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Assessment of decoupling between rural settlement area and rural population in China

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ABSTRACT

In China, changes in rural settlement patterns are crucial because they may affect agricultural sustainability through encroachment on productive cropland and water resources and also reduce biodiversity. Rapid urbanization with accompanying socioeconomic transformation has resulted in decrease of the rural register population (RRP) in China since 2000. The effects of this change in RRP on rural settlement area (RSA) and the factors shaping the relationship between these measures of population and land use have attracted extensive research interest. We investigated the changes in RRP and RSA and used a decoupling model to analyze the relationship between them. We found that whereas RRP in China increased by 1.12% during 1996–2000, it decreased by 4.91% during 2000–2005. RSA increased by 0.62% and 0.09% during the periods 1996–2000 and 2000–2005, respectively. The RSA was slightly decoupled from RRP during 1996–2000 due to the shift in rural housing from one-floor houses to multi-floor houses. In the period 2000–2005, RSA was actually strongly negatively decoupled from RRP due to village-hollowing, which was driven mainly by a dual-track real property system (ownership by collectives, but use rights for individuals) as well as institutional–managerial and socioeconomic factors. In central and western China, the RSA was better able to be decoupled from RRP than in eastern China due to interprovincial rural migration.

Introduction

Rural population change is a crucial issue for natural resource management and economics globally, as agriculture uses about one-third of Earth's land and employs more than 40% of the global workforce (Anríquez and Stloukal, 2008). According to the United Nations (2011), the rural population of the world's least-developed regions will increase to 3.12 billion in 2025 (compared with 1.42 billion in 1950 and 3.06 billion in 2010) and then decrease to 2.87 billion in 2050. Thus, rural population growth will switch from positive to negative in 15 years. This rural demographic change will have substantial regional and global environmental and socioeconomic effects. One could hope that falling rural population would be accompanied by decreasing impacts on the rural environment, but this would depend upon both the relationship between population and impacts, and the persistence of impacts.

In the present study, we examine recent changes in rural population in China, and investigate the linkage between these changes and changes in the total land area occupied by rural settlements. A developing country traditionally dominated by agriculture, China has witnessed rapid urbanization since the 1978 debut of the Reform and Opening-up Policy, with the urban proportion of its population increasing from 17.92% to 51.27% (NBSC, 2012). However, although the rural population proportion has been decreasing, the total rural register population (RRP), i.e., population with household registration classified as located in a rural settlement, kept rising until 2000 (DPSSTS of NBSC, 2001). Changes in the natural environment (Zhou et al., 2013), urbanization (Irwin and Bockstael, 2002; Tan and Li, 2013), housing construction (Bański and Wesołowska, 2010; Peng et al., 2013), social transformation (Kiss, 2000), and changes in employment opportunities (Lewis and Mrara, 1986) have all been identified as forces driving land use changes in rural settlements.

As rural land is limited in extent, any of its area used for settlements is likely to be at the expense of cropland. In China's rural areas, using land for settlements is the second major type of land use, following cropland (Liu et al., 2003; Tian et al., 2012). Thus, similarly to urban sprawl, expansion of this area can affect agricultural sustainability by encroachment on productive cropland and water resources, and can be detrimental to the environment by causing loss in biodiversity (Alkan, 2009; Carrion-Flores and Irwin, 2004; Foley et al., 2005; Su et al., 2011).

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Cropland loss is of particular concern in China, with population growth and changed diet increasing food demand while rapid urbanization and associated urban sprawl have encroached on agricultural lands (Huang et al., 2011; Lin and Ho, 2003; Liu et al., 2009; Long et al., 2012; Tan et al., 2005; Wang and Scott, 2008; Yang and Li, 2000; Yu and Ng, 2007). In this context, curbing the expansion in land consumed by rural settlements can be particularly important for maintaining total cropland area. Thus, it is important not only to assess the changes in rural settlement population, but also to determine the relationship between these changes and changes in area occupied by the settlements.

A particularly useful way to examine this relationship is by viewing it within the framework of decoupling. In the context of environmental and development policy, decoupling is defined by the Organization for Economic Co-operation and Development (OECD, 2001, 2005, 2006) as breaking the link between "economic goods"[1] and "environmental bads". The International Resource Panel of United Nations Environment Program (UNEP, 2011) classifies decoupling for sustainable development into two major categories: resource decoupling (i.e., reducing the rate of use of resources per unit of economic activity) and impact decoupling (i.e., reducing the negative environmental impact per unit of resource used).

China has a unique residential classification system (the *hukou* system) which can potentially influence both rural population and the area it occupies and be helpful in investigating the relationship (i.e., presence and degree of decoupling) between the population and area. In the *hukou* system, each person is categorized with respect to both their residential locality type (*suozaidi*, with rural settlement and urban center being the two most common designations) and their socioeconomic eligibility (*leibie*, i.e., agricultural or non-agricultural) (Chan and Zhang, 1999).

