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Impacts of protected areas on local livelihoods: Evidence of giant panda biosphere reserves in Sichuan Province, China

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ABSTRACT

Given the debates about whether Protected Areas (PAs) exacerbate local poverty or might contribute to poverty alleviation, there is a critical need for evidence to examine the impacts. In this study, we have conducted a household investigation of 560 rural households in 7 PAs of Sichuan province of China. We used matching method to value impacts of PAs on local livelihoods. The results showed that compared to the Average Treatment Effect, the results of traditional regression model exaggerate the negative impacts of the PAs. However, we should notice that the overall impact of PAs on local household wealth was still negative. Households inside the PAs had more Non-timber Forest Products gathering income and compensation, but fewer crop production income and forestry income. Better conservation policies need to be initiated to realize the harmonious and concurrent development of ecological objectives and livelihood objectives.

1. Introduction

Over 100,000 protected areas (PAs) comprise more than 12% of the world's land area (Nelson and Chomitz, 2011). PAs constitute the most important protection mode, and their function in biodiversity conservation and ecosystem services has been widely recognized (Balmford et al., 2002; Wang, 2014); however, the effect of PAs on local livelihoods and poverty reduction (be it positive or potentially negative) is debatable (Adams and Hutton, 2007; Roe, 2008; Clements et al., 2014).

In developing countries, pressures on natural resources are growing in line with growing human populations (Hackel, 1999; Kideghesho et al., 2005). Increasingly, the establishment of PAs is being adopted as the most feasible strategy in alleviating undesirable effects induced by those pressures (Kideghesho et al., 2007). China established its first PA[1] in 1956. During the 1956–1984 period, 274 PAs were set aside by the Ministry of Forestry (now the State Forestry Administration) to protect rare wildlife (such as the giant panda) and endemic primary forests (Wang et al., 2004). PAs were managed mainly through logging and hunting bans until 1994, when the first PA regulations—namely, the Regulations of the People's Republic of China on Nature Reserves (State Council of PRC, 2005)—were enacted. Between the late 1990s to the early 21st century, both the number and total area of PAs in China increased rapidly. As of the end of 2015, the Chinese government had established 2729 PAs that constituted 15.31% of the national territorial area, effectively protecting 90% of the terrestrial ecosystem, 85% of the wildlife population, and 65% of the advanced plant communities (Ministry of Environmental Protection of PRC, 2016; Zhang et al., 2017).

Although PAs in China have achieved great success in terms of biodiversity conservation, the effectiveness of PAs is largely threatened by local development. Most communities inside PAs tend to have low-quality traffic conditions, poor infrastructure construction, less autonomy in family production decisions, and low economic development levels; as such, the issue of local livelihoods within conservation areas should not be neglected (Nepal and Spiteri, 2011). In China, there tends to be great overlap between high-poverty areas and PAs (Liu et al., 2009): of 592 national poverty-stricken counties, 496 (84%) are located in mountainous areas in which PAs have also been established (Wang, 2014). In the early days of conservation efforts, local communities were considered threats to conservation; however, there is now widespread acceptance that conservation policy should, at least, do no harm, and wherever possible should contribute to poverty alleviation (CBD, 2008). Therefore, evaluating the impacts of PAs on local livelihoods is useful to ensuring that PA interventions do not negatively affect local

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[1] Protected areas (PAs) in this paper refers to nature reserves. Nature reserve is a clearly defined geographical space established to achieve long-term conservation of typical natural ecosystems, valuable and rare wild animals and plants, and nature relics with special significance. Nature reserves in China are divided into national level and local level (provincial level, urban level and county level). When it comes to the generalized concept, PAs also includes nature mini-reserves, national parks, forest parks, wetland parks, geo parks, scenic areas and nature relics, which are not considered in this study.

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citizens.

As China's unique endangered species and flagship species of biodiversity conservation, the giant panda (*Ailuropoda melanoleuca*)—as well its protection—has received substantial attention from the Chinese government. The Chinese government built a giant panda conservation network in Sichuan, Shaanxi, and Gansu provinces, and apart from the Chinese government, many nongovernment organizations and companies have also invested considerably in giant panda conservation (Kong et al., 2017). As of 2015, there were 67 giant panda PAs that comprised 3.36 million km^2. Giant panda conservation practices have garnered great success: as of 2014, the number of total wild giant pandas was 1864, increased by 67.32% from the second national giant panda survey conducted in 1988. However, local livelihoods around the giant panda PAs remain low. Min mountain, Liang mountain, and Qin mountain, all of which are sites of giant panda PAs, have high concentrations of poor areas (Zheng et al., 2012). Hence, it is necessary to evaluate the effect of establishing giant panda PAs on local livelihoods.

Research on the effects of PAs on local livelihoods has received great attention. It is commonly thought that local communities can benefit from PAs, from the collection of fuel wood, forest products, and wild plants; in these ways, PAs may provide alternative pathways out of poverty, through employment and business opportunities (Wunder, 2001; Coad et al., 2008; Sandbrook, 2010). Local residents also face many costs and constraints as a result of PA establishment, such as restrictions on traditional resources, increased crop damage inflicted by wild animals, and the deprivation and occupation of community lands (Lusigi and Glaser, 1984; Naidoo and Ricketts, 2006; Clements et al., 2014).

