Habitat International 53 (2016) 87–96

Contents lists available at ScienceDirect

Habitat International

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

An evaluation model for urban carrying capacity: A case study of China's mega-cities

Yigang Wei [a, b], Cui Huang [b, *], Jing Li [c], Lingling Xie [d]

[a] School of Economics and Management, Beihang University, Beijing, China
[b] School of Public Policy and Management, Tsinghua University, Beijing, China
[c] Department of Public Policy, City University of Hong Kong, Hong Kong, China
[d] Institute of Management Science and Engineering, Guangxi University of Finance and Economics, Nanning, China

ARTICLE INFO

Article history:
Received 14 April 2015
Received in revised form
27 October 2015
Accepted 28 October 2015
Available online xxx

Keywords:
Urban carrying capacity
China's mega-cities
Sustainability
Urban planning and management
Urban land use

ABSTRACT

China experienced unprecedented urbanization development in the last two decades. During the rapid urbanization, cities have been attracting large population inflows from rural areas, and concentrating a wide range of social and economic activities. However, an over-concentration of population and human activities has lead to severe and diverse challenges for sustainable urban development, such as environmental degradation, poor infrastructure, and inadequate public services etc. Against this backdrop, concepts within urban carrying capacity (UCC) have received growing attention. It provides local government and urban planners key conceptual underpinnings to improve urban sustainability. However, there remain huge ambiguities in its definitions, implications, particularly measurable indicators, and analytic procedures. These deficiencies significantly hamper the effective implications of UCC concepts in routine urban management. Using the mean variance analysis method, this paper aims to establish an integrated UCC analytic framework to improve decision-making on sustainable urban land use and development. 30 representative indicators drawn from literature are selected to systematically evaluate the UCC conditions. 30 provincial capital cities and municipalities in China are selected as data sample. The results reveal several important findings. First, there exists a positive link between the city scale and UCC. Second, this exists a geographical pattern that costal cities have a high UCC than the central and western regions. Third, infrastructural and environmental factors are of salient weights in evaluating the UCC. Through the broad validations in China's mega-cities, this system has demonstrated capabilities of simplifying, appropriately quantifying, and evaluating the complex process of urban planning and management towards sustainability.

1. Introduction

Urbanization has been an important feature in the process of human development all throughout history. This trend is often associated with a sweeping population migrating from the countryside to the cities (McKinsey Global Institute, 2011). Onishi (1994) summarized three features of a city that can attract a large population in a densely developed area. First is the centrality of public administration and private decision-making. For example, the centrality of decisions in peripheral regions significantly reduces the communication costs. Second is security for urban residents' daily livings and commercial opportunities. And the third is higher efficiency, due to a benefit of relatively easier cooperation and concentration of various factors of production. From a resident's perspective, these incentivizing features guarantee clear advantages for living and doing business, relative to rural or suburban areas. Therefore, attracted by the richer economic opportunities that cities can provide, people migrate from the rural areas to cities in search of better lives. Particularly in the last two centuries, cities with fast advancements in economy, technology, and transport, have contributed to unparalleled affluence and far better lives than the rural areas of many countries. Nowadays, the urbanization process has been increasing across the world. According to data from the United Nations, a new city with 1.3 million inhabitants will be built every week for the next four decades (Bentham, 2014). Meanwhile, rapid urbanization forms an important impetus for

* Corresponding author.
E-mail address: cui_huang@163.com (C. Huang).

http://dx.doi.org/10.1016/j.habitatint.2015.10.025
0197-3975/

economic growth (Li & Yao, 2009). Therefore, urban areas are of significant importance for the society since a large population and substantial social and economic activities are concentrating there.

China is currently at the stage of rapid urbanization. Heikkila and Xu (2013) have systematically analyzed the history, incentives, and means by Chinese government to promote the development of urbanization. They argued that the Chinese government holds a "pro-urbanization stance", i.e., the government is proactively guiding and controlling this unprecedented urbanization process. Promoting urbanization is not an end in and of itself, but to serve the strategic goals of the government. Urbanization is a centrally important step in China's reform and opening up and socioeconomic development plans because the government treats it as a strategy for driving economic growth (Heikkila & Xu, 2013). China's present urbanization rate remains low and is not compatible with its per capita income level (World Bank, 2014). The Chinese government has thus committed to significantly promoting the urbanization in the next two to four decades. World Bank predicts that China's urbanization rate will increase consistently from the current 50%–70% by 2030 (World Bank, 2014).

