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Land-use response to drought scenarios and water policy intervention in Lijiang, SW China

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ABSTRACT

As a part of the Asian highlands, Lijiang, in the northwest of Yunnan Province, China, is threatened by climate-induced drought and an increasing water demand by tourism development. Understanding local farmers' land-use options in response to drought and policy intervention is crucial for future adaptation strategies. We assessed farmers' land-use options and the socio-economic factors affecting decisions under drought and water policy scenarios using household surveys. From the total of 174 households surveyed, whether under a drought scenario or a drought scenario with water policy intervention, we found that respondents preferred land-use options focusing on four choices: keep current pattern; keep crops, but reduce areas; abandon farming; rent out farmlands. Findings suggest that there is a growing pattern of agricultural abandonment for urban jobs as a strategy to cope with climate change impacts. The results identified a total of five socio-economic factors that have a significant effect on the households' land-use options. These factors are important for the households' land-use decisions and could prevent people from altering their livelihood strategies. We provide some specific recommendations which could enhance local households' potential adaptation to drought, as well as for effective management of water to prevent potential conflicts in the design or implementation of water policy with the local community.

1. Introduction

Climate change is considered as one of the main environmental problems of the 21st century. According to the Intergovernmental Panel on Climate Change (IPCC), the global average surface temperature has increased by $0.74 \pm 0.18\,^{\circ}C$ in the last century and is projected to increase by another 1.1–6.0 °C in this century (IPCC, 2007a). The latest report of the IPCC establishes that warming of the climate system is unequivocal and will have profound environmental impacts (IPCC, 2013). Global warming and related climate changes are likely to significantly increase the weather-related risks facing human settlements, such as droughts, floods, rainfall variation, and associated economic collapse (Muller, 2007). These changing conditions are expected to affect natural resources and human livelihoods in many regions (Young et al., 2010). In particular, water resources are highly sensitive to climate change for water-dependent communities (Arnell, 2004; Gerten et al., 2007; Miller et al., 1997), which will undoubtedly have adverse effects on crop and livestock productivity (IPCC, 2007b).

The reduced water resource has inevitably resulted in agricultural drought. Indeed, drought has been one of the most widespread and prolonged environmental hazards, and it frequently causes sizeable agricultural losses, especially in less-developed countries with economies that are highly dependent on agriculture (Lei et al.,

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2014). Droughts may cause crop damage, low productivity, and high production costs (Alam et al., 2012), which in turn lead to income loss for farmers, increased poverty levels, and an aggravated seasonal unemployment rate (Hosseini et al., 2009; Keshavarz et al., 2013; Siwar et al., 2009). On the other hand, droughts can also significantly influence governmental policies and provisions of subsidies (Keshavarz and Karami, 2013).

However, drought has been exacerbated not only by climatic factors but also by non-climatic factors, such as rapid increases in the region's population, industries, and urbanization, as well as continuously increasing and unsustainable consumption of ecosystem resources (Siwar et al., 2009). These factors have led to changes in land use and in water resources (Fu and An, 2002; Habiba et al., 2012). Two examples of non-climatic factors are tourism and urban development. This study will address the land-use decision making of the local people under areas of rapid urban development due to tourism and explore local responses to scenarios under drought conditions and government proposed policy to sustain tourism development in the famous landscape of Lijiang, in southwest China. Although there are several definitions of droughts, for this study, we refer to drought as an agricultural drought, which is usually described in terms of crop failure from decline in soil moisture, without any reference to streamflow (Dracup et al., 1980; Palmer, 1965; Rowntree, 1989).

A large body of literature has already documented adaptation of local farmers to drought (Amelung and Nicholls, 2014; Bradshaw et al., 2004; Deressa et al., 2009; Dessai et al., 2005; Ducrot et al., 2004; Hageback et al., 2005; Hisali et al., 2011; Liu et al., 2008; Maddison, 2007; Malanson et al., 2014; Nhemachena and Hassan, 2007; Paavola, 2008; Reidsma et al., 2010; Siebert et al., 2006; Zheng and Byg, 2014). These studies report that local farmers can positively adjust their adaptation to drought conditions, such as through the use of new crop varieties and livestock species, changing planting dates, diversifying from farm to non-farm activity, and increasing the use of water and soil conservation techniques (Bryant et al., 2000; Dercon, 2002; Ellis, 1998; Ellis and Allison, 2004; Malchow-Møller and Thorsen, 2005; Zheng et al., 2014). Other studies have identified local environmental factors associated with land-use decisions, such as topography, climate, and soils that constrain land-use decisions in a particular place, as well as species that control ecological processes disproportionate to their abundance (Antle, 1996; Beratan, 2007; Gorton et al., 2008; Keshavarz and Karami, 2013; Lambin and Geist, 2003; Lambin et al., 2001; Osbahr et al., 2008; Rounsevell et al., 1999; Siebert et al., 2006; Willock et al., 1999). Villamor et al. (2011) identified factors of a landscape mosaic, among these are differences in space (i.e., land suitability for various land-use options under variable or changing climate conditions, even while the heterogeneous nature of topography creates complex spatial patterns), differences in resource endowment (i.e., with the land/labour ratio of the household interacting with its financial capital, effective discount rates for financial investment, and the cost of hired labour), and differences in cultural preferences (i.e., a preference for subsistence food production or traditional techniques, as a form of security, and negative preferences for certain types of work or food). In this paper, through a case study from Lijiang city, we will explore the preferences and other socio-economic factors affecting their decisions to land-use options and understand how they will cope with droughts.

