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“City in the park”, Greenway Network Concept of High-Density Cities: Adaptation of Singapore Park Connector Network in Chinese Cities

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Abstract

This paper uses the “Park Connector Network” (PCN) as a model, to analyze Singapore’s experience and to cope with the dramatic increase in population and urbanization, and then to apply this experience to Chinese high-density cities. The research goal is to provide guidance for the adaptation of “City in the Park” in China and the construction of high-density urban green space systems. The concept of “City in the Park” that was born in 2018 in China can be related directly to the “Park Connector Network” model.

Introduction

In 2018, the Chinese government put forward a national strategy, “City in the Park”, in order to build a newly formed urban planning model to make cities more ecological. “The expectation of a city is like a grand park so that when people go outside the door, they feel they are in the park” (Wang 2018). This is the vision of the “City in the Park”.

In Europe and America, the ideology of the park as a public area begins with an understanding of the importance of open space to the health and vitality of urban populations (Tan 2006). Parks are often built for a range of interrelated motives, including the improvement of physical and mental health, being close to nature, bringing nature back to the city, to satisfy both citizens’ recreational and social needs.

However, China has experienced rapid urbanization in the past decades (Peng et al. 2018). With the development of size, population and speed of these developing cities, high-density living became a common characteristic, which gives a serious threat to urban ecological development in the future (Chun & Guldmann 2014). While, for many of those cities, the highly developed urban area, the concern with housing environment and living quality, provision of social services such as the recreation and enjoyment of daily life, has lagged. Therefore, how to build a “City in the Park” has been a problem that is facing in Chinese cities. Here we summarize the problems common in Chinese high-density urban systems:

- Lack of land for building green space in densely populated cities;
- The functionality of land use has low efficiency with many underutilized areas;
- Insufficient connectivity of existing green space;
- Green space around the community does not meet the daily needs of residents;
- The management system is not completely developed.

This article explores how Singapore created a “Garden City” and offers a wide range of parks and open spaces in a context of a rapid industrialization and urbanization. At the beginning of building “City in A Garden”, Singapore also faced a series of difficulties, similar to those that situation that China is now

facing (Castelletta et al. 2005). Therefore, Singapore offers a model for urban planning that may assist the Chinese “City in the Park” urban future.

Background and Literature Review

The high density of cities has become the character and trend of growth of modern Chinese cities. Taking some cities as examples, the population density of the core areas in Beijing is 20,700 person/km², Shanghai is 25,600 person/km² and Zhengzhou has 10,362 person/km².

The development of urbanization in China went through the evolution of “**Shan-shui City**”, “**Landscape Garden City**”, “**Forest City**”, “**Ecological Garden City**” and “**City in the Park**” (Table 1) (Wang 2018). The opinion of Xuesen Qian’s “Shan-shui City”: a city derived from ancient poetry about hills and water, painting and classical landscape and emphasized on the feature of Chinese traditional culture (Fu 2005). “Landscape Garden City” is built on the basis of greening construction (Chen et al. 2013), and human aesthetics is the main guideline for the city model. “Forest City” is the abbreviation of the city with stable forest ecosystem as the main planning idea (Chen et al. 2006), focusing on trees in the city and surrounding areas. “Ecological Garden City” is the initial attempt that apply the ecological thinking into urban construction in China (Luo 2008). The basic selection indicators are urban ecological environment, urban living environment and urban infrastructure.

Table 1. Comparison of five urbanization stages in China

Urban construction stage	Proposal or implementation year	Implementation status	Keywords of the concept
Shan-shui City	1990	Only a vision, not implemented yet	Ancient poetry, Painting and Classical Landscape
Landscape Garden City	1992	345 cities and 7 districts until 2017 (Data source: Ministry of Housing and Urban-Rural Development)	Green Area Ratio
Forest City	2004	165 cities until 2018 (Data source: State Forestry Administration)	Forest and Tree
Ecological Garden City	2007	11 cities until 2017 (Data source: Ministry of Construction)	Urban Ecological Environment, Urban Living Environment and Urban Infrastructure
City in the Park	2018	Only a vision, not implemented yet	People-centered, Integration of Park System and Urban Spatial Pattern

Chinese scholars have many descriptions of the meaning of "City in the Park" (Wu et al. 2018; Zhu and Gao 2018; Li and Zhang 2018; Wang 2018), including:

- 1) "City in the Park" emphasizes human perception, adhering to a "people-centered" principle, focusing on the theoretical continuation of human feelings and human settlements.
- 2) The requirement of "City in the Park" is to construct the urban spatial structure based on the pattern of the park system planning, the integration of the hills, waterbodies, forests, farmland and grass, making full use of their respective park systems.

