Land Use Policy 78 (2018) 386–396

Contents lists available at ScienceDirect

Land Use Policy

journal homepage: www.elsevier.com/locate/landusepol

Quantifying urban land expansion dynamics through improved land management institution model: Application in Ningxia-Inner Mongolia, China

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ARTICLE INFO

Keywords:
Urban land expansion
Land management institution model (LMIM)
Path dependence
Ningxia-Inner Mongolia region along the Yellow River
China

ABSTRACT

It is of great importance to investigate mechanism of urban expansion as to policy-making and implementation of urban planning in China. The purpose of this study is to carry out a thorough investigation on quantifying dynamic process of urban land expansion through an improved Land Management Institution model (LMI), which was further applied in Ningxia-Inner Mongolia region, China. Therefore, an improved LMI model was developed by introducing the varying panel approach which can well determine the major contributors of spatial differences of urban land expansion and quantify the evolution of land management institution. Through this investigation, following findings were achieved. Firstly, the improved LMI model could efficiently quantify and determine spatial differences of endogenous factors of urban land expansion, and the land management institution evolution. The land management institution evolution presented a path dependence with a stable trajectory, which meant urban land expansion were well coincided with the evolution of land management institution. Secondly, the improved LMI model application in Ningxia-Inner Mongolia region disclosed that urban land expansion had an obvious negative effects of lock-in phase characters in land management institution evolution. Marginal effects of major influencing factors of urban land expansion contributed greatly to the differences of urban land expansion in terms of different sectors and regions. Finally, dynamics analysis of urban land expansion in this study area suggested that its urbanization had similar urbanization patterns with cities in elsewhere of China, and meanwhile it presented distinct characters. The massive conversion of land use has stimulated high-speed economic growth in the short term at the expense of eco-environment in the long term. It is suggested that governments at all levels should pay more attention to land management institution reform, industrial adjustment, technological innovation as to realize sustainable urbanization.

1. Introduction

As a crucial symbol of modernization, urbanization is a natural and historical process that population and non-agricultural industries shift from rural to urban area (Lu, 2013; Lu and Chen, 2015). Over the past decades, mass urbanization has occurred in China along with its fast industrialization process. However, the urbanization in China was primarily driven by the government, which has generated many problems (Bai et al., 2014). Firstly, compared to the industrialization process, the urbanization in China was seriously lagged behind. Secondly, the growth of the urban built-up land area was faster than the urban population growth. Thirdly, the urban construction land has been utilized in a relatively inefficient manner. Fourthly, the spatial distribution of urban areas are usually unparalleled with the carrying capacity of local environments, and the environment problems in many urban areas of China keep growing (Liu, 2008; Kuang et al., 2009; Pickett et al., 2011). Thus, aiming to address these issues and negative consequences accompanied with rapid urbanization, the central government of China has issued a number of policies and laws to regulate the land-use change, especially to constrain urban land expansion.

Urban land expansion can greatly promote the economic growth. Meanwhile, it may also bring contradictions on social and

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https://doi.org/10.1016/j.landusepol.2018.06.018
Received 25 January 2018; Accepted 14 June 2018
0264-8377/

