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Ecological compensation for hydropower resettlement in a reservoir wetland based on welfare change in Tibet, China

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ABSTRACT

The ecological compensation for hydropower development should internalize the exterior costs of losses to both humans and the environment from hydropower projects and their associated resettlement projects in a reservoir wetland. However, the externalities from the resettlement are rarely considered in current compensation policies or regulations, and thus many new environmental issues arise in the reservoir wetland region. In this context, an ecological compensation accounting method for hydropower resettlement was established in this study based on human welfare change. Within it, the preferences of respondents for environmental, social, and cultural attributes can be identified and evaluated through an integration of a choice experiment with a random utility model. Thus, the ecological compensation standard for hydropower resettlement could be determined, while various compensation schemes can be considered for the wetland region in accordance with the preferences of re-settlers. With a case study of the Pondo hydropower resettlement project in Tibet, China, the results showed the utility of the respondents for a single attribute ranged from 43.08 to 127.69 CNY, with the sequence of importance being natural environment, religious practice, and social relationships. Accordingly, the ecological compensation standard for the Pondo hydropower resettlement would be set in the range of 90–127.69 CNY per year, per family. Comprehensive environmental, social, and cultural compensation should be considered to improve human welfare and ecological service function in the Pondo reservoir wetland region.

1. Introduction

Hydropower resettlement is a key part of the ecological engineering project associated with hydropower development, although the potential eco-environmental impact is generally ignored by stakeholders. Mitsch and Jørgensen (2003) defined ecological engineering as a "design of sustainable ecosystems that integrate human society with its natural environment for the benefit of both". From this perspective, the sustainable development of a resettled area in the reservoir wetland region, in terms of both the ecological environment and human welfare, should be taken into consideration in the hydropower resettlement project.

Many ecological engineering approaches are taken to mitigate the adverse impacts from hydropower projects (Scruton et al., 2005; Richter and Thomas, 2007; Cai et al., 2011; Zhao et al., 2013). In contrast, the many subsequent social issues resulting from the enforced migration have rarely been solved (Tilt et al., 2009; Kibler and Tullos, 2013), and have even caused new environmental problems, which can be considered to be the secondary impacts of hydropower projects (Cernea, 2003; Egre and Senecal, 2003; Tan and Yao, 2006).

Ecological compensation is a management method to protect the ecological environment and improve ecological service function (Dobbs and Pretty, 2008; Barton et al., 2009), and can be also considered as a kind of ecological engineering from an economics perspective. Following hydropower developments in recent years, the ecological compensation for the direct ecological losses caused by the hydropower projects have been established by some form of payment for ecosystem or environmental services (PES) projects (Rojas and Aylward, 2002; Muñoz-Piña et al., 2008; Yu et al., 2016; Yu and Xu, 2016). The resettlement was also made some compensation available to people affected by hydropower development, either through the expression of laws or by inclusion in their environmental impact assessment process (State Council, 2006). However, there is no related countermeasure for mitigating the indirect ecological impacts generated from hydropower resettlement, as shown in Fig. 1. The insufficient ecological protection is not conducive to the development of the whole reservoir region,

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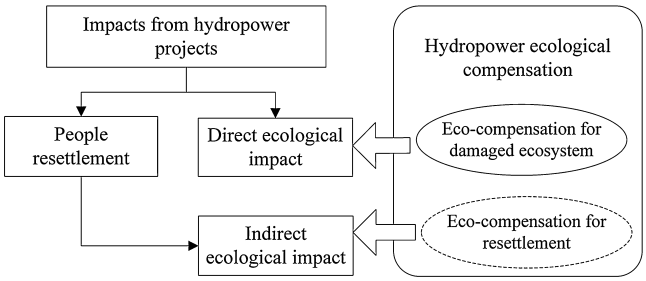

Fig. 1. The impacts of hydropower development and the related countermeasures. The figure shows the impacts of hydropower projects and the required countermeasures. In this figure, the solid line indicates the existing compensation, and the dashed line indicates compensation that is not yet established. The hydropower ecological compensation should include the eco-compensation for damaged ecosystems to mitigate the direct ecological impact from hydropower projects and eco-compensation for resettlement to mitigate the indirect ecological impacts from forced resettlement.

including the newly-created reservoir wetland and the resettled people within the reservoir region. Thus, the purpose of this study was to establish an ecological compensation accounting method for hydropower resettlement. It aims to internalize the exterior cost of loss to resettled people from the resettlement and stimulate them to protect local eco-environment.

In this resettlement ecological compensation, the public preference of re-settlers should be brought into the resettlement ecological compensation system to make hydropower resettlement more ecological. Just as Cernea (2008) reported, resettlement policies should meet the demands of re-settlers to ensure that people are resettled sustainably.

