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Public-private partnership in enhancing farmers' adaptation to drought: Insights from the Lujiang Flatland in the Nu River (Upper Salween) valley, China

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ABSTRACT

Agriculture is an important type of land use but suffers from drought, especially under global climate change scenarios. Although government is a major actor in helping farmers to adapt to drought, lack of funds has constrained its efforts. Public-Private Partnership (PPP) mechanism has been widely applied in urban infrastructure development to raise fund for public goods and services, but very few studies explored its role in rural areas. Based on interview of 139 farming households and open-ended interview of village heads, government officials and company representatives, in the Lujiang Flatland in the Nu River (Upper Salween) Valley, Southwest China, this paper aims to reveal how PPP functions to enhance farmers' adaptation to drought. We found that farmers have developed multiple strategies in their own ways to adapt to drought, including pumping and store water, using water-saving irrigation techniques, changing of crops, and strengthening water management at the community level, while insufficient funds, water resource scarcity and mismatch of time-scale of crop growth and drought even hindered their adaptation options. Limited fund sources, gap in policy implementation and weak performance of government-funded projects hindered governmental supports to be effective. Weak motivation and distrusted by farmers limited the engagement of private enterprises in supporting farmers to adapt to drought. PPP mechanism has the potential to mobilize fund from multiple sources, share costs, risks and benefits among different stakeholders, combine both scientific and local knowledge, and reduce uncertainty through formal and informal institutions. Benefited from these advantages, PPP mechanism could improve project performance, thus increase farmers' adaptation options and resilience to drought. This study offers referential lessons and valuable insights for agricultural development, especially for mountain communities vulnerable to exceptional and recurrent drought episodes under warming climate.

1. Introduction

Agriculture is an important type of land use as it provides food to humankind. Sustainable agriculture development is vital to food security. In many regions, agricultural production is adversely affected by climate-related disasters, with droughts and floods being the top-two disasters (FAO, 2015). An FAO study estimated that, between 2003 and 2013, some 25% of the total economic impact of climate-related disasters in developing countries was felt in agriculture; when only drought is considered, the share rises to 84% (FAO, 2015). Under global climate change scenarios, drought is projected to become more frequent and increasingly severe, posing a major threat to climate sensitive economic sectors, specifically agriculture (Mishra and Singh, 2010).Therefore, improving farmers' adaptability to drought is an important component to agricultural development.

Governments always play a major role in building and improving farmers' adaptation to climate change and variability (Chen et al., 2014). However, local government's financial support to water infrastructure become increasingly insufficient to close the expanding gap considering the wide-spread drought, especially in mountainous area where the agriculture sector is vulnerable and governments usually have limited financial resources for public infrastructures. Therefore, there is an urgent need to engage new sources of expertise and capital to minimize the infrastructure deficit and enhance the capacity of local communities to deal with drought (Chou et al., 2012).

The concept of Public-Private Partnership (PPP) refers to the quality

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infrastructure facilities and services provided based on a long-term contractual arrangement between public and private actors (Zhang et al., 2015). It is an important component of the New Public Management theory, and could supplement the government investment in providing public services (Lane, 2000). This strategy has been widely applied to resolve the conflicts between government monopoly and insufficient infrastructure worldwide, including in China (Chan et al., 2011). The State Council of China newly passed the draft of Farmland Water Conservancy Regulations to stimulate the involvement of social capitals (The State Council Information Office of the People's Republic of China, 2016). However, there are very few PPP cases of public facilities and services in rural areas that are reported, and the role of PPP project in enhancing adaptation to drought is still in the dearth of published information.

Yunnan Province, a typical mountainous region in Southwest China, had suffered from severe and sustained droughts during 2009–2010 (Yang et al., 2012; Zhang et al., 2012). Millions of rural residents were threatened with domestic and irrigation water shortage due to significant below-normal precipitation over an extended period. The impacts on agricultural sector ranged from marginal decreases in yield to widespread crop failure.

Based on a case study in middle Nu river (the upper reach of Salween) valley of China's Yunnan Province, this paper discusses how PPP mechanism could help to improve farmers' adaptation ability to drought. It first briefly introduced the background of the study in Section 1 and 2, describes the study area and detail methodology employed in this case. Section 3 highlights the adaptation efforts of farmers, and the contributions of governments and private enterprises in the process, and two typical cases of PPP project under drought adaptation. Section 4 discusses the limitations of separate adaptation and how PPP projects are of potential to fill the gaps. Section 5 is the conclusion that outlines the major findings. Although the study was carried out at a local scale, it offers referential lessons and valuable insights for other rural areas, especially mountain communities vulnerable to exceptional and recurrent drought episodes under warming climate.

