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Research Paper

Urban ecology in China: Historical developments and future directions

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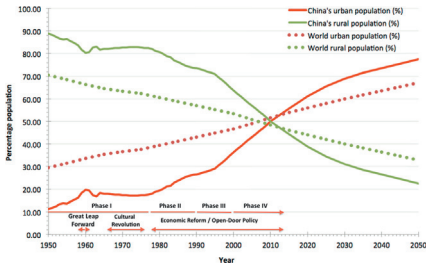
HIGHLIGHTS

- China's urban population rose from 18% in 1978 to about 50% in 2010.
- Urban ecology in China started in the early 1980s.
- China's urban ecology has focused on environmental pollution and eco-cities.
- Holistic and systems thinking has been important in China's urban ecology.
- Urban ecology in China is developing rapidly, embracing diverse ideas and methods.

GRAPHICAL ABSTRACT



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ABSTRACT

China has the largest population and the longest urban development history in the world, with primitive cities first occurring along the Yellow River in northern China more than 4000 years ago. After a long period of stagnation during recent centuries, urbanization has revived again in China since the economic reform in 1978. Strongly influenced by national land use policy and the history of urbanization after 1949, China's urban ecology has gone through three development periods: the emergent period (1983–1989), the early growth period (1990–1999), and the rapid development period (2000–present). In this paper, we first provide a historical review of urbanization and urban ecology in China; based on this retrospective analysis, we further identify the main characteristics of, and missing links in, China's urban ecological research; and finally we suggest future research directions. The amount and scope of research in urban ecology and environment conducted in China since the 1980s are impressive. Not only did Chinese scholars import Western ideas to develop urban ecological science, but also they have promoted a holistic, use-inspired, transdisciplinary philosophy for studying and managing urban systems – which has unique Chinese characteristics. After more than 5000 years of being predominantly agrarian, China is now urban, and will become only more urban in the future. This continued fast urbanization makes China a living laboratory for studying urbanization, and China's urban ecology seems poised to make strides in the coming decades.

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1. Introduction

One of the most salient features that characterize human civilization during the past millennium is accelerating urbanization. According to the United Nations (http://esa.un.org/unpd/wup/), more than half of the world's population now lives in urban areas, and almost all future global population growth will take place in urban areas. The world's population will continue to urbanize even after it stops growing around 2050, and we have entered "the century of the city" (Anonymous, 2010). Urbanization seems both a driver for, and a consequence of, socioeconomic development, cultural transformation, and technological invention. Higher levels of urbanization often correspond to higher levels of economic and social development at the national and regional scales, but urbanites usually have substantially greater and more diverse demands for resource consumption than agrarians, thus adversely affecting ecosystems and landscapes at the local and regional scales. As such, the ecological footprint of contemporary cities – the land (and water) area needed to support an urban population for resource consumption and waste disposal – is often tens to hundreds of times larger than their physical size (Luck, Jenerette, Wu, & Grimm, 2001; Rees & Wackernagel, 1996). Although cities often are engines of economic growth and centers of culture and innovation, they are also frequently the hubs of increasing environmental pollution, infectious diseases, and social inequity (Redman & Jones, 2005; Wu, 2008a, 2010).

As an increasing majority of humans will reside in cities, improving human well-being while preserving the environment within and beyond urban areas is a great challenge. This is especially true for developing countries because their cities are faced with more severe environmental and socioeconomic problems and because their small- and medium-sized cities will be home to most of the future urban growth (Redman & Jones, 2005; Wu, 2008a). To meet this challenge, we have to better understand the ecology and sustainability of cities. As noted elsewhere (e.g., McDonnell, 2011; Wu, 2014, this volume), the terms – urban ecology and urban sustainability – have various connotations. Here, we adopt the definitions in Wu (2014): Urban ecology is "the study of spatiotemporal patterns, environmental impacts, and sustainability of urbanization with emphasis on biodiversity, ecosystem processes, and ecosystem services," and "urban sustainability is . . . an adaptive process of facilitating and maintaining a virtuous cycle between ecosystem services and human well-being through concerted ecological, economic, and social actions in response to changes within and beyond the urban landscape." As illustrated in Fig. 1, ecosystem services, as benefits that people derive from biodiversity and ecosystem functions, provide a key nexus that links urban ecology and sustainability. Urban ecology clearly has an "ecological" focus while considering a number of socioeconomic and planning processes that influence or interact with the "ecology in cities" and "ecology of cities" (Grimm, Grove, Pickett, & Redman, 2000; Pickett et al., 2001; Wu, 2008a, 2014). On the other hand, the central issue in urban sustainability is human well-being, which depends on ecosystem services, and thus "sustainability of cities" requires maintaining and improving both ecosystem services and human well-being for the long-term. Urban ecology and urban sustainability (science) inevitably overlap with each other, but differences can be seen in cross-disciplinarity, main research foci, and major participating disciplines.

