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What drives urban growth in China? A multi-scale comparative analysis

Cheng Li[a], Junxiang Li[b,c,*], Jianguo Wu[d,e]

[a] Guangdong Key Laboratory of Integrated Agro-environmental Pollution Control and Management, Guangdong Institute of Eco-environmental Science and Technology, Guangzhou, Guangdong, 510650, China
[b] School of Ecological and Environmental Sciences, East China Normal University, Shanghai, 200241, China
[c] Shanghai Key Laboratory of Urbanization and Ecological Restoration, Shanghai, 200241, China
[d] School of Life Sciences & School of Sustainability, Arizona State University, Tempe, AZ, 85287-4501, USA
[e] Center for Human-Environment System Sustainability (CHESS), State Key Laboratory of Earth Surface Processes and Resource Ecology (ESPRE), Beijing Normal University, Beijing, 100875, China

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ABSTRACT

Driving forces of urban growth differ across spatial scales, but most previous studies have been done for single cities of different sizes. Multi-scale analysis of urbanization drivers is still lacking. In this study, we investigated the drivers of urban growth in the central Yangtze River Delta, China from 1990 to 2008, using a hierarchical patch dynamics (HPD) approach that consisted of three spatial scales or hierarchical administrative levels of county, prefecture, and the region. Logistic regression, partial least square regression, and Pearson correlations were used to identify specific drivers. Our results show that the main drivers of urban growth differed between hierarchical levels and over time. First, urban growth occurred frequently next to existing urban land for most cities at all the hierarchical levels, while accessibility to railways, waters and prefectural cities became unimportant to urban expansion over time. Second, GDP, non-agricultural population proportion, gross industrial output and foreign investment in actual use were the top four important socioeconomic factors influencing urban growth for the majority of cities at both the prefectural and county levels, but the relative importance of the key influencing factors of urban growth differed across different hierarchical levels. Third, economic policies and institutional shifts by the central and local governments also played an important role in urban growth especially for cities of Wuxi and Changzhou. These multiscale relations of urban growth to potential drivers, revealed via the HPD approach, are useful for strategic planning to curb excessive urban expansion in the study region. Although the geographical and socioeconomic variables could independently explain more than 75% of variations of urban growth across spatial and temporal scales, the impacts of their interactions on urban growth need further studies in the future.

1. Introduction

Urbanization, the conversion of rural and natural lands to urban uses, is arguably the most dramatic form of land transformation. Although urban area occupies less than 3% of the earth's land surface, it contributes to 78% of carbon emission, 60% of residential water use, and 76% of the wood use for industrial purpose (Grimm et al., 2008; Wu, 2008). Besides, by changing the natural lands to semi-natural, semi-artificial and artificial lands, urbanization brought great threats to the structure, function and services of ecosystems (Peng & Liu, 2016, Peng, Liu, Liu, &Yang, 2017, Peng, Tian, et al., 2017). Rapid urbanization will continue and it was projected that the world's urban population will add 2.5 billion by 2050, among most of the growth occurs in Asia and Africa, accounting for nearly 90% of the increase (United Nations, 2014). The resultant environmental issues will be one of the biggest problems in the 21st century (Liu, He, Zhou, & Wu, 2014; Wu, 2014). To better understand urbanization processes and their detrimental effects on the environment, it is critical to reveal the underlying driving forces.

Many studies have been conducted on urban land growth and its driving forces. For example, Müller, Steinmeier, and Küchler (2010) and Zhang, Su, Xiao, Jiang, and Wu (2013) found that urban growth was significantly affected by proximity factors (e.g. the distances to motorway, roads, urban centers, rivers etc.) using linear regression, analysis of variance, variance partitioning and spatial autocorrelation regression analyses. Li, Zhou, and Ouyang (2013) found that physical, socioeconomic and neighborhood interactions affected urban growth using logistic regression and variance partitioning analyses. Verburg,

* Corresponding author. School of Ecological and Environmental Sciences, East China Normal University, Shanghai, 200241, China.
E-mail addresses: licheng@soil.gd.cn (C. Li), jxli@des.ecnu.edu.cn (J. Li), Jingle.Wu@asu.edu (J. Wu).