2. Materials and methods

2.1. Study area

The case study focuses on the Lujiang Flatland (LJF) in Baoshan Municipality of Western Yunnan, China. This area is consisted of low and flat lands in the alluvial valley of middle Nu River with altitude ranging from 640 to 1400 m (Fig. 1). Local climate is characterized as dry and hot according to the significantly lower average annual precipitation (746 mm), higher average annual temperature (21.3 °C) and higher average annual evaporation (2101 mm) comparing to surrounding areas (Yunnan Meteorological Bureau, 1982). Most of rainfalls concentrated in summer, leading to obvious seasonal variability in water availability. Favored by local agro-climatic resources, LJF has built its reputation for high production and intensive cultivation of tropical cash crops like coffee, off-season vegetables, sugarcane and tobacco. Its coffee production reaches 70% of the total output of Yunnan, marking itself as one of the largest coffee seed bases nationwide. Multiple ethnic groups live here including Han, Dai, Yi, etc. and Han people make more than 90% of the total population. Crops were planted throughout a year. Farmers' depended on rainfall and rivers for irrigation in summer and autumn, and reservoirs, rivers, tanks in winter and spring. Recent cross-seasonal droughts and severe intra-season dry spells present great challenges to households and community livelihoods in the LJF. Farmers adapted to drought through various approaches, with different degree of success. PPP projects in pumping station construction and operation, which are important approach for farmers to adapt to drought, emerged in recent five years in this area.

2.2. Research methodology

This study is based on household interview and key informant interview. Household interviews were carried out from middle to late September 2014 in LJF to learn about farmers' approaches to cope with drought and the advantages and limitations of each approach. Eight representative villages situated in the core area of LJF along both banks of the Nu River were selected for household interview (Fig. 1; Table 1). This settlement pattern is representative to the dominant natural conditions in the study area, as the west bank normally receives more rainfalls than the east due to the dominant influence of the southwest monsoon. Most villages are located on relatively flat land except the Baihua village, which is on the south where hilly terrain. In each village, around 15 households were selected randomly for household interview. One adult member of each household was interviewed following a questionnaire. In total, 139 households were interviewed. As some respondents failed to give clear answers to certain questions, the number of valid samples was provided for each question in the results, as represented by the letter "n".

The designs of the PPP projects varied and are also with varied degree of success. As this paper is focus on the potential advantages of PPP in improving farmers' ability to adapt to drought, we focused on two projects which are relative more successful than others to do detailed research. Key informant interviews were carried out in September 2014 and October of 2016 with village heads and water managers from the communities, and governmental officials from Agricultural Bureau, Water Affairs Bureau and town administration, as well as businessmen from companies involved in the PPP projects. Open-ended interview methods were used to collect information about the background, implementation, operation, and performances of the PPP projects.

Fieldwork data from household interview were analyzed in Microsoft Excel 2010 and figured in OriginPro 9.0.0 for quantitatively concluding farmers' participation. Typed notes and observations were carefully reviewed and edited, and content-based data from the notes were entered into Excel sheets for extraction to derive major analytical materials and reference baselines.

3. Results

3.1. Farmers' responses to drought

Farmers in the study area adapt to drought through multiple strategies, mainly including storing water, pumping water, adopting sprinkler irrigation technique, changing crops, buying agricultural insurance and strengthening water management at community level.

3.1.1. Storing water

Reservoirs, ponds and cellars are the most common approaches local people used to balance the seasonal variability of water supply. Famers build cellars and pools near their fields to store water for irrigation, fertilizing and spraying pesticide. 62% (n = 138) of households owned pools and 14% (n = 138) of households had cellars. The volume of pools and cellars ranged from 20 m3 to 80 m3. Costs of building a cellar or pond ranged from 800 US$ to 3 200 US$ (1 US$ = 6.25 Chinese yuan in year 2014), depending on land surface and distance to roads. Besides, there were ponds in three villages, which were collectively or privately owned. Water-storing facilitates could store water for dry periods and provide convenient water sources. As ponds and cellars are besides their fields, famers don't needs to pump water or channel water from distant canals. But still, this approach shows some weakness, include: (1) the volumes is small and stored water is not enough for irrigation during drought. (2) Depending on rainfall or rivers for recharging, thus if there's continuous drought, the ponds and cellars will be useless as there's no water sources. For example, there were four ponds in the Daojie Village, and two of them had dry-up in 2014. (3)