

Comparison of the ecosystem services provided by China's Poyang Lake wetland and Bangladesh's Tanguar Haor wetland



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ABSTRACT

Wetlands are the most productive ecosystem on Earth. China's Poyang Lake wetland and Bangladesh's Tanguar Haor wetland are important natural Asian wetlands. In the past 10–15 years, the ecosystem services provided have been greatly affected by human activities and the resulting significant changes in the wetlands. In this paper, we chose food supply and biodiversity as typical ecosystem services provided by these wetlands, and combined field research with surveys to analyze the changes in the characteristics of these ecosystem services in the two wetlands and their driving forces. From 2000 to 2012, we found that: (1) per capita rice production has decreased greatly in both wetlands, while the rice consumption and the level of food security have decreased in the Poyang Lake wetland and increased in the Tanguar Haor wetland. (2) The fish supply has decreased in both wetlands, with a greater decrease in the Tanguar Haor wetland. (3) The biodiversity services have improved in the Poyang Lake wetland but decreased greatly in the Tanguar Haor wetland. These changes have been caused by differences in the combination of land use policies, land use planning, population growth patterns, and economic development.

1. Introduction

Ecosystem services connect natural science with economics, conservation and development, and public and private policy (Braat and de Groot, 2012). Ecosystem provide a series of goods and services to human beings (MEA, 2005; Nelson et al., 2009). However, these services have changed significantly around the world in recent decades (e.g., Fang et al., 2006; Rasul, 2009).

The Millennium Ecosystem Assessment (MEA) found that about 60% of the world's ecosystem services have degraded, and human activity (e.g., land uses such as intensive agricultural inputs and land reclaimed from a lake) is one of the main causes of this adverse change (MEA, 2005; Li, 2013). However, there are complicated interactions among the different kinds of ecosystem services, and examination of ecosystem services may also fail to consider the wider economic and social environments within which decision makers work (Ghazoul, 2007). The theory and practice of ecosystem services are controversial and there may be superficial understanding of the role of culture, agency, social diversity and power (Van Hecken et al., 2015). To improve scientific understanding of the theory and practice of ecosys-

tem services, and reduce the controversy surrounding them, it is important to undertake comparative research to clarify the changing features and driving forces of ecosystem services in different political, economic, and social contexts.

Among the natural ecosystem, wetlands has the richest biodiversity and are one of the most productive ecosystem (Pearee, 2002). Thus, there is a strong interest in understanding the ecosystem services they provide and finding ways to protect or enhance these services to promote sustainable natural resource use (Braat and de Groot, 2012; Potschin and Haines-Young, 2013; McKenzie et al., 2014; Adekola et al., 2015). Wetlands occupy only about 1% of the Earth's surface, but provide habitat for about 20% of the world's species (Dugan, 1993). With rapid population growth and unsustainable exploitation of these ecosystem, wetlands face a significant risk of degradation. This damage will increase the likelihood of nonlinear and potentially abrupt changes in ecosystem, with important consequences for human well-being (MEA, 2005).

China and Bangladesh are developing countries with large populations. Thus, there is a large need to exploit their natural resources to satisfy the demands of these people. However, these countries have

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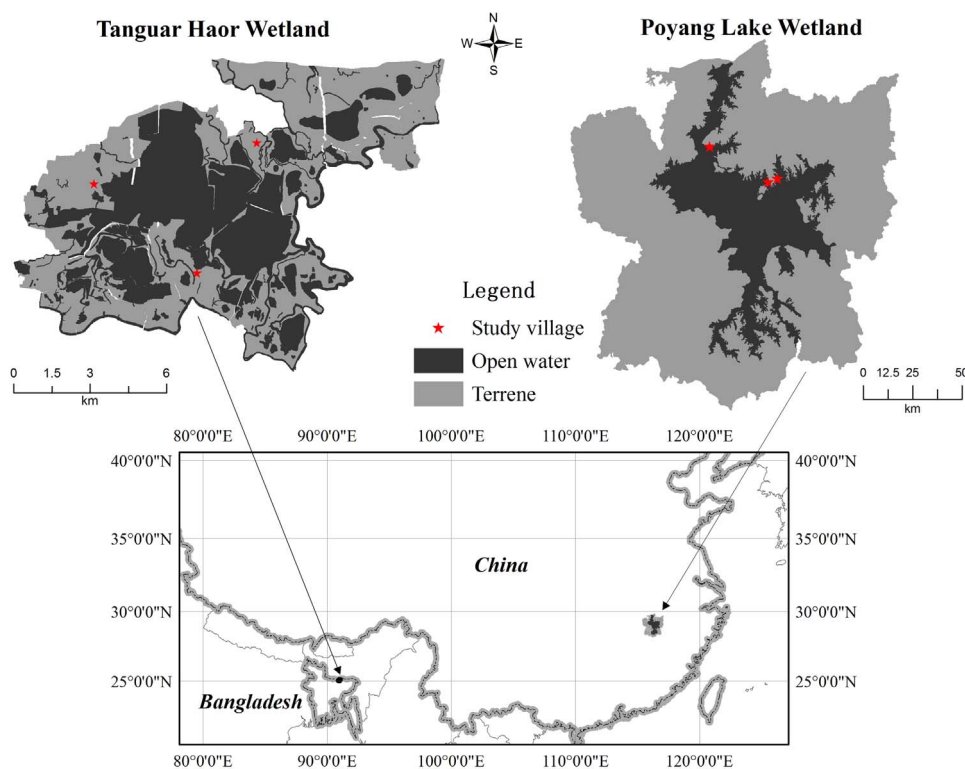


