Land Use Policy 40 (2014) 28–35

Contents lists available at ScienceDirect

Land Use Policy

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

Changes of livelihood due to land use shifts: A case study of Yanchang County in the Loess Plateau of China

Nahui Zhen, Bojie Fu*, Yihe Lü, Zhenmin Zheng

State Key Laboratory of Urban and Regional Ecology, Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences, P.O. Box 2871, Beijing 100085, PR China

ARTICLE INFO

Article history:
Received 14 January 2013
Received in revised form 28 April 2013
Accepted 6 May 2013

Keywords:
Grain for Green Project
Land use
Income
Livelihood
Population changes

ABSTRACT

Studies of land use policies are commonly based on the environmental impacts or on people's direct responses to the policies. However, research on the impact of policy implementation on people's livelihood and activities and the subsequent economic development of an area is incomplete. We selected Yanchang County as an example to track land use changes and their effects on the livelihood of the local population following the implementation of a new land use policy known as the Grain for Green Project (GGP). The data were collected from statistical yearbooks, questionnaire surveys, and satellite imagery from 1990, 2000, and 2008. We found that dramatic land use changes have occurred in Yanchang County. The vegetation coverage improved significantly from 1990 to 2008, as the grassland and forest areas increased from 44.1% to 60.1% and from 17.7% to 18.4% of the total land area, respectively. The cultivated land declined from 37.3% to 20.7%. With the agricultural area and grain production decreasing from 64×10^3 tons to slightly over 20×10^3 tons per year, an increasing number of local people sought employment in towns and cities. The non-farm income increased, and the local income structure shifted. Migrant and orchard worker income contributed the most to the balance of the total household income. We narrowed our focus to discuss how the GGP accelerated the changes in the participants' lifestyles and what might be done to sustain the long-term effects of the GGP. While the GGP has brought about considerable environmental benefits, a comprehensive study of environmental–social systems is still needed to achieve a more efficient land use policy. The research results presented in this paper demonstrate that changes in land use and people's activities were triggered by policy changes. We aim to pave the way for studies on the "policy-land-use-social development" chain and to provide references for new policies.

Introduction

Land is a globally scarce resource (Scherr and Yadav, 1996; Liekens et al., 2013). Human activities have led to pervasive and frequent changes of land use and land cover (Alphan, 2003; Booth, 2009; Wang et al., 2012). Land use changes have had a severe influence on the environment, ecosystem services, and social development (Butler et al., 2011; Lü et al., 2012).

Numerous insights have been proposed related to the drivers of land use change. For example, the expansion and intensification of agriculture are among the most significant human domestications of land resources (Matson et al., 1997; Grau et al., 2005; Bennett and Balvanera, 2007). Urbanization, as an inevitable developmental tendency, dramatically changes the land use of urban–rural transitional areas (United Nations Population Fund, 1991; Grübler, 1994; Yan et al., 2002; Lambina et al., 2011). In addition, bioenergy development (FAOSTAT, 2011; Miyake et al., 2012), increasing demand for tourism and recreation (Williams and Shaw, 2009), environmental protection (Chen et al., 2001), technology development, and the implications for future employment and work types (Pratt, 2009) all play a role as drivers for land use changes. Although these drivers for land use shifts and specific land use practices vary greatly worldwide, the final consequences are generally the same: they inevitably satisfy immediate human needs at the expense of other environmental goods and services (Foley et al., 2005).

During the past 50 years, 60% of the ecosystem services that previously benefited the population have been degraded, especially those related to land use (Millennium Ecosystem Assessment, 2005). Generally, in the poor and remote mountainous areas, the land resources are often characterized as infertile, having low soil productivity and a poor restoration potential; these characteristics, along with widespread shortages of social insurance, healthcare, and education, make the poor more vulnerable to climate change and land use shifts (Reardon and Vosti, 1995; Smit et al., 2000; Adger et al., 2003). For example, the intensification of agricultural land use provides essential food, timber, and fibers that play dominant roles in reducing poverty in many developing countries (Tilman, 1999). Cavendish (1997) reported evidence that poor

* Corresponding author. Tel.: +86 10 62923557; fax: +86 10 62923557.
E-mail address: bfu@rcees.ac.cn (B. Fu).

0264-8377/$ – see front matter © 2013 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.landusepol.2013.05.004

families rely more on common land resources because they derive a larger share of their income from wild lands and forests than well-off families. Therefore, to some extent, the fate of land resources is closely related to the fate of the poor (Wunder, 2001) due to the influence on energy use (Zulu and Richardson, 2013), income structure (Liu et al., 2008), and livelihood (Gentle and Maraseni, 2012).

As a densely populated country, China faces a severe situation in which it must either defend its valuable land resources or improve people's living standards, especially in the Chinese Loess Plateau area, which contains most of the nation's key impoverished counties (Lin and Ho, 2003; Cao et al., 2009; Wang et al., 2012). Hence, land use and land cover change in the Loess Plateau merit close attention.

