Habitat International 69 (2017) 114–125

Contents lists available at ScienceDirect

Habitat International

journal homepage: www.elsevier.com/locate/habitatint

Agricultural transformation and ecosystem services: A case study from Shaanxi Province, China

Bingjie Song [a], Guy M. Robinson [b,*], Zhongxue Zhou [a]

[a] School of Geography and Tourism, Shaanxi Normal University, No.620, West Chang'an Avenue, Chang'an District, Xi'an 710119, People's Republic of China
[b] Department of Geography, Environment and Population, School of Social Sciences, University of Adelaide, Adelaide, South Australia 5005, Australia

ARTICLE INFO

Article history:
Received 8 June 2017
Received in revised form
12 September 2017
Accepted 21 September 2017

Keywords:
Ecosystem services
Urban hinterland
Agricultural transformation
Orchards
Rural tourism
China

ABSTRACT

This paper analyses changes to ecosystem services (ESS) over the past thirty years in a small part of the hinterland of Xi'an, a city of nearly nine million population in Shaanxi Province, China. Using field survey and interviews with local farmers, the study provides micro-scale exemplification of the transformation occurring around major urban growth centres in China in response both to urbanization and agricultural modernization. The effects of urban growth upon agriculture are illustrated by wholesale changes in the type of production, increasing the value of provisioning services by replacing traditional cereals cultivation with fruit, which reflects the impact of the dynamic urban market. Five different types of ESS are calculated and analyzed, taking into consideration changing land management practices associated with the principal new crops in the study area, cherries and grapes. The widespread adoption of cherries as the main cash crop has also afforded farmers an additional source of revenue from tourists visiting the area to see the Spring-time blossom, pick the fruit and obtain a 'rural experience' by interacting with farmers and eating local food. The increased wealth for farm households has prevented the 'hollowing' of villages close to the expanding metropolitan area, but longer distance commuting to work in the city is now common for younger rural residents. Detailed calculation of the changing pattern of EES reveals the significant effects not only of the introduction of new crops but also the role of particular land management practices. Further analysis of these practices is proposed to obtain better understanding of the balance between positive and negative changes to EES.

1. Introduction

It has been widely recognized that rapid population growth and urbanization have a major influence on agricultural production, contributing to transformations in agricultural systems worldwide so that the demands of growing markets both locally and worldwide can be met (Rigg, 1998; Robinson & Carson, 2015; Theobald, 2001; Zasada, 2011). In addition, these changes have major impacts on agro-ecological systems, often transforming the ecosystem services (ESS) they generate. These services refer to the benefits people derive from natural and managed ecosystems, whereby the ecosystem directly or indirectly provides production, necessities and services, including clean air, water, food and fuel. Four categories of ESS are usually recognized: provisioning (e.g. food production), supporting (e.g. nutrient cycles), regulating (e.g. controlling disease) and cultural (e.g. recreation) (Costanza et al., 1998; Daily, 1997; Fu et al., 2009; MEA 2005; Su et al., 2012), all of which can be affected by changes in agricultural production.

In recent years, against the background of agricultural transformation in many countries worldwide, changes to ESS have attracted much attention in human geography, ecological economics and related disciplines (Baral, Keenan, Sharma, Stork, & Kasel, 2014; Costanza et al., 1998; Long, Liu, Hou, Li, & Li, 2014). This has been especially so in China where some of the greatest changes to ESS worldwide have occurred, driven by massive socio-economic change and innovation. The transformation of Chinese agriculture has corresponded with dramatic economic growth, leading to substantial modifications to land use and land cover (Long, Zou, Pykett, & Li, 2011; Tang, Bennett, Xu, & Li, 2013; Yu, Liu, & You, 2012; Zhao, 2013; Zhen et al., 2010). These have significantly affected biodiversity and ecosystem productivity, inevitably leading to modifications in the structure of ecosystems, and so affecting ESS both positively and negatively (Liu et al., 2015a).

Traditionally in Chinese agricultural landscapes, especially in

* Corresponding author.
E-mail address: guy.robinson@adelaide.edu.au (G.M. Robinson).

https://doi.org/10.1016/j.habitatint.2017.09.008
0197-3975/

lowland rural areas, by promoting soil fertility, irrigation and crop production, agriculture provided many positive ESS, for example through soil and water conservation measures, including the balancing of the provisioning function for grains with inputs from animal manures (Wan, Zhang, Huang, Ji, & Jiang, 2016; Wood, Rhemtulla, & Coomes, 2016). So, agriculture often played a role in maintaining a healthy agro-ecosystem and contributed to overall biodiversity conservation. However, rapid development of urbanization in recent decades, including dramatic losses of farmland to urban development (Deng, Huang, Rozelle, Zhang, & Li, 2015; Jiang, Deng, & Seto, 2013; Liu, Fang, & Li, 2014a), the intensive production patterns of modern agriculture and resultant land use modifications have led to many changes to ESS (Li, Ye, Song, Wang, & Tao, 2014; Long et al., 2014; Zhen et al., 2011). This has adversely affected biodiversity, with several native species endangered, resulting in some important functions of ESS being reduced, including pest control and pollination (Liu, Zhang, Zhang, & Duan, 2012; Wang & Zhou, 2014; Wang, Zhou, & Guo, 2014). Changes to agricultural practices, including adoption of new crops and associated technologies, have also introduced some negatives to ESS, e.g. in areas adopting viticulture, diseases and insect pests on grape trellises can damage or kill the vines, thereby reducing both crop yields and farmers' incomes (Lemessa, Hylander, & Hamback, 2013). Hence, though land used for farming purposes today can still provide many positive ESS, especially provisioning services, they may be associated with other changes that overall generate ecosystem disservices. Often, a mixture of old and new farming practices produces conflicting effects on ESS. For example, farmers in Henan province have traditionally scattered fertilizer and manures directly onto arable plots to increase crop yields, but extending this practice and using mechanization to raise output has contributed to increased non-point source pollution (He & Luan, 2006). Both positives and negatives are associated with the widespread burning of fallen leaves and other biomass on arable plots to add fertilizer for improved soil fertility and increased crop yield, which also discharges carbon dioxide and noxious gases, resulting in environmental pollution (Shi, Liu, Zhang, Hao, & Gao, 2014).