As connectors of the urban green space, these elements as greenways will become a structure connecting various types of green spaces such as parks, nature reserves, waters, forests and other green spaces (Zhang and Li 2013). Singapore, known as the "Garden City" (Yuen 1996), is a model of integrating gardens into the city, that has certain significance for the construction of "City in the Park" in China.

Goals and Objectives

The purpose of this paper is to analyze the experience of "Garden City" construction in Singapore. Our questions were how to make full use of the land; how to build a green open space system; how to enhance the ecological network; and how to create more connected and diverse functions for citizens especially in the context of high-density urban space.

Methods

This paper uses literature review and case study reports to interpret the Park Connector Network (PCN) as a model, to analyze Singapore's experience and to cope with the dramatic increase in population and urbanization. Finally, the research provides reference for the construction of "City in the Park" in China and discusses the construction of high-density urban green space systems using field survey experiences in Henan Province.

Results of best practice collection from Singapore

Singapore is a small, highly populated island country lying 1° north of the equator in southeast Asia. The land area is 722.5 km², made up of one main island and 62 other smaller islets. It has 5,638,700 residents, the population density was 7,804/km² in 2018 (Department of Statistics, Latest Data 2018).

Since the late 1980s, in response to the development of the population growth and urbanization, the government built the PCN, which is administered by the National Parks Board (Han 2017). The PCN is an island-wide network of connecting densely populated areas and nature sites in Singapore (Tan 2006), making it a green corridor throughout all of Singapore, allowing everyone to explore the island through an uninterrupted green network easily. PCN constructed different loops based on different themes: Central Urban Loop, Eastern Coastal Loop, Northern Explorer Loop, North Eastern Riverine Loop, Southern Ridges Loop and Western Adventure Loop (Fig. 1) (National Parks Board, Park Connector Network 2018).



Fig. 1. Park Connector Network in Singapore (Image source: National Parks Board, Park Connector Network 2018).

Singapore, as an island country with no hinterland, meets the requirements of public leisure use and protects wildlife habitat. The construction of PCN makes it more realistic, and the achievement of PCN employs two planning concepts. On one hand, making full use of low-efficiency land: a) Borrowing land that is not owned by National Parks Board to develop garden ambience; b) Land was re-zoned and allocated directly to the National Parks Board (Tan 2006). On the other hand, Nature Ways as biodiversity corridors and green corridors, connected two green spaces through planting specific trees and shrubs, provide travelling routes to facilitate the migration of species like birds and butterflies and integrate nature into the city closely. The nature ways are divided into four important layers: Emergent layer, Canopy layer, Understory layer and Shrub layer (National Parks Board, Nature Ways 2018), different layers cultivate different species to enrich the urban biodiversity.

Greening up the Island: At the beginning of the construction of the “Garden City”, pragmatism was adopted (Yuen 1996). Singapore introduced foreign species, and applied advanced plant breeding techniques in the Singapore Botanic Garden. This experiment provided an updated list of applicable trees with fast growth trees and strong trunks in Singapore (Liu and Shu 2003).

Correctly handling the relationship between “native plants” and “exotic plants”: By dealing with the choice of plants, Singaporeans found a balance between “native plants” and “exotic plants”. In nature reservation areas, native plants played a pivotal role to ensure the natural ecology. In artificial landscape all kinds of excellent ornamental plants in the world are used (Wang 2013). The urban greening movement of Singapore is based on practical principles and has gradually increased aesthetics and enjoyment, to create a “City in a Garden” that is evergreen, colorful and fragrant in the high-density city.

