Habitat International 56 (2016) 20–30

Contents lists available at ScienceDirect

Habitat International

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

Agglomeration and diffusion of urban functions: An approach based on urban land use conversion

Guolei Zhou [a], Chenggu Li [a, *], Moyin Li [b], Jing Zhang [a], Yanjun Liu [a]

[a] School of Geographical Sciences, Northeast Normal University, 5268 Renmin Street, Changchun, 130024 Jilin Province, China
[b] University of Illinois at Chicago, Chicago, USA

ARTICLE INFO

Article history:
Received 12 August 2015
Received in revised form
26 February 2016
Accepted 8 April 2016
Available online 19 April 2016

Keywords:
Urban spatial expansion
Urban land use conversion
Urban function
Urban land development
Urban land redevelopment

ABSTRACT

The growth of urban space occurs not only through urban land expansion, but also from the conversion of urban development land. Urban land use conversion can reveal the inherent characteristics of the agglomeration and diffusion of urban functions. This paper presents the central city of Changchun as a case study. With the help of topographic and urban land use maps covering the years 2003, 2007, 2010, and 2013, the authors analyze the spatial patterns of four urban functions. The authors examine the conversion characteristics of residential, commercial, public service and industrial land. Urban land development and redevelopment are used to explain the spatial pattern of urban functions. The study identifies three concentric zones in Changchun based on the evolution of urban functions. In addition, our work also finds that urban planning lags behind urban development in less developed cities due to its rapid urban growth.

1. Introduction

Urban spatial expansion is a process of changes in urban size, urban element, urban structure, urban form and various other aspects within a certain period of time, and it is currently a topic of considerable interest in the fields of urban geography and urban planning (García-Palomares, 2010; Poelmans & Van Rompaey, 2010; Webster, 2010; Zhou & Ye, 2013). With the trend toward rapid development within cities, urban space is constantly expanding outward, with urban function continuing to diffuse into the suburbs and urban fringes. It is difficult to describe the spatial variation of urban function because of its abstractness. However, an analysis of urban land use conversion can help us solve this problem. As we all know, urban land is the spatial carrier of urban function and urban land use conversion can reflect changes of urban function (Zhou, Li, Zhang, Luo, & Shen, 2015).

In the western context, researchers have carried out numerous studies on urban spatial expansion and related topics. Urban area structure theory has a far-reaching influence, including the concentric zone theory (Burgess, 1925), the sector theory (Hoyt, 1939) and the multiple nuclei theory (Harris & Ullman, 1945). Since the 1980s, urban spatial expansion in Europe and the United States has shown a trend toward decentralization and multi-centeredness, which has received much attention from scholars (Fujita & Ogawa, 1982; Fujita, Krugman, & Venables, 1999). While North American cities have tended toward suburban sub-centers (Giuliano & Small, 1991; Gordon & Richardson, 1996; McMillen & Smith, 2003) and metropolitan multi-centers (Anas, Arnott, & Small, 1998), European cities have paid more attention to creating polycentric city-regions (Burger, de Goei, van der Laan, & Huisman, 2011; Kloosterman & Musterd, 2001). Urban land economic theory explains urban land use structure, especially the land rent theory (Anas, 1996). Among them the most well-known is the bid-rent theory (Alonso, 1964). According to Alonso's bid-rent theory, the bid-rent affects the distribution of different types of urban land and can explain the layout of urban functions in mono-centric cities. And each type of urban land has its own bid-rent curve. In principle, each piece of land belongs to the people who is willing to pay the highest rent. The bid-rent curve of commercial land has the highest intercept and maximum slope, followed by industrial land, and residential land's is minimum. Thus, urban land forms several concentric rings which is characterized by different urban functions. As a research method, land use/cover change has been widely addressed in the existing literature (López, Bocco, Mendoza, & Duhau, 2001; Frondoni, Mollo & Capotorti, 2011; Salvati & Sabbi,

* Corresponding author.
E-mail addresses: z19870219@126.com (G. Zhou), lcg6010@nenu.edu.cn (C. Li), mli60@uic.edu (M. Li), zhangj888@nenu.edu.cn (J. Zhang), liuyj323@nenu.edu.cn (Y. Liu).

http://dx.doi.org/10.1016/j.habitatint.2016.04.002
0197-3975/

2011). As the spatial structure of the built-up environment is related to its function (Van de Voorde, Jacquet, & Canter, 2011), the study of urban land use conversion can be helpful for better understanding the characteristics of urban spatial expansion and urban functional agglomeration and diffusion (Xiao et al., 2006; Zheng, Shen, Wang, & Hong, 2015).

