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Original article

Spatial accessibility of country parks in Shanghai, China

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ABSTRACT

To deal with the challenges of nature conservation and public recreation in a rapidly urbanization, many big cities in China have launched country parks programs. However, seldom literature focus on the accessibilities of country parks as public infrastructure. By calculating the spatial accessibility indexes based on the Two-Step Floating Catchment Area (2SFCA) method, this paper evaluates the spatial accessibility of 14 country parks to 240 streets/towns in Shanghai. Our analysis indicates that the spatial differences of the accessibility of streets/towns are significant; the accessibility in Shanghai's central city and the Chongming Islands are lower than those of other urban areas. Based off our results, the spatial accessibility of streets/towns is far from ideal, with 85% of streets/towns having an index value less than 0.0025. Most of Shanghai's residents in streets/towns require a travel time of more than 60 min. The authors suggest that country parks cannot be replaced by urban parks in Shanghai because of their unique functionality and attraction to residents. To improve the spatial accessibility of country parks, the authors advocate for the improvement of population distribution in Shanghai and the integration of road networks and public transportation sites to country parks. Our results for Shanghai are applicable to other big cities that experienced similar rapid urbanization in China, East Asia, and Southeast Asia.

1. Introduction

Green Infrastructure (GI) is a strategic planning instrument aimed at sustainable urban development. The main functions of GI are to protect biodiversity and to enhance the provision of ecosystem services (ES) (Kopperoinen et al., 2014). Roe and Mell (2013) stress that what sets GI apart from regular green space is an emphasis on human modification and the recognition of ecosystem services. GI is comprised of parks, public green space, allotments, green corridors, street trees, urban forests, roofs, and vertical greening (Cameron et al., 2012). Due to the different types of GI, the types of ecosystem services are different as well (Wang et al., 2014). As one type of GI, parks are crucial elements in sustainable urban planning that provide multiple benefits for urban living (Jennings et al., 2016; Wolch et al., 2014). Since the 1970s, hundreds of country parks have been designated in the United Kingdom (UK). These country parks have made it easier for enthusiasts seeking outdoor recreation to enjoy their leisurely time without travelling too far (Lambert, 2006). A country parks program was initiated belatedly in Hong Kong in 1972. A total of 23 country parks have been designated by 2009, covering 41,043 ha, or roughly 40% of Hong Kong's land (Liu and Li, 2009).

Country parks are located on the outskirts of cities where there are natural landscapes, countryside vegetation, and pastoral features. They can provide residents with easy access to natural areas for walking, exercising, hiking, barbecuing, camping, educational services, and other recreational activities (Jim, 1986; Lewis and Cheung, 2013; Zhuang, 2006). The combination of natural conditions (including rich landscape resources, bio-diversity, heritage, and culture), good accessibility (in suburbs near cities), and humanized spaces for various recreational activities have gradually developed country parks into a typical park for recreation, environmental protection, and outdoor education (Lambert, 2006; Jim, 1989; Gong et al., 2015).

Rapid industrialization and urbanization resulting from the launch of economic reforms in 1978 have exerted a significant impact on the social, economic, production, and environmental landscape of China (Long and Woods, 2011). It has not only triggered a series of ecological risks, but also have stimulated the demand of residents for a better ecological living environment and for a natural and outdoor recreational area (Kabisch and Haase, 2013; Fan, Y., et al., 2016). Represented as a "weekend tours" and "family tours" setting in the urban suburbs, residents' desire for leisure and recreational activities have sharply increased since 2010 in China (Chen and Li, 2009). However, although the necessity for sufficient public urban green space has been emphasized by urban planners and policy makers since 1978 (Kong and

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Nakagoshi, 2006), many cities still struggle with the dilemmas of limited space, scarce resources, a highly concentrated population, and environmental carrying capacity overdraft (Hong et al., 2017). Urban planners and policy makers have turned their attention to the urban suburbs for solutions.

Affected by the rural-urban "dual-track" structure, past urban planning in China has focused on urban green spaces or urban city parks, and pay little attention to the green spaces in urban suburbs (Fan, P., et al., 2016). Furthermore, the green spaces in the suburbs are mainly comprised of agricultural land, especially basic cultivated land, which have been protected due to China's prudence on food security and the implementation of stringent cultivated land protection policy. To deal with the challenges of nature conservation and public recreation, basic cultivated land, together with forest, wetlands, and mountains, have been considered as one part of urban green space in Ecological Control Line. Ecological Control Line is a new part of comprehensive urban planning systems (Hong et al., 2017), which was designed to protect basic urban ecological safety, maintain the scientific nature, integrity, and continuity of ecosystems, and prevent urban construction sprawl (Sheng, 2010). Some important nodes of Ecological Control Lines were selected in building country parks.

Therefore, the country parks in China are slightly different from the country parks in the UK and Hong Kong. According to *The Opinions on the Management of Country Parks in Shanghai* in 2015, country parks are comprised of existing ecological and cultural resources and provided with recreational facilities. The establishment of country parks in China have proposed at least four objectives or functions: to meet the rapidly rising demands of residents for natural and outdoor recreation, to protect basic urban ecological safety, to protect cultivated land, and to prevent urban construction sprawl (Liu and Li, 2009; Chen and Li, 2009; Chen et al., 2011). In particular, some of these functions cannot be met by urban parks, such as the protection of cultivated land and the prevention of urban construction sprawl. Furthermore, country parks in China are not only one new part of urban green space in Chinese traditional urban planning, but also are conformed to the definition and characteristics of GI that are mentioned by Roe and Mell (2013).