Skyrise Greenery plays an important role in solving greening-rate problems in high-density cities. Singapore government supported vertical greenery and increased the air greening rate in the 21st century, "Two-dimensional Garden" transformed into "Three-dimensional Garden". Singapore's three-dimensional greening forms are diverse: wall greening, roof greening, bridge greening, fence greening, river greening, balcony greening and vertical flower beds.

Urban Administration Model: Singapore City Management is in charge of the Parks and Recreation Department and the Urban Redevelopment Authority under the Ministry of National Development and the National Environment Agency under the Ministry of the Environment (Fig. 2) (Tan 2006).

Fine and reward: Singapore's good urban environment is largely dependent on a strict fine system. It involves almost all public sectors; the fines imposed are strictly enforced (Qu et al. 2004), and Singapore is therefore called a "fine" city (Ng 2018). Singaporean law also provides rewards for greening. To provide good view into a private garden means lower real estate tax for the owner.

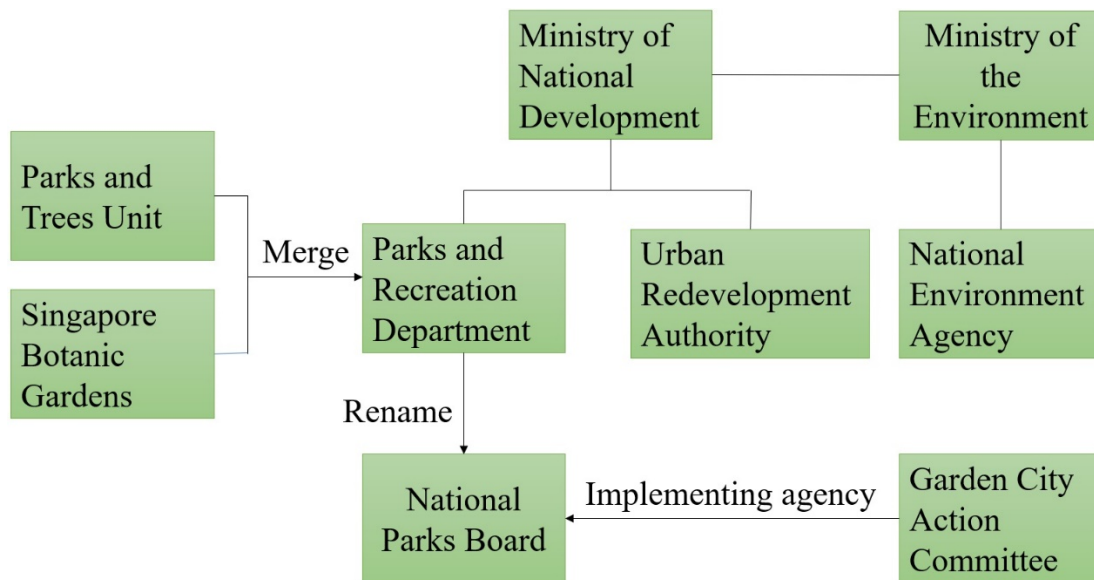


Fig. 2. Organization model of the city management in Singapore
(Image source: National Parks Board, Mission and History 2019)

Tree protection: The movements of Heritage Trees, Heritage Roads and Tree Conservation Areas largely protect mature trees in the city. Mature trees as natural heritage plays a vital role for green landmarks. Government announced Heritage Tree Scheme to conserve Singapore's mature trees, meanwhile, this scheme is open to the public. Anyone can nominate a Heritage Tree online, NParks will inspect and register for Heritage Tree (National Parks Board, Heritage Trees 2018).

Discussion

Although Singapore's landscape resources are relatively scarce, it has successfully established a thorough Park Connector Network by integration of green cities, tourism facilities, sanitation, legal management and environmental protection. Singapore and China have similar cultural backgrounds, and the

construction and management experience has a positive reference for the implementation of the “City in the Park” concept in China.