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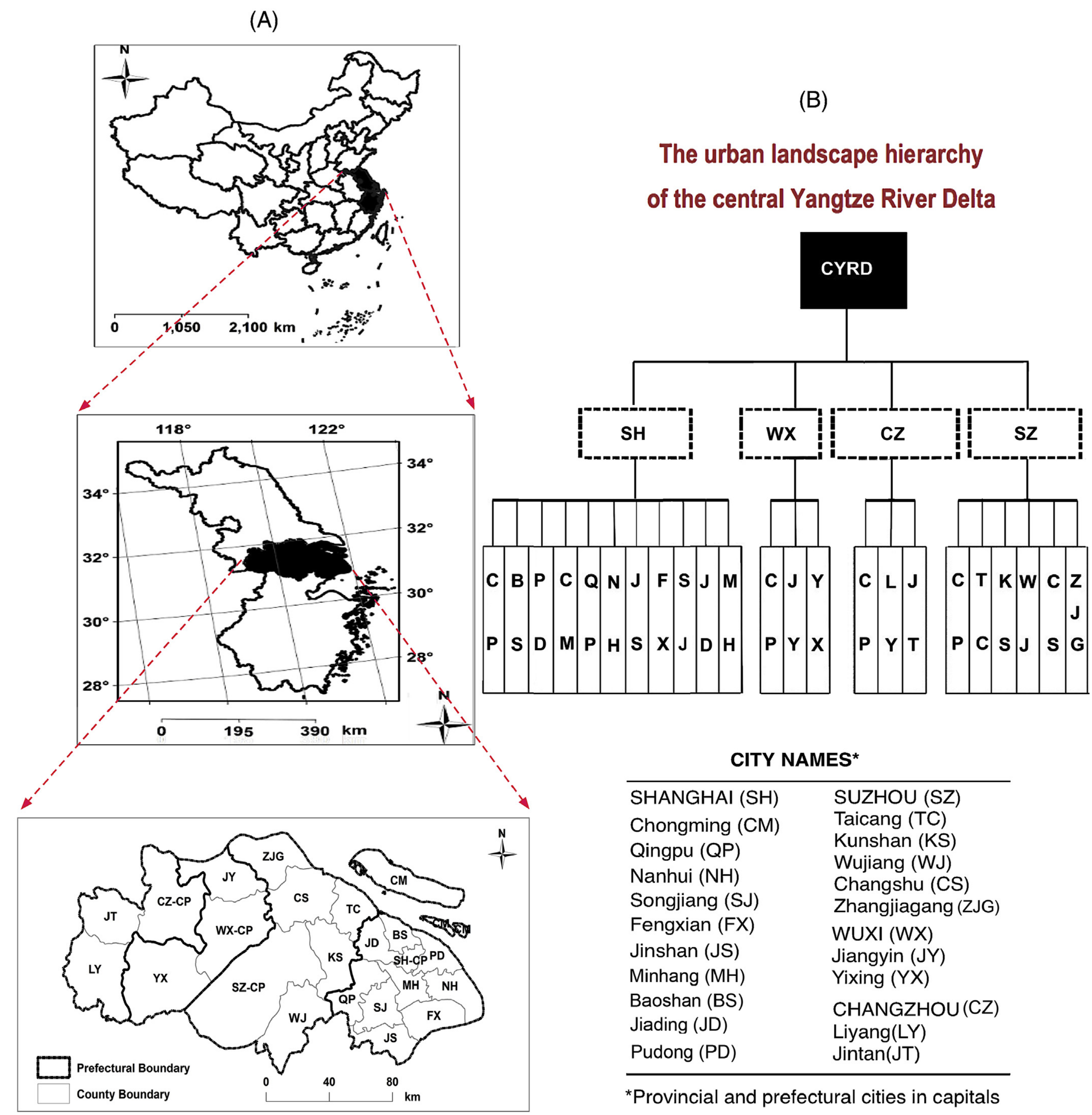

Fig. 1. Locational map of the central part of Yangtze River Delta (CYRD) in China (A) and illustration of the urban hierarchy used for analysis, which includes three hierarchical levels: the entire region of CYRD, the prefectural-level cities, and the county-level cities (B) (adapted from Li, Li et al., 2013).

Ritsema van Eck, de Nijs, and Paul Schot (2004) found that the combination of geophysical or biophysical factors (e.g. slope, elevation and soil characteristics), spatial policies and neighborhood effect simultaneously affected the locations of urban growth using binomial logit model. Lin, Wang, Wang, and Wang (2015) and Ma and Xu (2010) found that socioeconomic factors (e.g. gross domestic production, population agglomeration, industrial growth, investment, etc.) were the drivers of urbanization using multivariate regression and curve fitting. Fang, Li, and Wang (2016) found that the geographical indicators, socioeconomic factors, infrastructure variables, administrative level factors, policy factors, and historical factors simultaneously affected landscape pattern changes of urban development using spatial econometric model. Peng, Zhao, Guo, Pan, and Liu (2017) found that the slope, the minimum distance to and the growth rate of construction land significantly affected the change of urban ecological land using multivariate logistic regression. Among these five types of driving forces (i.e. proximity, geophysical/biophysical and socioeconomic factors and land planning and policies), two or more were considered by previous studies. The problem, however, is that most previous studies were conducted on a single city or a single spatial scale with various geographical and political context. In fact, the driving forces may change with spatiotemporal scales (Lesschen, Verburg, & Staal, 2005). For instance, the extent, spatial and thematic resolution of analysis unit all influence the correlation between land use system and their