Urban Forestry & Urban Greening xxx (xxxx) xxx–xxx

Contents lists available at ScienceDirect

Urban Forestry & Urban Greening

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

Assessment and optimization of green space for urban transformation in resources-based city – A case study of Lengshuijiang city, China

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ARTICLE INFO

Keywords:
Green space
Network analysis
Park service radius
Resource-based city
Urban transformation

ABSTRACT

Urbanization in China has changed gradually from production-oriented to consumption-oriented in recent years. Comfort and accessibility of green infrastructures effect the rate of urbanization and transformation. A well designed urban green space system is an essential part of the urbanization process. In this paper, the urban green space of Lengshuijiang city was assessed both qualitatively and quantitatively using data of field survey and high resolution remote sensing. In the study area, green space coverage was 37.14%, green space percentage was 33.45% and per capita park green space was 16.25 m^2. The high green space coverage suggested that there were ample potentials for further urban transformation. Within a 30 min service radius of existing green space, total service area was 204.49 ha, which accounted for 16.26% of the study area. A high proportion of the green space was made up of urban parks which were unevenly distributed across the study area. A green space optimization strategy, aimed at improving green space quality and accessibility, was proposed. After optimization, total service areas within the 30 min service radius will increase to 492 ha (39.12%), an increase of 22.86%. Our study demonstrated that combining qualitative and quantitative methods is an effective and reliable way for green space assessment and reliable and can be used for urban green space planning and management for small resource-based cities like Lengshuijiang in its process of urban transformation.

1. Introduction

As an important part of the urban ecosystem, urban green space provides multiple functions such as regulating microclimate, providing residents' recreation space, and purifying the atmospheric pollutant (Larson et al., 2016; Ngom et al., 2016). Further, urban green space plays an important role in solving many environmental problems, such as loss of biodiversity, water pollution, soil erosion, and rising temperatures associated with city heat-island (Lee and Maheswaran, 2011; Lovell and Taylor, 2013; Adinolfi et al., 2014). In addition, planning and construction of urban green space are not only the direct embodiment of city's soft power, but also the momentous symbol of urban civilization level (Swanwick et al., 2003; de la Barrera et al., 2016). Therefore, scientific planning and management of urban green space is essential for the benefit of urban development both ecologically and social – economically.

With the development of green space assessment and planning theory, urban green space assessment and optimization have attracted more attention recently (Jansson, 2013; Yao et al., 2014). Urban green space assessment is an important measure for ecological environment, and can provide the foundation for planning and optimization. In terms of quantitative analysis, each country has its own indicators to quantify urban green space. These indicators are used to measure the health of urban ecosystem associated with the process of urbanization (Rupprecht and Byrne, 2014; Santiago et al., 2014). The assessment of ecological service quality of urban green space is based on the landscape evaluation method, using landscape metrics, Analytic Hierarchy Process (AHP) and green space accessibility. The landscape metrics method is a powerful tool for landscape pattern analysis, nevertheless, it is unable to describe accurately all the ecological processes of urban green space (Kong et al., 2007). Suitability analysis based on AHP can effectively reflect the spatial difference of urban green space services quality, but the suitability layer weight is greatly influenced by individual judgments (Uy and Nakagoshi, 2008). Green space accessibility analysis can quantitatively reflect users' performance overcoming the difficulty, such as distance, time and cost to reach a service facility or activity place, which can be used to detect the potential service areas of urban green space more scientifically (Dony et al., 2015; Laatikainen

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https://doi.org/10.1016/j.ufug.2017.12.016
Received 2 March 2017; Received in revised form 3 December 2017; Accepted 24 December 2017