An actual application study of Singapore Park Connector Network is illustrated by case studies in Zhengzhou city and Luohe city of Henan province in China. We focus on the following points as proposals in expanding cities of China:

- A. Make full use of low-efficiency land, especially linear space;
- B. Collect public information to meet the needs of residents;
- C. Pay attention to the ecological benefits of greenways and protect diverse habitats;
- D. Improve ecological design and focus on habitat creation;
- E. Establish a complete green space construction management system and department;

A) Make a full use of low-efficiency land

In terms of the issues in urban and rural low-efficiency land, the Chinese government can learn from re-zoned and borrowed land in Singapore, re-planning and integrating rural and urban low-efficiency land, and reserve sufficient land for greenway network construction and urban planning. Extensive urban land use patterns caused unreasonable construction land structure, scattered spatial layout and low land use efficiency (Lambin and Meyfroidt 2010; Wang et al. 2014; Zhao et al. 2018).

Steps of eliminating low land use efficiency:

- (1) Discover the areas of low efficiency land by mapping.
- (2) Evaluate historical values and suitability of recreation potential of habitats.
- (3) Prepare zoning.
- (4) Constructing land policy: land policy keeps balance between supply and demand of land resources (Han and Zhang 2014).
- (5) New-style urban construction: urban construction is carried out on existing built up land and abandoned land to improve land use efficiency.

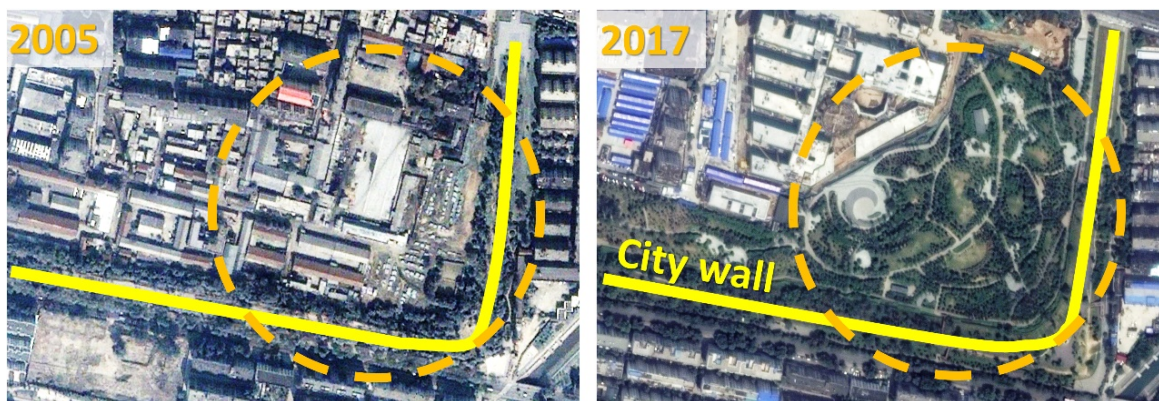


Fig. 3. Park prepared next to the Ruins of the city wall from the Shang Dynasty
(Image source: Google Earth)

A “best practice” example is park around the 3500 years old city ruins, located in downtown Zhengzhou city, in Henan Province. The layout of land use under construction areas is scattered and unreasonable, and the land use efficiency is low in this area. In 1955, a 7 km city wall was discovered (Fig. 3 and 4). The wall surrounding was developed to a park which increased landscape functionality. The discovered

house foundations, cellars, water wells, ditches and graves increase the cultural and historical significance of this area, and tourism and services appeared.



Fig. 4. Park prepared next to the Ruins of the city wall from the Shang Dynasty

B) Use public support

In planning process public support can be collected through questionnaires, interviews, case study analysis and feedbacks, field surveys, workshops usually. We recommend to use “big data” in site analysis. Big data can provide actual information in large scale and help planners to get exact geographical information about people’s preferences. Tencent Location Big Data can analyze the location traffic trends, and show in regional heat map, population map currently through active operation of mobile phone users. This kind of ways satisfied the information acquisition needs of residents.

Big data has advantages for landscape planners in different phases:

- (1) Preliminary research: Get comprehensive geographic information of urban system.
- (2) Design concept: Analysis or simulated activities of plan or design.
- (3) Implementation: Modelling dynamic changes of future landscapes.
- (4) Maintenance: Record site use information.
- (5) Dissemination: Present landscape form to the public, users can give feedback providing a reference for future landscape planning.