In the context of rapid urbanization and agricultural transformation in China, this paper focuses on a specific example of the evolution of ESS in recent decades to illustrate both positive and negative changes at the micro-level. To complement some of the regional and meso-scale analyses of changes to EES in China (e.g. Jia et al., 2014; Qiu et al., 2015; Wu, Ye, Qi, & Zhang, 2013), this case study focuses on a single village in the hinterland of Xi'an (with a current population of 8.7 million in a metropolitan region of 13.6 million), the largest city in Northwest China and capital of Shaanxi province. The city is in the process of rapid urban growth (with its population growing by 6.5 million in the last 25 years) and associated agricultural modernization. With the rapid expansion of urbanization, agricultural land resources in the city's immediate hinterland in the centre of the Guanzhong Plain have been greatly reduced, and agro-ecosystems have been transformed, resulting in an imbalance to the ecosystem structure, in the form of reduced biodiversity, soil degradation, and water pollution (Zhu, Wang, & Caldwell, 2010). A broader national context to these changes is provided by contrasting policy changes. On the one hand these are addressing the loss of agricultural land to this rapid urban development, with a concern to protect national food security creating a national base-line of 120 million hectares of farmland, with local authorities urged to control urban sprawl (He et al., 2013; Jiang et al., 2016; Wang Peng, Zhao, Liu, & Chen, 2017a). On the other hand, environmental measures such as the much-vaunted Grain for Green program have taken more marginal land out of production to deliver ecological gains (Wang, Zhang, Wu, Zhou, & Skitmore, 2017). Together, these policies may not only help improve the supply of food, but also the capability of specific ecosystem services, e.g. environmental health, carbon sequestration and oxygen release (Cheng et al., 2017; Song & Liu, 2017).

In the mid-1980s, agriculture in the immediate hinterland of Xi'an city was mainly dominated by arable production. In the past thirty years, wheat, maize and other grain crops have remained as the leading components of agricultural production, but in a much more diversified agricultural economy, partly reflecting farmers' responses to the growing demand from urban consumers. Especially after 2000, moves to introduce different forms of production have promoted greater diversification leading to decline of grain production and notable increases in the growing of vegetables and a range of fruit, including apples, grapes, melons and cherries. Hence today, agriculture in Xi'an's hinterland has acquired several 'modern' characteristics, still mainly focused on grain crops, but rapidly adopting specialty fruit and vegetable crops. In addition, improved transport links and greater urban-based employment opportunities have stimulated both out-migration and longer distance daily commuting to work in the city (Chong, Ding, & Yinghui, 2016), leading to the 'hollowing out' of some villages in the more distant reaches of the urban hinterland (Liu, Liu, Jin, & Qi, 2017; Wu & Ye, 2016).

In this study, we aim to measure the change of ecosystem services from 1985 to 2016, and analyze which and how farmers' behaviors have influenced the agro-ecosystem and ESS at a micro-scale for a case-study village near Xi'an. This locale was chosen because it exemplifies several aspects of the direct impacts of the growing influence of the burgeoning city upon farming in the urban hinterland. Specifically, it illustrates local responses to new opportunities presented by economic change accompanying market reforms by central government, which can then be measured in terms of changes to ESS.

2. Materials and methods

2.1. Study area

The study area is Duling village (109°7′47″E, 34°13′36″N), in Baqiao district of Xi'an City, Shaanxi province, at an altitude of around 760 m (Fig. 1). The region is characterized by a medium latitude temperate and continental monsoon climate, with the highest mean monthly temperature (26.8 °C) in July and lowest (−1.3 °C) in January. Annual precipitation is about 585 mm, falling mainly in summer; annual mean relative humidity is 70%. The morphology belongs to the loess tableland with a top-surface that is flat, broad, deep and fertile. The groundwater resource is relatively rich, but it has consistently been depleted during recent years because of irrigation. There were 770 people living in the village, in 180 households, in 2016 (when survey work was undertaken), with 45 households solely reliant on farming for income, and in the rest of which farming is combined with other occupations, typically with children and/or at least one adult working in Xi'an and its suburbs. The village is just 16.7 km from the city centre and 8 km from the outskirts so there is widespread commuting to work in the city. The village comprises 66.7 ha, 6.7ha of which are homesteads and garden plots, and 60 ha are under agricultural production, mostly farmed by extended family groups, representing several households who all possess use-rights over the land (Zhu, Zhang, Li, & Zhu, 2014).

2.2. Methods

2.2.1. Ecosystem service evaluation method

2.2.1.1. Environmental health. The environmental health function includes dust removal, sterilization, and absorption of noxious gas.