The Chinese Loess Plateau is a typical ecologically fragile area that has suffered from austere soil erosion and considerable economic losses for long periods of time. People living there make their living mainly by agriculture. Due to the lack of rainfall and small investments in fertilizer, people have to clear more land, most of which is composed of hill slopes, for crops to support their families (Yang and Li, 2000). This type of land transformation leads to serious land degradation problems (Rozelle et al., 1997; Chen et al., 2001; Wu and Ci, 2002). In response, the Chinese government launched a series of land use policies to improve the environment and economic situation in this region, and these policies greatly changed the land use and land cover (Ding, 2003; Liang et al., 2012). The government spent enormous financial and human resources on one of the world's largest ecological restoration projects: the Grain for Green Project (GGP) (Zhang and Lu, 2002; Liu et al., 2008). This dramatic land use change has attracted considerable attention. Various studies have been carried out, involving the exploration of reliable mathematical methods to simulate soil erosion (Liu et al., 2000; Van Remortel et al., 2001; Essa, 2004); investigation of the dynamics of erosion at different scales (Kang et al., 2001; Yang et al., 2002; Fu et al., 2004, 2005); determination of soil properties and moisture migration processes as well as vegetation succession and ecosystem services (Zheng, 2006; Chang et al., 2012; Liu et al., 2012; Lü et al., 2012); and the farmers' awareness of the policy's effects (Lian et al., 2005; Chen et al., 2006). However, our understanding of the impact that the GGP has had on the livelihoods of farmers and how lifestyle changes have influenced the local environment and social development is incomplete.

Sustainable development cannot only be based on the improvement of food production. It must also involve environmental protection and the development of people's livelihoods (Scherr et al., 2008). Policymakers need to know how people change their needs and interests in relation to environmental changes.

In this paper, we use satellite imagery to map land use changes in Yanchang County following the implementation of the GGP, as well as household surveys and government documentation to quantify the changes in rural people's incomes and in the population structure due to land use changes. Through our narrow focus on people's livelihood, we describe the lifestyles, activities, and needs of the population and provide reasonable suggestions related to the long-term effects of GGP and other conservation programs.

Materials and methods

Description of the study area

Yanchang County (36°13′37″–36°45′20″ N, 109°33′4″–110°29′43″ E) has a total area of 2432.7 km^2 and is located in the lower reaches of the Yanhe watershed, which lies in the middle part of the Loess Plateau in the Northern Shaanxi Province of China. The topography is characterized as a gradually tilted valley-peak pattern, with high altitude in the north and south and low altitude of the intermediate region. From northwest to southeast, the altitudes range from 600 to 1100 m. The Yanhe River winds through Yanchang County from west to east for 144 km and flows into the Yellow River. This area is influenced by semi-arid continental climate with 565.7 mm average annual rainfall, of which 70–80% occurs from June to September in intense rainstorms. Yanchang County is one of the key national poverty counties. Most of the inhabitants are supported by farming on the sloping areas and are limited by the local geographical conditions. The county has 12 towns and 288 administrative villages. The population was 15.5×10^4 in 2010, and the population density was 65 inhabitants/km^2. Highway transport is the leading mode linking the towns and villages of Yanchang County.

As a downstream county of the Yanhe River, Yanchang has suffered severe soil erosion for over half century (Fu and Gulinck, 1994; Fu et al., 2005; Su et al., 2011). To control soil erosion, rehabilitate the degraded land, and ensure the ecological security of the environmentally fragile region, the large-scale Grain for Green Project (GGP) for ecological restoration was launched in 1999 by the Chinese government with a top-down, compulsory approach. By the end of 2011, approximately 286 km^2 of croplands and 227 km^2 of barren mountains in Yanchang County had been converted to forests and grasslands. The vegetation can be divided into two categories: (1) ecological forests with acacia and alfalfa whose ecological value is much greater than their economic value, and (2) economic forests with apple and apricot trees. After more than 10 years of rehabilitation work in Yanchang County, both the environment and the lifestyles of the inhabitants have changed dramatically.

Data sources

In this study, we focused on the land use changes promoted by the top-down GGP. People's livelihoods and local population changes were surveyed for the purpose of identifying the relationship between land use changes, lifestyles, and economic development in the context of the national policy. The land use data were collected from remote sensing-based products (TM-ETM-Cbers-2B). The income sources and dependence of the rural population on natural resources were analyzed based on Yanchang statistical yearbooks and questionnaire surveys. The data from the 1990 to 2008 yearbooks from the Bureau of Statistics in Yanchang County were used to identify the changes in the grain planting area and grain production. A sample of 227 households in 67 villages (23% of the total villages in Yanchang County) was selected and stratified by watershed, topography, and the areas of forests and grasslands restoration using cartographic information for the topography and administrative boundaries. Finally, 221 valid questionnaires were collected. The data collected by the questionnaire surveys and face-to-face interviews were used to determine the sources of income. These data were also used to calculate the residual rural population to assess people's dependence on land resources (Fig. 1). The main objective of this study was to investigate how people's activities and incomes change as a result of the land use shifts under the GGP in Yanchang County.

Methods

Land use changes

LandSat TM images from 1990 and LandSat ETM images from 2000 with 30-m ground resolution were used to extract the land use data for Yanchang County. For the 2008 land use data, we used China–Brazil Earth Resources Satellite (CBERS-2b) images. These images have a 20-m ground resolution and a similar number of spectral bands, as do the LandSat ETM images. Based on the