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Households' willingness to reduce pollution threats in the Poyang Lake region, southern China

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ABSTRACT

Environmental threats to wetland ecosystems are increasing, and these ecosystems are becoming increasingly sensitive to human impacts, leading to deterioration of these already fragile ecosystems. Poyang Lake is the largest freshwater lake in China and one of the most important wetlands in the world. However, water pollution and related environmental changes have increasingly drawn the scientific community's attention. The goal of this paper is to provide insights into the environmental threats to the Poyang Lake region as perceived from the households' perspective, and to investigate their willingness to pay for conservation of the lake's environment. We collected both primary and secondary data through a questionnaire delivered to 270 households and analysis of existing water monitoring data. The major threat confronting the Poyang lake region is water pollution; water quality, as represented by the total nitrogen (TN) and total phosphorus (TP) concentrations and by chemical oxygen demand (COD), suggests a moderate to severe degree of eutrophication. The situation has worsened in recent years, particularly due to high TN and TP in agricultural drainage water caused by increasingly intensive use of chemical fertilizers by local farmers. Most households were willing to pay to mitigate these threats, but the magnitude of the payment was related to a farmer's dependence on the lake for their production and daily life. The results of our analysis will help managers develop more effective environmental management policies.

1. Introduction

Human societies depend on ecosystems and their delivery of environmental services, but through the actions of broader biogeochemical cycles, human activities at one place can influence environmental conditions and people elsewhere (Vatn, 2010). This problem becomes severe in wetland ecosystems, where people and the environment are interconnected through the water resources provided by the ecosystem and used by local residents. This is particularly true in China's Poyang Lake region. Poyang Lake is the largest freshwater lake in China and one of the most important wetlands in the world. It is situated in northern Jiangxi province (Fig. 1), near the southern bank of the middle and lower reaches of the Yangtze River, which accounts for 9% of the Yangtze River basin. The lake exhibits marked seasonal changes in both area and volume (Wang et al., 2004). Poyang lake is an overflow lake; instead of being supplied by streams or rivers that flow directly into the lake, it increases in size when the Yangtze River overflows its banks or during heavy rainfalls that produce large volumes of surface flow, and decreases in size due to less water inflow from the Yangtze River, reduced precipitation, deep drainage and evaporation, and both receives and releases water in response to seasonal variations. The shape and water level in the lake vary seasonally, with a 13-m difference in the water height between the summer rainy season and the winter dry season. In the study area, mean temperatures range from a low of 4.4 °C in winter to a high of 30.0 °C in summer. Annual precipitation averages 1387–1795 mm, with 48.2% of this total falling during the summer growing season (Wang et al., 2004). Because of the fertile surrounding land and rich bio-resources, Poyang Lake is an important habitat for a number of wild animals, including 159 water bird species (53% of the total number in China). It is one of the most important overwintering areas for migratory water birds in Asia, and is home to 98% of the global population of Siberian cranes (*Grus leucogeranus*), 50% of white-naped cranes (*Grus vipio*), 50% of swan geese (*Anser cygnoides*), and tens of thousands of egrets, spoonbills, storks, swans, geese, ducks, and shorebirds. Based on the existing research (e.g., Li et al., 2009), it is known that the Poyang Lake serves all the main functions of an ecosystem, including provisioning,

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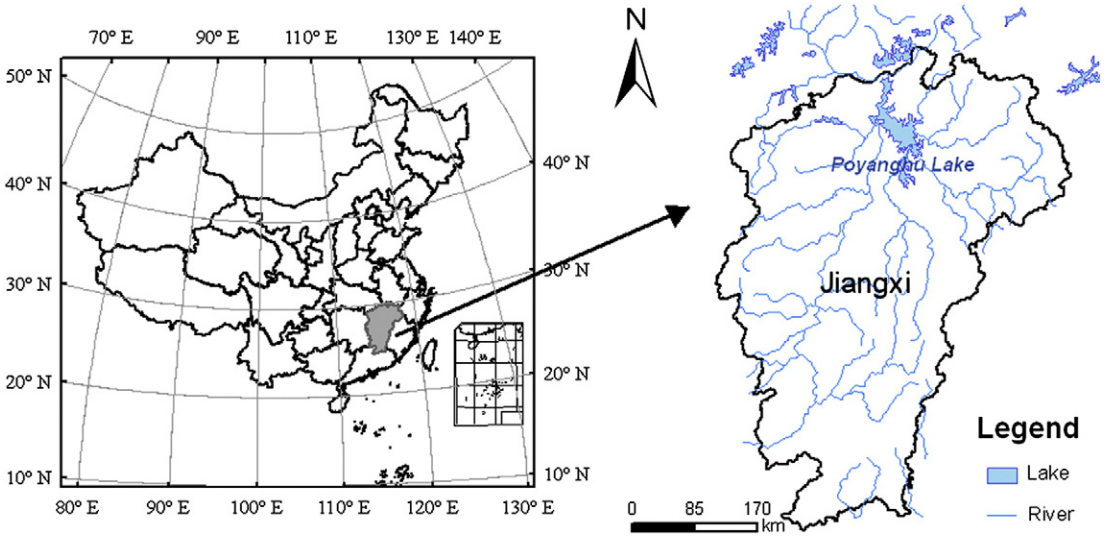

Fig. 1. Location of Poyang Lake in China and in Jiangxi Province.
Software: ArcGIS. Source: Data Center for Resources and Environmental Sciences, Chinese Academy of Sciences, 2004.

supporting, and regulating environmental functions, as well as serving cultural and recreational functions for local residents.