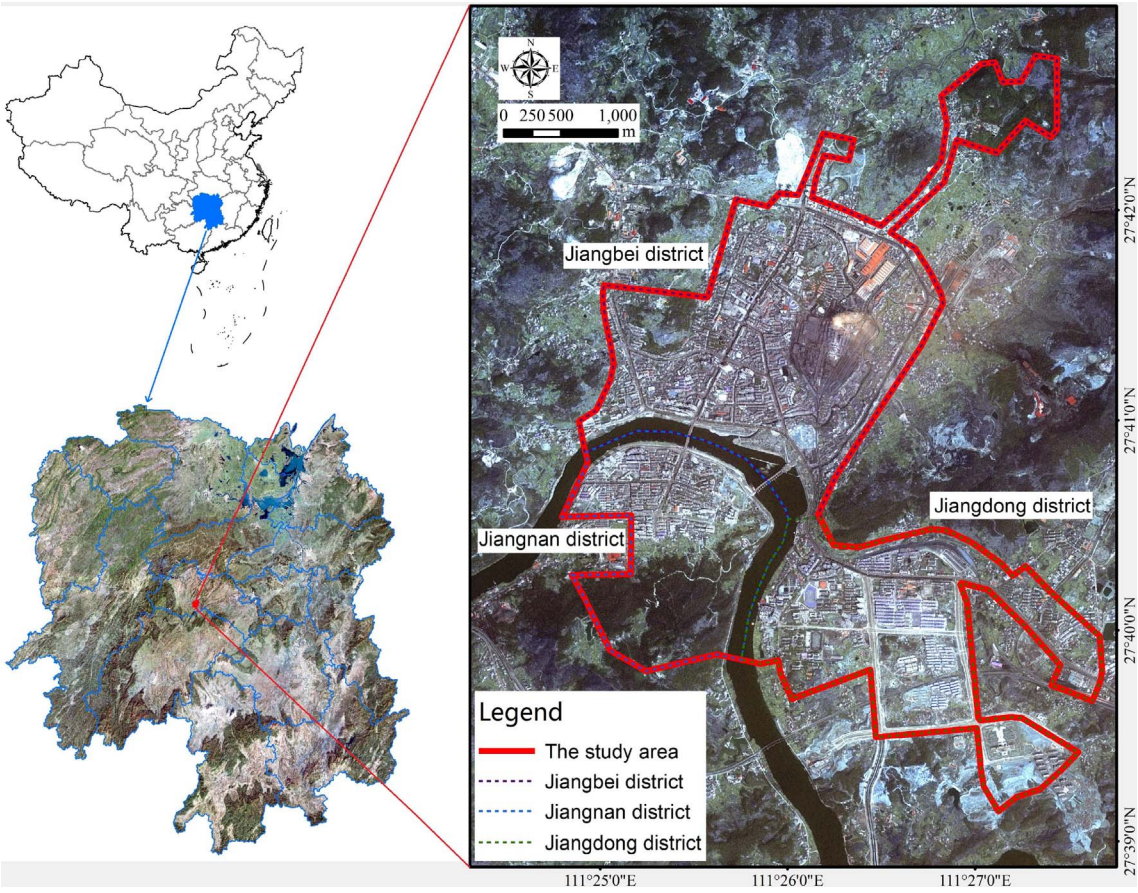

Fig. 1. The study area.

Table 1
Typology and definition of urban green space.
Source: Classification Standards of Urban Green Space CJJ/T85–2002.

Main typology	Definition/Description	Main types of green space	
Urban park	To create green spaces for the recreation of the public urban population, including function of ecological, beautification, take precautions against natural calamities, etc.	Comprehensive park	City's parks, community park, etc.
		Community park	A small green space, garden in the community
		Theme park	Zoo, botanica1 garden, historical garden and park, etc.
		Greenbelt park	River and Canal Banks, Transport Corridors(road, rail, cycleways and walking routes)
Productive plantation area	To provide green space for urban nursery-grown planting, flowers and grasses, woodland for greening, etc.	Nursery stock, flowers, seed nursery, tree nursery and grass garden, etc.	
Protective green space	Green space used for urban environment protection, sanitation, safety and calamity prevention	Railway protective greenbelt	Green space in the both sides of railway used for health segregation, environment protection, etc.
		River protective greenbelt	Green space in the river and canal banks, but smaller and narrower than greenbelt parks.
Attached green space	The various types of land affiliated green space without the urban construction land	Residential green space	Green space in the residential land
		Urban road green space	Green space in the land for traffic, square of road, etc.
		Municipal green space	Green space in the municipal facilities lands, public facilities lands and land for special use, etc.
Other green space	Green space for quality of the city's, health and well-being of residents life, ecological environment and biological diversity protection	Forestland Shrubland Grassland	Green space in landscape and famous scenery, country parks, forest parks and nature reserves, woodland, natural preservation areas, wetland, wild zoo and botanical garden, landfill recovery land, etc.

et al., 2015). Quantity indicators such as park accessibility and landscape metrics have been used for urban green space optimization by a number of researchers (Lee and Hong, 2013; Moseley et al., 2013; Reyes et al., 2014). Their studies, however, focused mainly on large or medium-sized cities with adequate infrastructure. Few studies using the combined qualitative and quantitative method to assess urban green space.

In recent years, the urban development gradually changes from production-oriented to consumption-oriented (Yeh et al., 2015). Following the rapid urbanization, traditional industries with manufacturing as the core are gradually being replaced by the emerging creative, cultural and leisure industries (Aboy, 2012; Demirtas-Milz, 2013; Qian, 2015). In the process of urban transformation, a complete infrastructure can accelerate the urban development process, and a