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Comprehensive evaluation of trends in human settlements quality changes and spatial differentiation characteristics of 35 Chinese major cities

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ABSTRACT

This paper constructs a comprehensive evaluation system of human settlements focusing on housing conditions, urban natural environments, social economy, and public infrastructure. Principal Component Analysis and Cluster Analysis are used to analyze and rank the 2003–2013 human settlements index and create five clusters for 35 major cities in China (including municipalities, provincial capitals, and Prefecture-level cities). On the basis of four years of a spatial analysis of the human settlements index, we find that living conditions of 35 Chinese cities have significantly improved; severe air pollution persists in China, with large differences between the north and the south; weak correlation between urban human settlements and the growth rate of economic development; and the infrastructure of China's mega cities is overloaded. The results confirm and quantify growing geographic disparities and deep structural urban challenges that are associated with rapid economic growth and social change, leaving many cities in China to struggle with worsening pollution, excessive demand on existing infrastructures, and housing prices that rise faster than disposable incomes.

1. Introduction

With rapid industrialization and urbanization in China, urban environmental pollution, ecological destruction, traffic congestion and housing problems become ever more prominent (Shen, Shuai, Jiao, Tan, & Song, 2017). Environmental requirements must not just meet survival needs but provide the qualitative contributions often associated with modern urban housing conditions, public infrastructure and a broad set of social and economic conditions in order to achieve or maintain long-term social, economic and environmental prosperity (Wu, 2001, 2011). Under the current pace of economic development and urbanization, China faces extremely difficult challenges in human settlements (Li, 2017).

Ekistics, the science of human settlements (Doxiadis, 1968a,b), is found within several fields of research, such as urban planning, the school of human settlements society, geography (Doxiadis, 1976; Doxiadis and Dix, 1978), and human ecology (Qi, Cheng, Chen, & Chen, 2007; Li, Ye, & Qi, 2000). Urban planners such as Howard (1989), Mumford (1961) and Geddes and Johnson-Marshall (1968) focus on people centered planning and advocated for the combination of large, medium, and small cities, as well as an equilibrium between urban and rural areas (Howard, 1985). Human settlements research in geography (Zhang, 1993) mainly includes the study of urban spatial structure, including residential and real estate, and the creation of specialized housing and economic geography (Bourne, 1986; Pablo, Maria, Montserrat, & Eva, 2013; Fedoseev and Timofeev, 1981). Human ecologists have focused on ways to harmonize social, economic, and natural changes in accordance with each other, using ecological principles as guides (Macharg, 1969; Park, Burgess, & Mckenzie, 2012; Register, 1987; Yanitsky, 1987). Collectively, the body of research in these areas has contributed, at citywide and neighborhood scales, to generate insight into the impacts of investments and policy on livability in urban areas (Ruth & Franklin, 2014).

In China, researchers normally can't get all the details of the construction methods of the human settlements evaluation index system and mathematical evaluation methods, including frequency statistics and theoretical analysis (Zhou, Zhang, & Li, 2013). China's human settlements include two aspects: the soft human settlements and the hard human settlements, most inhabitants are in the age of economic worship, pursue the development opportunities from the economy, lack of understanding of natural environment base (Chen and Cha, 2010). The development of human settlements in China ignores the themes of

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"people first" and "environment first", blindly pursues the economic benefits (Zhang, 2015; Chen and Zhao, 2000), results in "urban disease" problems arise repeatedly (Ma et al., 2014).

In this paper, we draw on the theory and practice of these main schools of thought to propose a data-driven analysis and country-wide quality assessment system of human settlements. In particular, we study the cities of municipalities, provincial capitals, and prefecture-level cities, which cover almost all of China's first-tier and second-tier cities. Focusing on the five essential elements, housing condition, economy, society, nature, and Infrastructure, which are tightly related to the urban living environment and the corresponding factors, we establish a comprehensive evaluation system of human settlements. Our research on human settlements consider not only the residential community environment, but also residential living resources, residential disposable income, education and culture, medical resources, public infrastructure and other factors, which are rarely included in other theoretical research in this field. We would argue that human settlements should not only meet the basic needs of human habitation and living, but also go one step further to establish harmonious relations between humans and the ecosystems in which their societies and economy fit in. Both qualitative description and quantitative analysis are used to evaluate urban human settlements (Michael, 2014).

2. Study scope and methods

2.1. Study scope

For the evaluation and analysis of human settlements, this paper selects 35 major cities in China, including 4 municipalities, 26 provincial capitals and 5 economically developed prefecture-level cities, and also the most representative cities in different regions of China (Fig. 1). The raw data sources are the Statistical Yearbook of China from 2004 to 2014, the Statistical Yearbook of Chinese Cities, and the statistical bulletins of municipal governments.