China, as a developing country and a major emerging economy of the world, has been urbanizing at a record speed with rapid economic development during the past three decades. The myriad environmental problems induced by urbanization in China are similar to those encountered in many developing countries today and in many developed countries during their intensive industrialization several decades ago. As one of the fastest urbanizing nations and with more than one fifth of the world's population, China has a critically important role to play in promoting urban sustainability. Indeed, the Chinese government has placed an increasing emphasis on urban development in the past several decades, attempting to guide the trajectory of urbanization through a number of institutional changes and reforms (Huang, 2006; Wang, 2013a). Furthermore, Chinese scholars have much to share with the rest of the world as their unique experience in urban ecological research dates back to the early 1980s – well before urban ecology became mainstream in North America and other parts of the world. It is thus timely to review some of the key characteristics in China's urban development and urban ecological research.

Specifically, this paper has three distinct yet interrelated objectives. First, we briefly review urban development in China, identifying major characteristics in urban landscape dynamics during the past few decades. As urban ecological studies often focus on the interactions among biodiversity, ecological processes, and landscape pattern, all of which are influenced by urban planning and myriad sociopolitical factors, their theoretical frameworks, dominant methodologies, and emphasized applications are influenced by culture. Thus, our second objective is to review the historical development of China's urban ecology as it has been shaped by its own history of urbanization. Based on this retrospective analysis, our third objective is to identify main characteristics of urban ecology in China and missing links in its development, with suggested future directions.

2. Urban development in China

China has the longest history of urbanization in the world, with nine development periods (Wu, 1988; Xu, Zhou, & Ning, 2009). Reviewing the urban history of China in detail is beyond the scope of this paper, and such publications exist (e.g., Huang, 2006; Lu, Yao, Li, Liu, & Gao, 2007; Wu, 1988; Xu et al., 2009). In this section, we provide a succinct overview of China's urban development to facilitate our discussion and understanding of China's urban ecology. Here we use the term "urbanization" to refer to the development and expansion of cities and regard cities broadly as areas with high concentrations of people and human-made structures.

2.1. China's urbanization before 1949: Five development periods

Archeological evidence indicates that the earliest Chinese cities occurred along the lower and middle reaches of the Yellow River more than 4000 years ago (the Xia Dynasty – the Shang Dynasty in Chinese history) (Xu et al., 2009). According to Xu et al. (2009), the long history of urbanization in China before 1949 can be divided into five periods: (1) emergence and nascent development of cities between the Shang Dynasty and the Spring and Autumn Period (2000 BC–770 BC), (2) urban development of the early feudal society between the Spring and Autumn Period and Han Dynasty (770 BC–206 BC), (3) urban development of the mid-term feudal society between Han Dynasty and Yuan Dynasty (206 BC–1279 AD), (4) urban development of the late feudal society between Yuan Dynasty and the First Opium War (1279–1840), and (5) urban development of the early modern era between the Opium War and the founding of the People's Republic of China (1840–1949).

During the first two periods of urban development in China (about 2000 BC–206 BC), cities were mainly political and military centers with few other functions, and they began to assume major economic functions during the third urban development period (206 BC–1279 AD) (Wu, 1988; Xu et al., 2009). The total number of cities in China was 800–900 in Qin Dynasty (221–207 BC) when China was unified, and reached 1500 by the end of Western Han Dynasty at the beginning of the first century A.D. (Wu, 1988). In the