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Assessing the Habitat Quality of Aquatic Environments in Urban Beijing

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Abstract

Aquatic environments are important habitats for plant and animal species. In this case study we assessed the impact of rapid urbanization on the habitat quality of urban water bodies in Beijing in the past decade. The changes of surface areas, locations, and types of water bodies were estimated through interpreting QuickBird and WorldView-2 images acquired in 2002 and 2012, respectively. The land use change in areas surrounding 30 selected urban water bodies were interpreted using Landsat images. The impact of land use change on the habitat quality of those 30 water bodies was evaluated using the habitat threat index (HTI). The result showed that the total area of urban water bodies has expanded from 15.54 km² to 16.02 km² in Beijing in the past decade. However, the increase was mainly due to the construction of golf courses, water pools, new parks, and new drainage ditches. Most water bodies with high habitat quality such as fishponds and semi-natural ponds have been converted to other types of land cover. The mean value of HTI decreased by 8.96% between 2002 and 2015. The improvement was largely due to the large-scale urban greening projects implemented in Beijing during this period. We concluded that there is an urgent need to preserve water bodies with high habitat quality so they can play a more important role in preserving urban biodiversity in Beijing.

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1. Introduction

We are living in an increasingly urbanized world. Around 54% of the world's population now lives in cities (World Urbanization Prospects 2014). In cities across the globe, urban aquatic environments possess very high ecological value and play an important role in a healthy and functional ecosystem. It provides ecosystem services such as regulating the microclimate, maintaining biodiversity, regulating floods, and providing recreational and educational opportunities, which is highly correlated with the human's development¹⁻³. At the same time, urban aquatic environments have been subjected to the impact of urbanization. Their hydrology, ecology, and water chemistry can be altered profoundly, which in turn affect the biodiversity supported by the urban aquatic environments^{4,5}. Therefore, to keep a track of the habitat quality of urban aquatic environments is necessary for protecting urban biodiversity⁶.

Habitat quality refers to the ability of the ecosystem to provide conditions appropriate for individual and population persistence⁷. The quality of a habitat is significantly affected by its proximity to human land uses and the intensity of these land uses⁸. Urbanization is a process that changes both the types and intensity of land use⁹. Water bodies located inside and near to urban areas are therefore exposed to the impact of these changes. Due to the wide spread of water bodies and the inaccessibility of some, it is difficult to monitor all the changes through traditional field surveys. The remote sensing technology has the advantages of acquiring reliable information and plays a significant role in monitoring the changes in water body areas^{10,11}. Geographic Information System (GIS) provide useful tools, which helps the integration and analysis of spatial information^{12,13}. The combination of these technologies becomes an available method to detect the spatio-temporal changes of water bodies and help explore its ecological effects¹⁴. So far studies on urban water bodies mainly focused on two aspects: (1) changes of surface areas and spatial distributions of urban water bodies^{1,15}, and (2) changes of the physical and chemical properties of water^{16,17}. The impact on the habitat quality of water bodies and its variation in cities with different urbanization rate and pathways has not been well studied. Therefore studies are urgently needed to provide important information for protecting the habitat quality of urban aquatic environments and conserving urban biodiversity.

In this study we ask the question: how has urbanization changed the habitat quality of urban water bodies in Beijing in the past decade? More specifically, the objectives of this case study include: (1) to quantify the spatio-temporal changes of urban water bodies in Beijing; (2) to assess the habitat quality changes of these water bodies.

2. Materials and methods

2.1. Study area

Beijing is the capital city of China and densely populated. Beijing has an administration area of 16,808 km² and the urban population reached 21.71 million by 2015. Beijing has undergone a rapid urban expansion since the economic reform in 1978. It is also one of the world's most water-challenged cities: the average per capita water availability is less than 200m³ per annum, i.e. 1/40 of world's average¹⁸. The influences on aquatic environments in Beijing caused by the rapid urban expansion have already drawn a wide range of attention^{1,15,19}. In this study we focused on the central city enclosed in the 5th Ring Road where the impact of urbanization is most intense (Fig.1).

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