	28.87	7.22	5.69	1040.50
2007	14.24	6.82	31.6	12.43	9.02	1128.70
2008	14.43	8.79	38.32	19.66	15.00	1231.57
2009	14.75	9.06	43.68	32.95	27.58	1267.32

Data source: Fuping statistical yearbook

4. Data Analysis

Firstly, correlation analysis method is used to determine whether there is a dependency relation between two variables, and measure the relative direction and degree of correlation between the two variables. The degree of linear relationship between the two variables is described by the correlation coefficient R, when the absolute value of R is no less than 0.8, there is correlation between two variables, when the absolute value of R is no less than 0.95, two variables are significantly correlated. Use SPSS 19 to analyze the correlation of status data in Table 1, the results are shown in Table 2. The target value “construction land scale” has a positive significant correlation with urban population, GDP, fixed asset investment and urban fixed asset investment, and it has a positive correlation with total population. No factors need to be eliminated after the election.

Table 2 Correlation analysis of construction land and influence factors

Correlation	Total population	Urban population	GDP	Fixed asset investment	Urban fixed asset investment
Construction land scale	.766*	.958**	.992**	.966**	.971**

* significant correlation at 0.05 level (bilateral); * * * significant correlation at 0.01 level.

Secondly, normalized factors in Table 1 to calculate comparable value of each factor and normalized correlation coefficients in Table 2 to calculate comparable value of each correlation coefficient. The two normalized eigenvalues are multiplied into a matrix of factor effects $\{A_{ij}\}$.

$$A_{ij}=\begin{Bmatrix} 0.0575 & 0.0737 & 0.0740 & 0.0744 & 0.0785 & 0.0793 & 0.0803 & 0.0815 \\ 0.0652 & 0.0671 & 0.0679 & 0.0696 & 0.0833 & 0.0860 & 0.0853 & 0.1199 \\ 0.0639 & 0.0690 & 0.0751 & 0.0826 & 0.0819 & 0.0932 & 0.1066 & 0.1164 \\ 0.0174 & 0.0351 & 0.0349 & 0.0537 & 0.0599 & 0.0617 & 0.0703 & 0.1210 \\ 0.0081 & 0.0263 & 0.0301 & 0.0549 & 0.0634 & 0.0649 & 0.0718 & 0.1139 \end{Bmatrix}$$

Thirdly, Entropy method is used to calculate the weight of the index by measuring the information provided by each index. In the index data matrix of samples I and indexes J, if the gap between indicators is wider, the indicator will provide more information, and the impact of the index will be greater, the weight will be much bigger.

$P_{ij}=\frac{x_{ij}}{\sum_1^n x_{ij}}$,represents the proportion of the sample i in the index j； $e_j=-\left(-\frac{1}{\ln(n)}\right)*\sum_1^n P_{ij}\log(P_{ij})$, represents the entropy of index j; g_j=1-e_j, represents the variation coefficient of index j; $W_{ij}=\frac{g_j}{\sum_1^m g_j}$, represents the weight of index j. The results are shown in Table 3.

Table 3 Weights of driving forces of construction land expansion

Influence factor	e_j	g_j	W_{ij}
Total population	1.000	0.000	0.000
Urban population	0.992	0.008	0.053
GDP	0.996	0.004	0.029
Fixed asset investment	0.930	0.070	0.453
Urban fixed asset investment	0.928	0.072	0.465

5. Conclusion and Discussion

According to the results of the analysis, construction land scale in Fuping county is mainly driven by fixed assets investment and urban population, urban fixed asset investment has more influence than fixed assets investment, and the contribution of GDP is slightly weaker. Fuping is in the period of industrial construction. The rapid economic development and the improvement of construction projects and supporting facilities have led to the expansion of construction land scale. Therefore, the growth of land use is similar to that of economic development. Although the town has the largest collection of population in the county, the county population has been in a stable growth stage, so the expansion of construction land has little to do with the population.

Previous studies predicted the target year construction land scale according to the index, the weighted average of the predicted results is used to obtain the final result. It is unscientific and not practical to think that all indexes play the same role in expanding construction land. Therefore, the accuracy of the prediction is improved by weighting the results of each factor according to their weight. Forecast of target year construction land scale in Fuping County is shown in Table 4. The prediction model selects the highest fitting regression model. By weight calculation, construction land in target year is about

1350ha. Only about 100ha is added on the basis of the current situation, which is in line with the current national policy of intensive land use.

Table 4 Prediction of construction land in Fuping County

Predictive factor	urban population (10,000people)	GDP （100 million）	fixed asset investment (10,000 yuan)	urban fixed assets investment (10,000 yuan)
Target year factor value	20.5	70	50	40
Prediction formula	y=455.33*LN (x)+258.12 R^2=0.9679	y=508.21*LN(x)-645.11 R^2=0.9822	y=179.32*LN(x)+655.3 R^2=0.9506	y=139.51*LN(x)+783.8 R^2=0.8729
Prediction result	1633	1514	1357	1298
Factor weight	0.053	0.029	0.453	0.465
Construction land scale		1349		

Urban land expansion is the result of the combined effects of various factors. Fuping county is in the acceleration period of economic development, more and more land will be occupied in the coming years. Government departments must fully understand the stage characteristics of urban development and pay more attention to social and ecological benefits, and focus on the coordinated growth of economic, social and ecological benefits. The total size of construction land should be controlled strictly to realize the sustainable development of urban land use.

Reference

[1] Xu.Y., Shen H.Q., Gan G.H., et al. Rural residential land use change and its correlative model with population in Fengtai district of Beijing. *Acta Geographica Sinica*, Vol.57, No. 5,2002, pp.569-576.

[2] Yu.C., Song.W., Wu.C, Forecast of construction land scale based on ridge-gray coupling model: a case of Jiaozuo city,Henan province. *Areal Research & Development*, Vol.34, No.1,2015, pp.155-159.

[3] Hou.X.Y., Wu.L., Lu.X., et al. Effects of time-duration on the performance of the Spatial-Markov model for land use change forecasting. *Journal of the Indian Society of Remote Sensing*, Vol.43, No.2,2015,pp.1-9.

[4] Liu.K. Application of BP neural network in the prediction of urban built-up area: a case study of Beijing. *Progress In Geography*, Vol.26, No.6,2007,pp.129-137.

[5] Liu.Y.G., Wang.F.L. Holistic forecast method of land use in leap-forward of urbanization. *Geographical Research*, Vol.30, No.7,2011,pp.1187-1197.

[6] Liu.J., Li.H., Ma.Y.G. Analysis and prediction of land use change in typical city of central Asia based on CA-Markov model. Research of Soil and Water Conservation, Vol.21, No.3,2014,pp.51-56.

[7] Lu.J.X., Li.Y.X. Research on the relationship between urban land use and population with the city economic development of Xinjiang: based on the analysis of the allometric growth model. *Areal Research and Development,* Vol. 32, No.6,2013,pp.121-126.

[8] Shu.B.R., Zhu.J.J., Li.Y.L., et al. Driving forces of urban land expansion at different stages of economic development: an empirical analysis based on provincial panel data. *China Land Sciences*, Vol. 11,2013,pp.65-71.