Shanghai has the highest urbanization in China and has one of the highest population densities in the world. The population urbanization in Shanghai has increased dramatically over the past 30 years, reaching 69% in 1993 and 90% in 2015. Shanghai has a population of over 24 million people, while public green space is only 7.1 m^2per capita in 2015. To meet the rapidly rising demands of its residents, the Master Plan of Shanghai Country Parks was launched in 2013. 21 country parks, a total area of 400 km^2, will be established. Together, these 21 country parks and another eight in use will form the Shanghai Country Park System in the future. As of 2016, six country parks have been identified as pilot parks in Shanghai during the first phase of construction. The remaining 15 country parks are a part of the long-term plan that has yet to start the preliminary site selection demonstration.

Accessibility is an important factor for planning parks. It is often denoted in terms of the level of services of the parks' spatial distribution (Wright Wendel et al., 2011). Based on spatial factors (e.g., geographic location and distance) and non-spatial factors (e.g., social class, income, age, sex, etc.), each of the broad categories can be further divided into spatial accessibility and non-spatial accessibility (Khan, 1992). Spatial accessibility to parks is adequate when the population is in harmony with the parks' spatial distribution (Langford and Higgs, 2010). Spatial accessibility further differs in the level of services offered to different population groups, which are effected by non-spatial factors (Comber et al., 2008; Tan and Samsudin, 2017). The primary focus in this paper is to examine how much of the demand population, regardless of ethnicity, wealth, income, education, age, etc., is undersupplied with country park services. This paper will only focus on the spatial accessibility of country parks, since identifying where the truly underserved populations are located is the primary step towards meaningful and effective government intervention programs (Luo and Qi, 2009).

Among the numerous amounts of research on measuring spatial accessibility of urban parks, green space and other public service facilities (Luo and Wang, 2003; Kong and Nakagoshi, 2006) Comber et al., 2008; Luo and Qi, 2009; Langford and Higgs, 2010; Chen et al., 2011; Wei et al., 2014; Li et al., 2016), we found that the two-step floating catchment area (2SFCA) method is most suitable in measuring spatial accessibility of country parks. As the geographic information system (GIS) was applied to analyze spatial accessibility over 10 years ago, the 2SFCA method was first proposed by Radke & Mu in 2000 and subsequently revised by Luo and Wang in 2003. Luo and Qi (2009) proposed the enhanced 2SFCA method to improve the actual simulation of spatial difference and population distribution density. Though it is used only to measure spatial accessibility, it is easy to operate and overcome the limitation of the administrative area boundary of the selected place. Thus, the method is widely used in the assessment of spatial accessibility of public service facilities, including urban public greenbelts (Chen et al., 2011; Wei et al., 2014; Li et al., 2016).

Similar to Shanghai, many big cities in China have also launched country park programs, such as Shenzhen, Beijing, Tianjin, and Wuhan. More cities have announced plans of creating their own program in the future. Although much literature has been published on country parks (Jim, 1986, 1989; Lambert, 2006; Zhuang, 2006; Chen and Li, 2009; Lewis and Cheung, 2013; Li et al 2010; Gong et al., 2015), seldom focus on the accessibilities of country parks as public infrastructure. In this study, we attempt to calculate the accessibility index of country parks in Shanghai based on the 2SFCA method and to measure the spatial accessibility and distribution differences. Our study will thus hold useful lessons for improving both the spatial accessibility of country parks in Shanghai and other cities in the rapidly urbanizing areas of East Asia and Southeast Asia.

This study has four objectives. The first objective is to establish a country park spatial accessibility assessment method in Shanghai with its 240 streets/towns as demand sites and its 14 country parks as service sites. The second objective is to calculate the accessibility of country parks with 30, 60, and 90 min thresholds, rank the accessibility of country parks enjoyed by the residents in the 240 streets/towns, and then analyze the characteristics of their spatial accessibility. The third objective is to analyze the sensitivity of the spatial accessibility index under different service thresholds and measurement indices. The last objective is to promote scientific suggestion for improving the spatial accessibility.

2. Study area, data sources, and research methods

2.1. Study area

Shanghai is located on the eastern edge of the Yangtze River Delta, with the East China Sea to the east, the Hangzhou Bay to the south, Jiangsu and Zhejiang provinces to the west, and the opening of the Yangtze River to the north. In 2015, Shanghai had a total area of 8359 km^2. The population of permanent residents was 24.15 million with a gross domestic product of 366 billion USD. The disposable income per capita of Shanghai is 7333 USD, where the income per capita of urban residents is 7788 USD, and the income per capita of rural residents is 3412 USD. As of 2015, the agricultural land area in Shanghai was 317,926 ha. The construction land area was 301,709.27 ha, and the unused land area was 193,564.46 ha.

This study evaluated the spatial accessibility of 14 country parks to 240 streets/towns in Shanghai. The country parks include 8 existing country parks and 6 new country parks, which were completed in 2016 and are currently in use. The spatial layout of these country parks is shown in Fig. 1.

2.2. Data sources

In China, a city includes a number of districts, which then includes a