Fig. 1. Location of the study wetlands in China and Bangladesh.

different political systems, resource ownership and management systems, and patterns of natural resource consumption; they are also at different stages of economic development and are growing at different rates, and have different conservation strategies for management of their wetlands. China's Poyang Lake wetland and Bangladesh's Tanguar Haor wetland are two of the most important wetlands in Asia. These have been designated as important resources that require protection by the World Wide Fund for Nature (Olson and Dinerstein, 1998) and by the Ramsar Agreement (Miah et al., 2013), respectively. Both wetlands have a monsoon climate and undergo dramatic hydrological changes between the rainy and dry seasons. These changes lead to equally dramatic changes in the ecological processes and directly affect the characteristics of their wildlife habitats and their rich biological diversity (Harris and Zhuang, 2010; Sun et al., 2015b); aquatic vascular plants, migratory birds, and fish are particularly influenced by the changes of habitat area and structure caused by the variation of water level (Fang et al., 2006). Both regions provide important wetland habitats for waterfowl and have rich biodiversity (Fang et al., 2006; Alam Sarowar and Hasibur, 2011; Miah et al., 2013). Moreover, they are important food production areas for the local people, which directly support a population of 1.43 and 0.07 million, respectively, with rice and fish being the most important food products.

Over the last 10 years, Poyang Lake wetland and Tanguar Haor wetland have experienced land reclamation, population growth, overdevelopment of natural resources, ecological restoration, and some other changes (Jiang, 2005; Li et al., 2009; Fang et al., 2006; Zhen et al., 2011; Enamul Haque and Mizanul Haque Kazal, 2008; Miah et al., 2013). A lack of scientific assessment means it is unclear how these wetlands have changed and whether their ecosystem services have recovered following ecological remediation.

These two wetlands have both similarities and differences, therefore, we chose to compare them to provide insights into recent changes in their ecosystem services and the driving forces responsible for these changes. We used integrated methods from geography, ecology and sociology to provide a rigorous quantitative-qualitative way to identify

the ecosystem services, change characters and their driving forces. Thus, it may be possible to detect principles that describe the changes in wetland ecosystem services, for providing a more scientific basis for natural resource management.

The MEA (2005) defines four types of ecosystem services (supply, regulation, culture, and support). Both of these wetlands are major grain-producing areas with known biological diversity, and are protected. Grain production and biodiversity are the most important functions of wetlands. Therefore, in the present study, we chose these two features: biodiversity (to represent the natural components of the ecosystem) and food supply (to represent the human components of the ecosystem). Several studies have focused the biodiversity and food security issues in other regions (e.g., Chappell and Lavalley, 2011; Smith, 2013). However, few of these studies compared two or more wetlands to identify the driving forces responsible for changes in the wetland ecosystem and any underlying principle (Li et al., 2013). Some driving forces are summarized, such as human activities, climate, lake degradation, construction of large hydroelectric dams, establishment of nature reserves, and lake restoration practices (MEA, 2005; Fang et al., 2006; Li et al., 2009; Sun et al., 2015c). Driving forces under different political, economic, and social contexts have not yet been clearly identified. In the present study, we randomly chose three typical villages around water bodies in each wetland, and combined field studies with participatory rural appraisal and household questionnaires to identify changes in ecosystem services and the driving forces responsible for these changes.

2. Material and methods

2.1. Study area

The Poyang Lake wetland is located in northern Jiangxi Province, in central China, and is on the southern bank of the middle and lower reaches of the Yangtze River (Fig. 1). The region has a subtropical humid monsoon climate. The annual average temperature ranges from 16.5 to 17.8 °C, with monthly means ranging from 4.5 °C in January to

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