Poyang Lake and its surrounding regions comprise two cities and ten counties: Nanchang and Jiujiang cities, and Nanchang, Xinjiang, Jinxian, Yongxiu, Dean, Xingzi, Duchang, Hukou, Yugan, and Poyang counties. These cover a total land area of 202.89 ha and sustain a population of 8.86 million. The rural population totals 5.99 million (68% of the total). Farmers practice small-scale farming activities, and cultivate more than ten types of crops in small farm fields, including rice (double or triple cropping), cotton, sweet potato, beans, peanuts, oil plants, vegetables, and fruits. To ensure a high yield, farmers usually use high inputs of fertilizers and pesticides.

Arable land and water area surrounding the lake are the two main types of land use (Fig. 2), and there is usually competition between the two types of land use in areas at risk of flooding. The area of arable land per capita totals 0.045 ha, which is only 42.4% of China's average value and less than the FAO's minimum recommendation (=0.053 ha) to sustain a human life. The most significant land use changes in recent

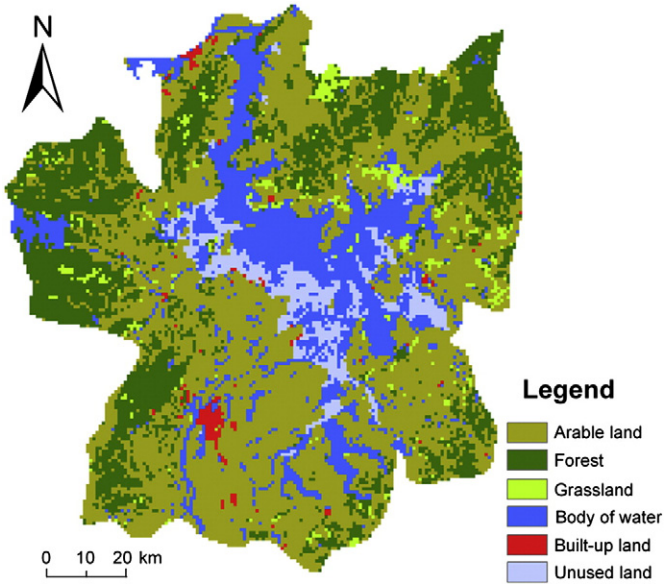

Fig. 2. Land use patterns in the Poyang Lake region in 2008.
Software: ArcGIS. Source: Data Center for Resources and Environmental Sciences, Chinese Academy of Sciences, 2005.

years have been a decreasing farmland area and an increasing water area. The farmland area decreased by 19 416 ha between 1997 and 2005 (a 4.7% decrease compared with the area of cultivated land in 1997), and the total area of bodies of water increased by 14 661 ha (by 3.9% of the area in 1997) as a result of a land use policy designed to convert cultivated land into natural water areas to assist in wetland conservation (Wang et al., 2004). During this period, the forest area decreased by 1066 ha (0.2% of the 1997 value) and the grassland area decreased by 7.5% of the 1997 value. The built-up land increased from 59 148 ha in 1997 to 62 957 ha in 2005, a 6.4% increase, due to increasing urbanization, and the area of unused land increased slightly (by 0.42%) during the same time period.

Due to population growth (a 19.3% increase from 1997 to 2007) and increasingly intensive economic activities, environmental degradation has begun to occur. Pollution (including eutrophication) has intensified due to the discharge of waste water from industrial and domestic sources (Yang et al., 2011), as well as due to agricultural chemical inputs (Lv, 1996; Wang et al., 2008). The total nitrogen (TN) and total phosphorus (TP) concentrations averaged 1.06 mg/L and 0.067 mg/L, respectively, in the lake water, indicating severe eutrophication (Wang et al., 2008). The region's biodiversity has also decreased due to water pollution (Yu and Sun, 2006).

These statistics suggest that overuse of agricultural chemicals is a major cause of the lake's water pollution problems (e.g., Wang et al., 2008). Researchers from other countries have also explored the impacts of agricultural chemicals on water quality; for instance, OECD (1982) summarized data from around the world and reported that the nitrogen and phosphorus loading from communities and from the fertilization of cultivated land and forests have resulted in excessive nutrient inputs to lakes around the world.

Local households are the users and managers of the region's resources, and Wunder et al. (2008) noted that, at least in theory, systems based on the needs of these households are “much more likely to be efficient” because these people have better knowledge of the resource and their needs than is possible for a central management agency. Therefore, it is imperative for decision-makers to understand the perspectives of the local people on environmental changes and their willingness to pay (WTP) for conservation of the resources that sustain them; this knowledge can guide them to improve management of the resources. In the present study, we attempted to provide insights into the environmental challenges in the Poyang Lake region from the households' perspective. To do so, we investigated their willingness to pay for conservation of the lake's environment. We used environmental