Previous studies provide an excellent foundation for the research reported here, although those studies have some limitations that require further analysis. First, most of the previous studies that focus on the benefits and costs of PAs to local communities are based on qualitative analysis, which cannot give us any clear conclusions regarding the overall effect of PAs on local livelihoods. Whether poverty in PAs is due to the establishment of PAs or other reasons, it is especially true that those areas located in ecologically fragile regions face limited development opportunities (Sims, 2010; Naughton-Treves et al., 2011). Further analysis is needed to adopt various policy appraisal methods, through which we can better understand the relationship between conservation interventions and rural household livelihoods.

Second, many previous appraisal studies used ordinary regression models, which are based on the assumption of individual-level homogeneity. In fact, the distribution of PAs is nonrandom, and this raises the problem of sample selection bias (Heckman and Li, 2004). An accurate way of measuring the income effect of PAs is to compare the income level of the same households before and after the establishment of the PAs, rather than compare income levels inside the PAs to those outside the PAs; the use of this latter method would lead to selection bias (i.e., overestimated or underestimated effects of PAs). We used matching methods to simulate the random experiment process and to estimate the treatment effect, based on the condition that the treatment group and control group are as similar as possible.

Third, previous studies tended to use household income to measure household poverty. However, rural household poverty is a multi-dimensional concept that features social, political, cultural, institutional, and environmental dimensions (Scoones, 1998). In merely using income level to measure poverty, one overlooks the noneconomic dimensions of poverty. In addition, an income indicator is an instantaneous flow concept that cannot precisely reflect household wealth conditions. If poverty can be defined as a "lack of necessities," one approach to poverty assessment would be to poll people on whether or not they possess this set of basic necessities. In China, one such poll is the *Basic Necessities Survey* (*BNS*). It has been proved that using *BNS* data is a time-saving and relatively accurate way of measuring and analyzing household-level poverty.

The objectives of this study are to address the impacts of PAs on household livelihoods. Specifically, three questions are examined. 1) What factors affect rural household poverty and income levels? 2) What is the overall effect of the PAs on the rural household poverty level and their livelihood strategy? 3) Compared to the control group, what is the effect of the PAs on rural household livelihoods? To address these questions, a survey of 560 households was conducted in seven PAs in Sichuan province, China.

2. Study area

Sichuan province is home to the majority of wild giant pandas. There are 10.85 million population lived in 870 counties which all distributed giant panda habitat. The distribution area of giant panda have such characteristics: 1) less cropland area, abundant forestland area and high forest coverage rate; 2) low population density, high population natural growth rate, and large population of ethnic minorities; 3) low fiscal revenue, low per capita income, and large gap between per capita income (Sichuan Forestry Department, 2015).

As of 2014, there were 46 giant panda PAs in Sichuan province, of which 15 were national PAs and 20 were provincial PAs. The total habitat area of giant panda PAs is 997,804 km^2. We chose 7 typical giant panda PAs as the study area (more details about 7 targeted PAs can be seen in Appendix A). The terrain of these seven PAs varies, owing to their different latitudes and altitudes. Daxiangling, Yele, and Wawushan are located in the transition area between the Sichuan Basin and the Tibetan Plateau; this area is characterized as an alpine and gorge region. Wolong, Xiaozhaizigou, Tangjiahe, and Wanglang are in the northwest of the Sichuan Basin, which is characterized by basins, mountain, and uneven terrain. All seven PAs contain abundant forest resources, with a forest coverage rate ranging from 58% to 87%; however, there is much diversity among them in terms of geographical location, quality of forest resources, and level of local development. In terms of local economy, Wolong and Tangjiahe are richer than the other five PAs, mainly because of eco-tourism.

As the PAs were established after the villages were, all the PAs contain villages. Most of the village residents who lived in the core zone[2] and buffer zone were resettled outside the PAs or in experimental zones, with the help of local government and PA authorities. The population in these seven PAs predominantly comprises ethnic minorities—including the Zang, Yi, Qiang, Hui, Man, Meng, and other ethnic groups—with the remainder being ethnic Han.

Land clearance, the harvesting of timber for sale inside the PA, and trade in emphatically protected wildlife are illegal according to Chinese law (Huang and Hu, 2007); hence, residents face constraints in natural resource use, to some extent. Meanwhile, some PA authorities have also organized skills training or development projects that aim not only to improve and diversify household income, but also to alleviate the pressures that accompany natural resource reliance (Liu et al., 2009) (Fig. 1).

3. Methods

3.1. Data collection

Our research group carried out data collection in February and June 2015. So-called rapid rural appraisals and a household survey were carried out in the study area. Samples were selected using multi-stage and cluster sampling. First, based on the specific natural environment required to conduct the research, seven PAs were chosen from the Sichuan province. We ranked the villages according to the per capita

[2] PAs in China are divided into 3 parts: core zone, buffer zone and experimental zone according to Chinese law. Core zone is forbidden for anyone access, buffer zone are allowed for scientific observation, and experimental zone are allowed for scientific experiment, teaching practice, eco-tourism and livelihoods activities.