From 2003 to 2013, with booming economy and population have dramatically increased in this period of time, because of the fast but unordered economic growth and increasing population density, China experienced a lot of problems too in this period, especially the natural environmental condition deteriorated greatly. In the same period, as a result of urbanization, many people move from countryside to urban area and social issues arose and human settlements apparently became one of the most important issues (Cohen, 2006). In 2003, these 35 cities had 17.6% of the total population of China and contributed 35% of the national GDP but accounted for only 5.2% of the total land of China. By 2013, their shares in population and GDP rose to 44% and 41.9%, respectively. Both the size of the economy and the density of population showed an increasing trend year over year.

2.2. Method

Principal Component Analysis provides an objective evaluation of multiple performance metrics (Chen, 2013; Xu, 2004). We use Dimension Reduction to highlight the most important factors that influence the evaluation results and to generate a Human Settlements Index of 35 cities. Cluster Analysis is used to compare and classify 35 cities in order to better analyze the cities individually and also by groups (Chen, 2013; Xu, 2004).

Principal Component Analysis (PCA) is a procedure for identifying a smaller number of uncorrelated variables, from a large set of data (Erick, Mural, & Bjarne, 2017). The goal of principal component analysis is to explain the maximum amount of variance with the fewest number of principal components. In general, variance decomposition of PCA is used to extract the principal components that have characteristic values greater than 1, and whose cumulative contribution is greater than 80% (Wang, Meng, Song, Kang, & Guo, 2014). Data in the principal component load matrix are divided by the square root of the principal components.

Cluster Analysis (CA) is based on the notion that the same types of entities have greater similarity than that between entities of different types. CA analyzes the degree of similarity (affinity relationships)

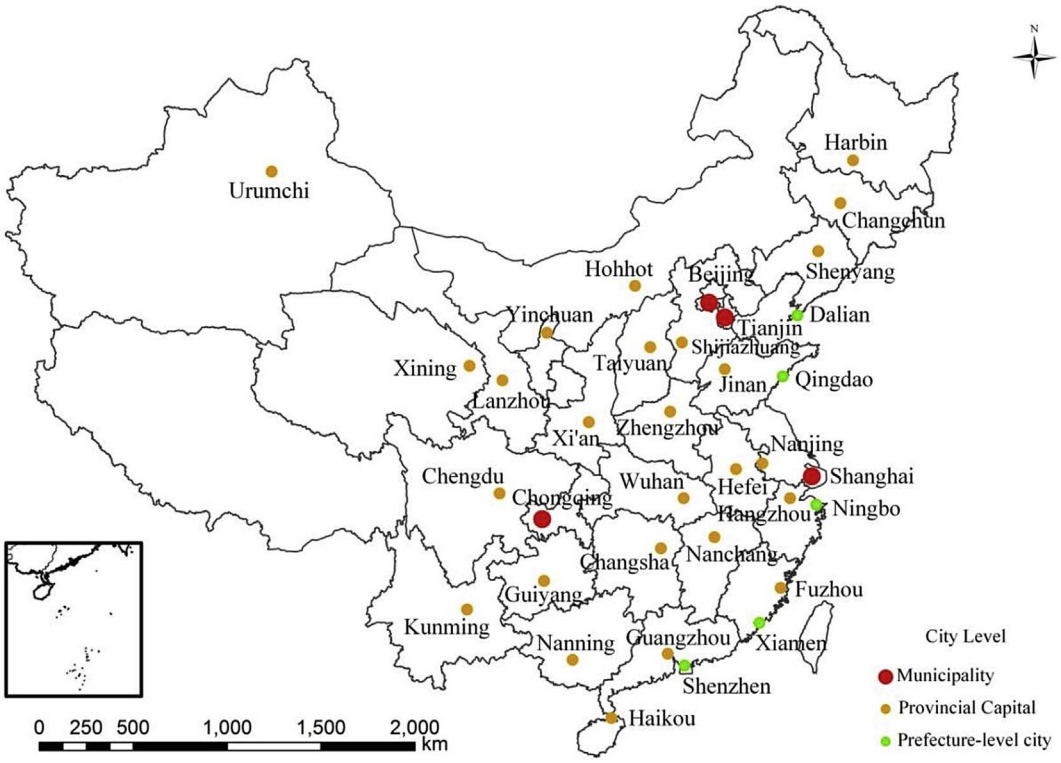

Fig. 1. Location diagram of study focused cities.