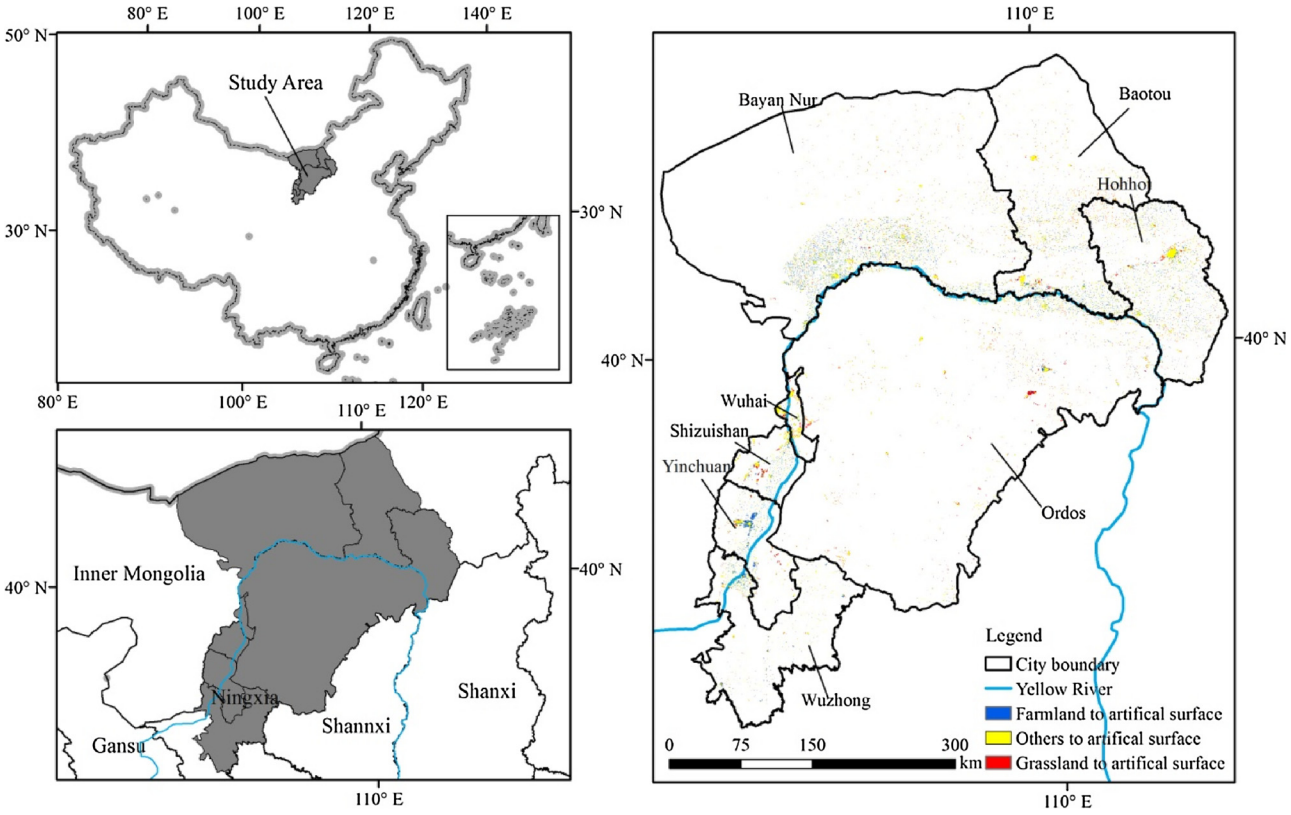

Fig. 1. Location of Ningxia-Inner Mongolia region along the Yellow River and the artificial surface expansion from different land type.(1990–2010).

environmental sustainability (Angel et al., 2011; Bai et al., 2014). Specifically, China has developed its own mode of urban economic development depending on urban land since 1990s (Liu et al., 2012b). To investigate the mechanism of mass urban land expansion in China and its effects on the content, process and results, a large number of studies have been conducted. Among those studies, there are two major progresses in understanding the effect and evolutionary mechanism of the urban land-use change (Ding, 2003; Wang et al., 2012; Wu et al., 2016). Firstly, the driving forces of land-use change has been advanced from the single economic factor to multi-factors, i.e. social, institutional, and technical factors, etc. Secondly, the dynamic mechanism of the land-use evolution has been discovered from the surface morphological evolution to inner mechanism. Specifically, some representative efforts in such fields are listed as follow:

(1) The coupling-mechanism among and within urban economic development, industry structural evolution, and environmental change has been discovered. This finding has provided the theoretical foundation to optimize urban industry development and environment pollution management (Grossman and Krueger, 1995; Wan and Dong, 2012; Huang, 2010; Liu and Deng, 2009; Li, 2011).

(2) The study on the effect of urban land change on environment and urban ecosystem sustainability has been furthered. Specifically, the effect from climate and environment factors have been used in urban land change research by employing the GIS and remote sensing techniques. From the similar perspective, the understanding on the interaction between urbanization, urban ecosystem, and global climate change have also been furthered (Liu and Deng, 2009; Bowler et al., 2010; Huang et al., 2011; Dai et al., 2015; Yang et al., 2010; Liu et al., 2012a; Guo et al., 2011; Nicole et al., 2014; Guo et al., 2011; Liu et al., 2012a; Yu et al., 2015).

(3) The pattern of urban land expansion, the major driving factors, and the their driving mechanism has been disclosed by employing the GIS spatial analysis techniques, along with the combining the factor analyzes in terms of social-economics, institution, technology, and etc. (Alonso, 1964; Kuang et al., 2009, 2014; Ding, 2003; Wang et al., 2012; Verburg et al., 1999; Kumar et al., 2011; Yue et al., 2013; Zheng et al., 2012; Dorning et al., 2015; Wu et al., 2010; Zhang et al., 2011a; Taylor, 1998; Huang et al., 2015; Huynh, 2015; Christensen, 2014).

At present, some existing studies show that LMI plays a key role in driving urban land expansion (Taylor, 1998; Christensen, 2014; Huang et al., 2015; Wu et al., 2016). However, the key processes and major factors that underpin urban land expansion remains unclear. Specifically, there are some questions are yet to be answered: (1) How does the LMI work in different patterns, i.e. how to use LMI model to quantify its effects and its dynamic influences on urban land expansion? (2) What are the spatial differences of major factors on urban land expansion with regard to the evolution of LMI? In this study, our primary focus will be on the second one, i.e. the spatial differences and the process of LMI evolution.

When referring to the LMI and related effects as the major factors on urban land expansion, only describing the process of the LMI evolution is obviously not enough. This is because that qualitative description without firm empirical evidences may lead to misrepresentations of the urban land expansion and misleading consequences. Thus, based on the data collected from our study area, the objectives of this study are: (1) to test whether the marginal effects of major factors with the quantified LMI on urban land expansion are varying across different cities; (2) to explore the process of LMI evolution; (3) to figure out how the local governments make their LMI.

The empirical results of this study are used to explore the nature of the process of the LMI evolution, and to compare the spatial differences of major factors on urban land expansion and quantifications of the LMI evolution across our study area. Meanwhile, this study will also provide empirical implication and theoretical support for resolving the existing problems that caused by urban land expansion in China, especially from the perspective of urban planning regulations and land management policy.