Today, the distribution of urban functions is still a very important topic in academia. It is by now a well-recognized fact that the 21st century will be an urban one (Cumbers, 2014). More advancing theories regarding urban spatial expansion and urban function will appear and many insightful findings will emerge. However, given the differences between China and the West, many of these advancing theories or findings may not be suitable for China. In light of this, this paper discusses the topic of agglomeration and diffusion of urban function within a Chinese context. Fortunately, more and more such studies have emerged in academic journals, conferences and books. In China, research on urban spatial structure started in the 1980s (Zhou & Ye, 2013). Research findings have mainly concentrated on urban morphology (Luo, 2004a; Lin, 2004; Pan & Han, 2013; Shang, Zhang, & Zhou, 2012; Wang, 2002; Wang, Liu, & Zhuang, 2005; Wang, Wang, & Wang, 2012; Yang & Wu, 2001), the mode of urban spatial expansion (Chen, 2010; Deng, Tang, & Dan, 2004; Luo, 2004b; Liu, Wang, & Zhuang, 2003; Yang & Zhang, 1997) and the mechanism for urban spatial expansion (Shi, 2004; Chen & Yu, 2007; Han & Liu, 2010; Liao, Peng & Hong, 2007; Zhang, 2001). Based on the review of the existing literature, we find that there are lots of literature focusing on urban function, and land use conversion also has been widely discussed. However, the two topics—urban function and urban land use conversion, have been discussed separately, for example, industrial function and industrial land (Chapple, 2014; Gili, 2009; Lester, Kaza, & Kirk, 2013). Therefore, this paper analyzes the agglomeration and diffusion of urban functions through studying urban land use conversion in a Chinese city. Based on the study of urban land use conversion, this paper discusses spatial evolution of residential, commercial, public service and industrial function and characterizes agglomeration and diffusion of urban functions.

In urban areas, land use conversion includes two modes—urban land development and urban land redevelopment. Here the term “urban land development” means that non-urban development land at the edge of urban built-up area is transformed into urban development land, which can reflect the diffusion of urban functions. For instance, the transformation of non-urban development land into residential land in the urban fringe indicates that residential function has diffused to the edge of urban built-up area. “Urban land redevelopment” means that one type of urban development land is converted into another within the urban built-up area, which can reflect agglomeration and diffusion trends of urban functions in the urban built-up area. For instance, the transformation of industrial land into residential land indicates that residential function has replaced industrial function; moreover, residential function may tend to be clustered, while industrial function has a tendency to spread. Generally speaking, analyzing urban land development and redevelopment can offer insight into the agglomeration and diffusion of urban functions. In this paper, urban land use conversion is discussed in detail. As mentioned above, urban land development often occurs at the edge of urban built-up area and urban land redevelopment often occurs within the urban built-up area. Thus, this study focuses on the concentric and directional features of urban land development and the concentric features of urban land redevelopment.

Urban development land is one element of urban material space and the spatial carrier of urban function (Zhou et al., 2015). The conversion of urban development land is closely related to a change in urban function. The conversion of one type of urban development land embodies the evolution of the corresponding urban function. The conversion of all types of urban development land reflects the overall evolution of urban functions. This research of urban land use conversion and its spatial patterns will make a valuable contribution to the study of urban spatial expansion and urban function. Fortunately, there has been an increasing number of such studies in China. However, most of them focus on the most developed cities, such as Beijing (Li, 2005; Yu, Chen, & Wu, 2008; Tian, Wu, & Yang, 2010; Lu, Li, & Sun, 2011; Kuang, 2012), Shanghai (Zhang & Du, 2001; Li & Ning, 2007; Wang & Wei, 2007) and Hangzhou (Liu, Yue, & Fan, 2011), where development levels are close to those of western cities and where more data are available. To the authors' knowledge, there have been few studies about urban land use conversion and urban function in less developed cities in China. Cities, such as Beijing and Shanghai, have nearly stabilized, with relatively little urban land use conversion in the urban built-up area. In contrast, China's less developed cities are undergoing the process of urban land use conversion in their central cities, while urban functions continue to gather and spread. In Changchun, for instance, with a period of rapid development in 2003–2013, the level of urban land use conversion has been dramatic (Zhou et al., 2015) and urban functions have also experienced a series of changes.

This study uses the central city of Changchun as a case study in order to identify the characteristics of urban functional layout in China's less developed cities. To achieve this goal, we examine the spatial patterns of four major urban functions through urban land use conversion. Thus, we analyze the conversion of the four main types of urban development land—residential land, commercial land, public service land and industrial land. Based on the findings, the authors propose that urban land development and redevelopment can play a positive role in explaining the process of urban functional agglomeration and diffusion. Our work not only studies the spatial pattern of urban functions from a theoretical perspective, but also gets some practice instructions for urban planning. We sincerely hope that this study will make a valuable contribution to the development of the city from the perspective of both theory and practice.

2. Study area and data sources

2.1. Study area

Changchun is the capital city of Jilin Province and the second largest city in northeast China with a total population of 7.57 million in 2012 (China City Statistical Yearbook, 2013). With a history of only 200 years, Changchun is a relatively young city famous for its large-scale automobile industry, its numerous universities and research institutions, its high proportion of parks and spaces, and its film studio, the first in China. The city proper area of Changchun is comprised of the districts of Chaoyang, Nanguan, Kuancheng, Erdao, Luyuan, Shuangyang and Jiutai, and covers a total area of 7557 km^2. The central city, the focus of this research, is the core part of the city proper area, extending over an area of 612.08 km^2 (Fig. 1), and is the residential, commercial, public service and industrial center of Changchun.

The ring-roads play an important role in the urban road system and form the basic framework of the urban spatial structure. The major road around the Old City is known as the first-ring road and the concentric roads beyond the first ring-road are in turn called the second, third and fourth ring-road (Fig. 1). The ring-roads are the spatial boundaries for this study of urban functional agglomeration and diffusion. The central city can be divided into five zones according to the four ring-roads in order to study the changing characteristics of urban functions at different distances from the