The intention of this paper is to explore prospects for a better understanding of farmers' land-use options in response to drought scenarios and government water policy intervention, through examination of local experiences. It will provide some practical, valuable information and specific recommendations for enhancing local households' potential adaptation to drought, as well as for effective management of water to prevent potential conflicts in the design or implementation of water policy with the local community. The objectives of this study are: (1) to assess the households' land-use preferences under drought scenarios and with policy intervention; (2) to compare the differences in land-use options between drought scenario and with policy intervention so as to explore how the farmers' land-use decisions change under government-led policy intervention; and (3) to identify the factors influencing land-use decision making under these scenarios.

2. Droughts and water policy intervention in Lijiang city

Lijiang city, located in northwest Yunnan province, is a UNESCO World Heritage Site. It is situated in a subtropical zone influenced by the South Asia/Indian monsoon with mean annual temperature of 12.6 °C and the mean annual precipitation of 967.8 mm (i.e., 94% of which falls from May to October). Winter is relatively dry, which controlled by the winter monsoon of continental origin (Baoying and Yuanqing, 2007). The city has been experiencing rapid urban/rural development, stimulated by tourism. The majority of tourists recognized the Lijiang Ancient Town (LAT) as the most attractive scenic spot in Lijiang city (Ning et al., 2006). Bridges, water veins, and Naxi households have been the three basic features of the LAT landscape (Baoying and Yuanqing, 2007; Zheng and Byg, 2014). The water flowing in the LAT has been an important natural resource based for the tourism industry of Lijiang.

However, the annual precipitation trend in Lijiang is declining (Fig. 1). In 2012, the amount of precipitation has reached the lowest value (i.e., 655 mm but second only to 648 mm recorded in 1983). Translating this precipitation trend to Palmer drought severity index (PDSI) (as a standard indicator for drought) (Palmer, 1965; Palmer, 1968) shows that Lijiang was experiencing periodic mild droughts before 2003 and the dry seasons of 2006, 2007, 2010, and 2012 had reached the extreme drought degree (Fig. 2). Furthermore, according to the data of Lijiang meteorological station, during the three years of severe drought from 2009 to 2012, the average precipitation in each county of Lijiang is 56% less and the temperature is 0.5 °C more than the normal year. This drought event led to drying-up of 10 reservoirs and channel cutoff of 65 rivers, which caused 160 thousand people without adequate drinking and 22 thousand hectares of crops affected (Yang, 2013).

To sustain the tourism development in Lijiang, the local government developed a water transfer policy. The Sanshu River is one of the sources of agricultural water in Baisha Township, and one-third of the water in the Sanshu River has been transferred to the LAT since 2000. In 2007 alone, with the increase of tourism water demand, as well as continued droughts, two-thirds of the local agricultural water from the Sanshu River was transferred to the LAT. Currently, all water in the Sanshu River is being transferred to support the LAT. The farmlands dependent on the Sanshu River for irrigation have been affected by this policy and some were abandoned. To compensate, all affected local households were provided a monthly subsidy of $19 (120 RMB) per person paid by the local government. This kind of compensation was implemented in five villages, namely Baisha, Xinshan, Mudu, Yuhu, and Wenhua villages (see Fig. 4). The Wenhai Lake in Wenhai village has been extended for storing more water to transfer to the LAT and an annual $355 (2200 RMB) subsidy for each person was paid for those households whose farmlands were normally irrigated by the lake. However, there is not a special subsidy for the water transferring in Wenhai village. Since the waters in Wenhai Lake were transferred to LAT for the use of tourism water, the Wenhai village and the previously stated villages together were considered to be affected by the policy. Only Wenping village (of the total seven villages) was not part of the said policy due to already insufficient water for domestic water demand during the dry season.