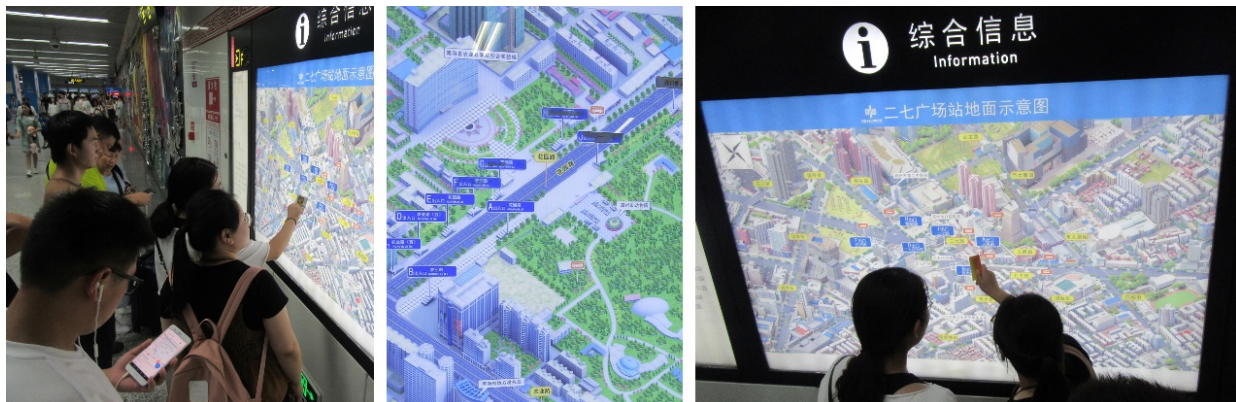


Fig. 5. Public transport and information management in Zhengzhou

C) Consider ecological benefits of greenways and protection of habitat diversity

Greenways in China were planned as key elements to reduce landscape fragmentation and protect habitat diversity (Yu et al. 2006). Proposals for greenway planning in Chinese cities:

- (1) Evaluate the ecological potential of greenways, besides residents' needs.
- (2) Network-oriented greenways are necessary.
- (3) Construct nature-friendly greenways to increase landscape connectivity, using overpasses and green traffic islands and green lanes (Fig. 7).

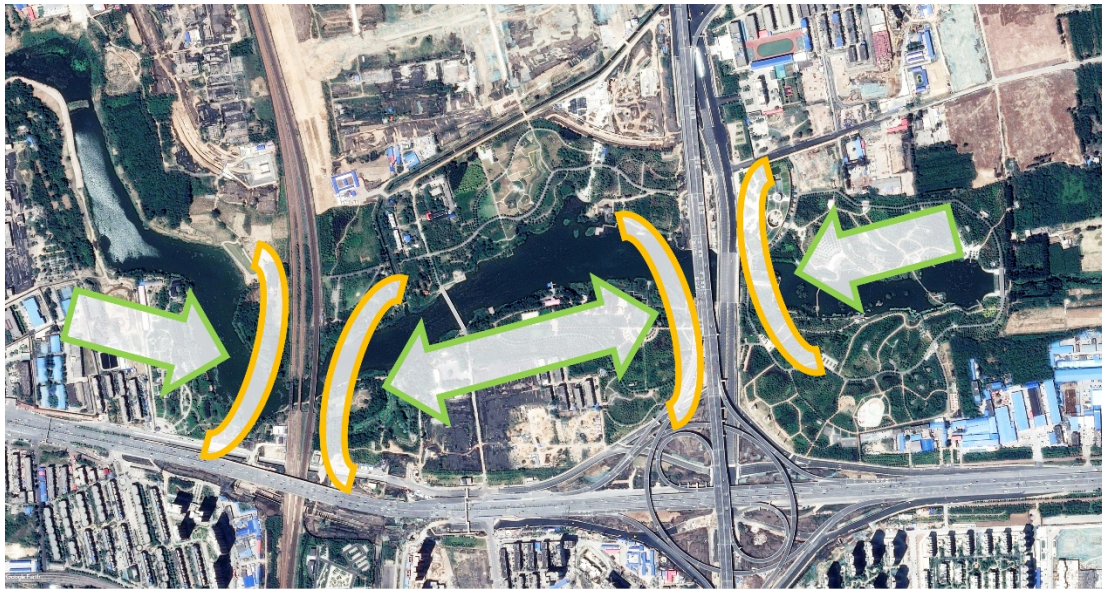


Fig. 6. The barriers of ecological corridors between Sculpture park and Xiliuhu park
(Image source: Google Earth)



