



Quantifying changes in multiple ecosystem services during 1992–2012 in the Sanjiang Plain of China



Zongming Wang^a, Dehua Mao^{a,*}, Lin Li^b, Mingming Jia^a, Zhangyu Dong^a, Zhenghong Miao^a, Chunying Ren^a, Changchun Song^a

^a Key Laboratory of Wetland Ecology and Environment, Northeast Institute of Geography and Agroecology, Chinese Academy of Sciences, No. 4888, Shengbei Street, Changchun 130102, China

^b Department of Earth Sciences, Indiana University-Purdue University, 420 University Blvd, Indianapolis, IN, USA

HIGHLIGHTS

- We studied changes of multiple ecosystem services and their synergies and trade-offs.
- We developed several methods to quantify ecosystem services in a spatially explicit manner.
- Wetlands shrinkage, agriculture expansion and urban sprawl were observed during 1992–2012.
- Provisioning services (food production) increased significantly during the 20 years.
- Large losses in ecosystem carbon stocks and suitable waterbird habitats were found.

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ABSTRACT

Rapid and periodic assessment of the impact of land cover changes on ecosystem services at regional levels is essential to understanding services and sustainability of ecosystems. This study focused on quantifying and assessing changes of multiple ecosystem services in the Sanjiang Plain of China as a result of land cover changes over the period of 1992–2012. This region is important for its large area of natural wetlands and intensive agriculture. The ecosystem services that were assessed for this region included its regulating services (water yield and ecosystem carbon stocks), supporting services (suitable waterbird habitats), and provisioning services (food production), and the approach to the assessment was composed of the surface energy balance algorithms for land (SEBAL), soil survey re-sampling method and an empirical waterbird habitat suitability model. This large scale and integrated investigation represents the first systematic evaluation on the status of ecosystem carbon stocks in the Sanjiang Plain in addition to the development of an effective model for analysis of waterbird habitat suitability with the use of both remote sensing and geographic information systems (GIS). More importantly, the result from this study has confirmed trade-offs between ecosystem services and negative consequences to environment in this region. The trade-offs were typically manifested by increased water yield and significantly grown food production, which is in contrast with significant losses in ecosystem carbon stocks (–14%) and suitable waterbird habitats (–23%) mainly due to the conversion of land cover from wetland to farmland. This finding implies that land use planning and policy making for this economically important region should take ecosystem service losses into account in order to preserve its natural ecosystems in the best interest of society.

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1. Introduction

Ecosystems generate a range of goods and services important for human well-being, collectively called ecosystem services (Nelson et al., 2009). Over the past decade, ecosystem services have been a central issue when the sustainable management of natural resources is considered (Dearing et al., 2012), and progress has been made in

understanding how ecosystems provide services and their associated economic (NRC, 2005). Ecosystem services are affected by a number of factors including changes in demographics, economics, sociopolitical issues, science, technology, and religion, as well as physical and biological conditions (Millennium Ecosystem Assessment, 2005; Lü et al., 2012). Over the last 50 years, 60% of the worldwide ecosystem services have degraded due to increases in the global population and economic growth (Millennium Ecosystem Assessment, 2005). In China, widespread ecological degradation has constrained sustainable socioeconomic development in recent decades. For instance, between the early 1980s and 2000s, 23% of the land area in China suffered ecological

* Corresponding author at: Northeast Institute of Geography and Agroecology, Chinese Academy of Sciences, No. 4888, Shengbei Street, Changchun 130102, China.

E-mail address: maodehua@iga.ac.cn (D. Mao).