In recent years, the contingent valuation method (CVM) and choice experiment (CE) have been used to identify a stakeholder's preference (Cai et al., 2009; Kataria, 2009; Yu and Xu, 2013; Xu et al., 2014). The CVM is used to directly elicit a stakeholder's preference by expressing their willingness to pay (WTP) or accept (WTA), while the CE is grounded in random utility, which requires respondents to make choices from a series of alternatives (Hanley et al., 1998; Carson, 2000). Individual preferences regarding these environmental non-market tradeoffs are not always straightforward; thus, using the CE to explore the role of both financial and non-market variables in individual preferences is the better approach (Richardson et al., 2013). Through the choice experiment design, the decision making problem can be typically solved through optimization techniques (Soufiani et al., 2013). The random utility model has been popular in measuring welfare changes among a set of mutually exclusive alternatives. Through it, the choice making problem can be transferred as the utility comparison issue. Thus, the maximum utility can be used to represent the individual optimal choice, and a more behaviorally realistic representation of the choice process, a better understanding of behavior and valuable information can be obtained (Leggett, 2002; Walker and Ben-Akiva, 2002). Nowadays, the CE approach could also be used as a tool in environmental policy-making, such as for land-use decisions in the U.S., European countries, and land ecological compensation in China, but was rarely applied in hydropower ecological compensation (Boyle and Özdemir, 2009; Han et al., 2008; Kataria, 2009; Ma et al., 2012; Jin et al., 2013). In this study, we tried to bring the random utility theory into the ecological compensation policy-making in the resettled area.

With a case study of the Pondo hydropower project in Tibet, China, a new ecological compensation accounting method for hydropower resettlement was established based on the human welfare change, which can be identified by CE and the random utility model. It can be used for the determination of ecological compensation standards and the selection of various compensation schemes in the reservoir wetland region.

Table 1
The planned hydropower resettlement in Pondo reservoir wetland.

Resettled village	Pondo Township				Tanggu Township
	Pondo	Bangdo	Ningbu	Ribu	Jiangdo
3rd–4th year	1137 people (185 households)				
5th year					586 people (86 households)
6th–7th year			453 people (91 households)		

Data source: Pondo hydropower project environmental impact assessment report.

2. Material and methods

2.1. Study site and data collection

Several large hydropower projects are currently under construction in the Lhasa River Basin and the middle reaches of the Yarlung Zangbo River (Zhang et al., 2014). Although Tibet has the highest theoretical potential of hydropower in China, its unique geographical features and special religious culture demand that hydropower developers pay attention to ecological protection. Li et al. (2015) had evaluated the ecological losses from Tibetan hydropower projects at different spatial scales. However, there has been relatively little research on the ecological impact of hydropower resettlement (Zhang et al., 2015). In this context, we selected Pondo hydropower project as a case study, to consider the utility transformation of minority groups during hydropower development. The aim of the study was to establish a method to determine ecological compensation for hydropower resettlement in Tibet, China.

The Pondo hydropower project is the most important control engineering project in the Lhasa River, and has generated a large inundated area and many migrants. The project started in 2008, with a total running time of 7 years. The resettlement work was scheduled to be completed in three phases over 3–5 years, as shown in Table 1. According to its environmental impact assessment report, Pondo reservoir inundated five villages in Pondo and Tanggu Township, and caused about 2176 people to be resettled. Among these, most of the affected people were resettled within the reservoir region, and have experienced difficulties with the living habitat. Thus, the reservoir wetland region selected for this study includes the Pondo reservoir (inundated habitats) and the resettled area within the reservoir region, as shown in Fig. 2.

The resettlement from Pondo and Tanggu Township has been largely completed, with 271 affected households forced to move away. The re-settlers could be divided into two types: rural resettlement for partially affected households (type I) and completely affected households (type II). Pondo village has been totally inundated and its 150 households have been resettled into Dalong, Bangdo, Qiazha, and Barong villages. The affected residents in Ningbu, Jiage, Rubu, and Jiangdo villages were relocated within the local region. A field survey in the eight villages was conducted from 25th July to 5th August, 2014, based on door-to-door interviews. With the help of local village heads, 100 households were interviewed and 92 valid surveys were collected, the results of which are presented in Table 2. Considering the language barrier, the survey questionnaire was translated into Tibetan, and two local translators were also employed to assist the respondents to fill out the questionnaire. Before the survey, the respondents were also told that the survey was anonymously and only used for private academic research, to eliminate their worry and avoid the potential "protest" answers.