



# Comprehensive concept planning of urban greening based on ecological principles: a case study in Beijing, China

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## Abstract

Greenspace is an important part of complex urban ecosystems and provides significant ecosystem services. It benefits urban communities environmentally, esthetically, recreationally and economically. Beijing Province is in north of China, and has a total area of 16,807.8 km<sup>2</sup> and a population of about 13.8 million. This paper aims to develop a comprehensive conceptual framework for urban greening of Beijing Province based on landscape ecological principles. It attempts to answer how to establish an urban greening plan at the regional, city and neighborhood levels to achieve long-term sustainability. At the regional level, a big natural and semi-natural forest area in the northwest and an ecological buffer belt in the southeast are planned to protect the environmental quality of Beijing and provide habitats for wildlife. At the city level, a green network system of green wedges, parks and green corridors has been proposed. This green network helps to limit future urban expansion, improve urban environmental quality and serve as habitats and migration routes for wildlife. At the neighborhood level, green extensions and connections of riverside greenway, road greenway, parks and vertical greening permeate into the built-up areas. They provide open space close to residential areas and offer places for recreation. This three-level green system constitutes an integrated ecological network for urban sustainable development of Beijing. For future development of Beijing, urban parks, forestry, agriculture, water and infrastructure should be planned and designed in an integrated way. After this greenspace plan is legislated and completely realized, Beijing will develop an interconnected and integrated network of urban greenspaces. It has the prospect of achieving the aim of “Green Olympic City 2008” and the long-term goal of developing Beijing towards an “Eco-City”.

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## 1. Introduction

The world is becoming an increasingly urban place. Some 65% of the world's population is expected to be urban by the year 2025 (Schell and Ulijaszek, 1999). Due to fast urbanization, natural ecosystems are in-

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creasingly replaced by urban development. Urbanization increases the distance between people and natural space. To counter these trends, it is important to make sufficient provision of quality greenspace within urban areas as well as improve access to the countryside around towns.

Urban greenspaces are an important component of the complex urban ecosystem. Parks, forests and farmlands are three main types of urban greenspace, which have significant ecological, social and economic functions (Bradley, 1995; Shafer, 1999; Tyrväinen, 2001; Lütz and Bastian, 2002). People are eager to access these greenspaces for recreation and to experience nature (de Groot and van den Born, 2003; Lynn and Brown, 2003). Greenspace has significant ecosystem services, which are defined as “the benefits human population derives, directly or indirectly, from ecosystem functions” (Costanza et al., 1997). It can sequester carbon dioxide emissions and produce oxygen (Jo, 2002), purify air and water, regulate micro-climate, reduce noise (Bolund and Hunhammar 1999), protect soil and water (Pauleit and Duhme, 2000; Jim, 2001), maintain biodiversity (Attwell, 2000), and have recreational, cultural and social values (Savard et al., 2000; Tarrant and Cordell, 2002). Furthermore, greenspaces such as public parks, natural areas and golf courses can have a statistically significant effect on the sale price of houses in close proximity to those resources (Bolitzer and Netusil, 2000; Luttik, 2000). Thus, urban greenspace improves the urban environment, contributes to public health and increases the quality of life of urban citizens. In future, the social and spatial implications of new lifestyles, values, attitudes to nature and sustainability will even lead to higher demands for urban greenspace (Thompson, 2002).

The planning and management of urban greening is of significance to urban sustainable development (Miller, 1988; Grey, 1996; Teal et al., 1998). In Canada and the US, as well as in Europe, there has been a growing recognition among community groups and environmental organizations that brownfields hold enormous potential for “greening” city environments (Sousa, 2003; Kühn, 2003). Some studies have shown how green or open space planning based on ecological principles can be implemented. Flores et al. (1998) proposed ecological content, context, dynamics, heterogeneity and hierarchies as ecological principles for the development of a greenspace system for the New

York City region. Leitão and Ahern (2002) argued for a common framework that applies ecological knowledge in landscape and urban planning. Jim and Chen (2003) applied landscape ecological principles to the greenspace planning of Nanjing City, China. Ong (2003) proposed an ecological indicator – the green plot ratio (the single-side leaf area per unit ground area) – as a suitable measure for the greening in architecture and urban planning. Herzele and Wiedemann (2003) developed an integrated indicator to assess the accessibility and attractiveness of urban greenspace in four Flemish cities. Pauleit et al. (2003) proposed a more flexible approach named Accessible Natural Greenspace Standards Model to promote the natural greenstructure of towns and cities and devised a decision-support framework for its implementation. Li and Wang (2003) proposed a method for the evaluation, planning and prediction of ecosystem services of urban greenspace, applying landscape ecological principles, taking Yangzhou City in China as the case.

In Autumn 2002, the Beijing Municipal Institute of City Planning and Design asked the Research Center for Eco-Environmental Science, Chinese Academy of Sciences and two other institutes for scientific support to revise the current Beijing Urban Master Plan. Our research team was commissioned to develop a plan for Beijing based on ecological principles. It provides basic information, specific space-related objectives and a strategic conceptual framework for future eco-urban development of Beijing region. The study was finished by the end of July 2003.

This paper aims to outline the conceptual ecological framework developed in this study. It will then show how an actionable urban greening plan at the regional, city and neighborhood levels to achieve long-term sustainability could be developed for Beijing City.

## 2. Study area

Beijing Province is in the north of China and located at 39°38′–41°05′N in the temperate climatic zone with a mean annual temperature of 12 °C. Precipitation averages 640 mm per annum. It has a total area of 16,807.8 km<sup>2</sup> and a population of about 13.8 million with an average population density of 821 persons/km<sup>2</sup> (Beijing Municipal Statistical Bureau, 2002). Beijing

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