Backed by strong government willpower, China's urbanization has been encouraged to grow on a fast and unprecedented scale. In the past 35 years, China's urbanization increased rapidly from less than 20% in 1978 to 52% in 2012, much faster than that of the U.S. and U.K., although slightly slower than the rates of Japan and South Korea from the same development phrases (World Bank, 2014). Fig. 1 compares the urbanization process in China and U.S. The incremental population in China's urban areas will reach 425.53 million from 2000 to 2030, compared with 93.13 million new urban residents in U.S. in the same period, meaning that China's new city dwellers will far exceed the total U.S. population.

With the fast-paced urbanization process, continuous congregation of larger population, urban services, production, consumption, and social wealth have been occurring in most cities around the world. However, these factors have made cities vulnerable in terms of achieving sustainable development and providing comfortable living standards for urban inhabitants (Chen, Tao, & Zhang, 2009). A host of urban symptoms induced by excessive population inflows and overdevelopment of the urban areas have been emerging and growing more severe (Abernethy, 2001; Oh, Jeong, Lee, Lee, & Choi, 2005). Due to the worsening living environments in urban areas, particularly in mega-cities, concerns related to the urban carrying capacity (UCC) concept have often been voiced when debating whether the current rate of urban development has exceeded inherent limit of the city (Wei, Huang, Lam, & Yuan, 2015). The issue of overladen urban carrying capacity has become a widespread challenge, despite the immensity and variety of global cities (Oh et al., 2005; Onishi, 1994).

Currently, China has 288 cities categorized at the prefectural levels or above. According to the CEIC database in 2013, there have been 31 cities with a population of 2–4 million, and 14 cities with a population over 4 million. According to the *Green Book of Small and Medium-sized Cities* released in 2010, cities with a population of 3–10 million are defined as mega-city in China. Since the mega-cities have been the highest concentrated areas of people and human activities, resources, and environmental pollution (Liu, 2012), they are thus more prone to the issues of overloaded UCC than small and medium cities. Thus, the mega-city is especially subjective to the occurrence of various "urban diseases", reflected in a degrading environment, poor infrastructure, and insufficient public services, etc. Hence, to develop a reliable UCC evaluation model is of strategic importance to China's sustainable development. The government has understood the importance of promoting urban sustainability as a priority policy objective. The phrase "urban carrying capacity improvement", which has been permeating official documents and regulations, has been fully institutionalized in national development planning and policies (see Table 1).

Sustainable urban development may be defined as "a process of synergetic integration and co-evolution among the great subsystems making up a city (economic, social, physical and environmental), which guarantees the local population a non-decreasing level of wellbeing in the long term, without compromising the possibilities of development of surrounding areas and contributing by this towards reducing the harmful effects of development on the bio-sphere" (Camagni, 1998, p.4). Progressing sustainability is essential responsibility for urban planning and development. The UCC concept provides a useful theoretical foundation and methodological base for guiding sustainable urban development. According to the UCC concept, there is a certain inherent limit on a given urban area, beyond which will lead to irrecoverable changes, degradation or damages to the environment (Liu & Borthwick, 2011). Therefore, a UCC assessment can provide an indication on the maximum potential population, and also serve as an important guide to the service load of the region, which should be maintained above a specified/minimal/acceptable standard (Summers, 2004).

UCC has become a popular term in the field of urban planning and management, environmental, and social studies. However, there remain huge ambiguities on its definitions, implications, and particularly, its measurable indicators and evaluative methods. The elusiveness surrounding UCC concept is mainly attributed to the integrative elements and properties associated with urban development. These problems become inhibitors for the effective implications of UCC concept in routine urban management and planning. This study aims to develop an effective UCC evaluation framework to fill the gap of previous studies. The evaluation model can systematically assess the present state of UCC and identify its deficient factors. The applicability of the model is then widely demonstrated in China's 30 mega-cites. This research is of

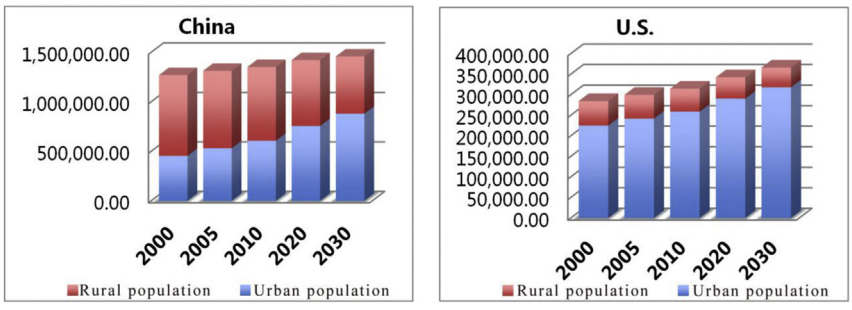

Fig. 1. Comparisons on urban-rural population in China and the U.S. Source: http://www.unhabitat.org/stats/Default.aspx (Accessed on 14 November 2013).