Fig. 7. Connected new green spaces next to Dragon lake in Zhengzhou
(Image source: Google Earth)

In Zhengzhou an urban road divides Sculpture Park and Xiliuhu Park, and there is a railway in the middle of Xiliuhu Park (Fig. 6) as a barrier in ecological corridors. Urban roads and railways hinder most of the ecological flow of animal migration and plant dispersal in this area. Close to Dragon lake the connection is partly provided (Fig. 7)

D) Improve ecological design and focus on habitat creation and restoration

Building an integrated ecological network has been found to be an effective strategy to regulate urban climate change like urban heat island (UHI) effect in cities. Many studies also proved the ways in which the inclusion of ecological networks in urban areas can contribute to reducing surface temperatures, the green spaces like greenway, parks, green roofs, green walls etc. are the good examples. Moreover, the ecological network such as large-scale patches and corridors provides migration routes for habitats and also their creation and restoration. Therefore, improved ecological planning and design should be concentrated in the next "City in the Park" strategy.

In expanding cities we recommend to support:

- (1) Construction of green roofs, green walls (Fig. 8), green facades and roof gardens, linear green elements related to road infrastructure to mitigate urban heat island effect
- (2) Park construction with higher ecological significance in city parks or park forests with native plants that strengthen the ecosystem stability and protect biodiversity.
- (3) Construction of key habitat patches as part of long-distance ecological corridors.

There are three wetland parks (Zhengzhou National Wetland Park of Yellow River, Zhengzhou New District Wetland Park and Longquan Wetland Park) in Zhengzhou city. These serve as very good compensating surfaces in moderating urban climate stresses. And there are different kinds of endangered, rare species to live, preserve and restore in wetland areas. In Luohe city, there are more sites of habitat creation near the Shali river (Fig. 9).



Fig. 8. Green walls in Zhengzhou Central Business District (CBD).



Fig. 9. Shali River Scenic Resort system used habitat creation.
(Image source: Google Earth)

E) Construct green space management system, enhance responsible department

The Ministry of Natural Resources was established, and the State Forestry Administration was transformed into the National Forestry and Grassland Administration (State Forestry Administration, baike. baidu 2019). This ministry integrated the departments of planning, landscape, agriculture and forestry departments among others. The main responsibilities of it is to supervise the exploitation and protection of natural resources, to establish a spatial planning system and supervise its implementation, to fulfill the duties of natural resource asset owners of the public, to unify investigation and confirm registration, to establish a system of paid use of natural resources, and to be responsible for mapping and geological exploration industry management.

We recommend that cities larger than 1 million inhabitants should have an extended green space management system and an independent department that is responsible for urban green infrastructure development and maintenance. This department should implement the concepts of LID (low impact Development), Sponge City, and Storm water management, among others. In Louhe city thanks to the continuous development of the river shore in the last decades we can find a multifunctional greenway in the middle of the city (Fig.10).



Fig. 10. Greenway along Shali River.
(Image source: Google Earth)

Conclusions

This paper reviewed and analyzed the development process of “Garden City” in Singapore and proposed solutions for similar challenges in China. Through a series of proposals like construction of Park Connector Network, “Greening up the Island” movement, Skyrise Greenery, Singapore changed its urban image and constructed a “Garden City”. Singapore’s experience provides some reference for Chinese urbanization in utilizing low-efficiency land, ways of public support, considering ecological benefits of greenways and protection of habitat diversity, improving ecological design, habitat creation and restoration, constructing a green space management system and responsible department. The vision of “City in the Park” can come true using Singapore as a reference.

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