The *hukou* designations of registration locality and the socioeconomic eligibility are inherited from one's parents. Urban *hukou leibie* carries certain privileges with it, such as access to urban public housing and superior medical insurance coverage (although rural medical insurance has been improving) and schools. Changing one's *hukou* registration requires government approval, which is not easily granted.

The *hukou* system was first implemented in the late 1950s as a core mechanism for controlling migration from rural to urban areas (Shen, 2013; Zhu, 2007). Working with other social and economic control mechanisms, it substantially regulated this migration from the 1950s to the 1970s, and was accompanied by several major political initiatives that encouraged migration from urban to rural areas during this period (Chan and Zhang, 1999; Fan, 2005a; Shen, 2013; Shen and Tong, 1992; Song et al., 2012).

Since the early 1980s, the influence of the *hukou* system on rural–urban migration has been weakening because of the emergence of huge labor demands in the cities, driven by the newly market-oriented economy (Chan and Zhang, 1999; Shen, 2013). During the past four five-year periods, i.e., 1985–1990, 1990–1995, 1995–2000, and 2000–2005, interprovincial migration in China reached 11.0, 10.3, 33.9, and 38.2 million, respectively (Fan, 2005b; Poncet, 2006; Shen, 2013). The east coast of China became the most highly developed region due to China's early regional development policy that focused on the coastal areas (Chen and Zheng, 2008). This region therefore grew into a net in-migration area which attracted migrants mostly from rural areas of central and western China (Fan, 2005b).

In China, the spatial patterns and total extent of land occupied by rural settlements are determined by tradition, household income, government policies, society, and their interactions (Liu et al., 2012; Long et al., 2009). Although the lack of accurate and reliable land-use data in China has been a subject of concern for a long time (Lin and Ho, 2003; Liu et al., 2005; Yang and Li, 2000), the first national land use survey was begun in 1984 and completed in 1996. Since 1996, a survey of land use change was conducted annually by local land administrative departments, with the survey data reported to the Ministry of Land and Resources of China (MLRC) (Song and Pijanowski, 2014). These data provide a basis to assess the total Rural Settlement Area (RSA), i.e., the total land area occupied by rural settlements both national and regionally. The term "rural settlement" in this context means a village, i.e., dwellings and associated facilities that are not within the boundaries of a city or town. In calculating RSA, the land classified as occupied by such settlements includes all of their buildings (e.g., dwellings, barns, shops) as well as associated facilities such as village roads and parks (Long et al., 2007; Porta et al., 2013; Tian et al., 2007). RSA specifically excludes agricultural land, thus making it an excellent measure of rural land subjected to human use, but not for cultivation.

In the present study, we aimed to ascertain: (1) the changes in RSA and RRP in China from 1996 to 2005; (2) the types of decoupling, if any, shown between the RRP and RSA in this period, and whether there were any regional differences in this relationship; and (3) the driving forces underlying any such decoupling.

Research methods and data sources

Decoupling model

To ascertain the status and degree of decoupling, we used Tapio's model (2005):

$$\beta_{n+1} = \frac{(EP_{n+1} - EP_n)/EP_n}{(DF_{n+1} - DF_n)/DF_n} \quad (1)$$

where n is the year; $n+1$ is the next year; β is the decoupling elasticity; EP is the environmental pressure (in this paper, it refers to RSA); and DF is the driving force (in this paper, it refers to rural population).

For the rural population, we included only those people designated as residents (pursuant to the *hukou* system) of rural settlements, because under the Land Administration Law of the People's Republic of China (LALPRC) (LCLPC, 2009), only they can apply to building house on rural land.

Classification of decoupling

In Tapio's (2005) classification, the relationship between pressure indexes (i.e., resources, in our case, RSA) and driving forces (i.e., growth, in our case, RRP), can broadly take three forms: *decoupling*, *negative decoupling*, and *coupling*. Decoupling, in turn, has three types (Fig. 1):

Strong decoupling: $\beta_{n+1} < 0$, $(EP_{n+1} - EP_n)/EP_n < 0$, and $(DF_{n+1} - DF_n)/DF_n > 0$;
Weak decoupling: $0 < \beta_{n+1} < 0.8$, $(EP_{n+1} - EP_n)/EP_n > 0$, and $(DF_{n+1} - DF_n)/DF_n > 0$;
Recessive decoupling: $\beta_{n+1} > 1.2$, $(EP_{n+1} - EP_n)/EP_n < 0$, and $(DF_{n+1} - DF_n)/DF_n < 0$.

Similarly, *negative decoupling* is divided into three types, i.e., *strong negative decoupling*, *expansive negative decoupling*, and *weak*

[1] Here, "environmental bads" refers broadly to things or processes that endanger or damage ecosystems. Economic goods could also be understood as economic commodities, including tangible property and services. In assessing decoupling, GDP (Gross Domestic Product), the market value of all officially recognized final goods and services produced within a country in a given period of time, usually represents economic goods.