Journal of Environmental Management 211 (2018) 306–312

Contents lists available at ScienceDirect

Journal of Environmental Management

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

Research article

Establishment of an eco-compensation fund based on eco-services consumption

Moucheng Liu [a], Lun Yang [a], Qingwen Min [a, b, *]

[a] Institute of Geographic Sciences and Natural Resources Research, CAS, Beijing 100101, China
[b] University of Chinese Academy of Sciences, Beijing 100049, China

ARTICLE INFO

Article history:
Received 7 September 2017
Received in revised form
16 December 2017
Accepted 12 January 2018
Available online 3 February 2018

Keywords:
Eco-compensation fund
Eco-services consumption
Zhang-Cheng eco-region
Beijing-Zhang-Cheng eco-conservation cooperation

ABSTRACT

Eco-compensation is a type of institutional arrangement that uses economic measures to adjust the relationships among stakeholders in order to conserve and/or sustainably use ecosystem services. The externality of the value of ecosystem services is one of the theoretical bases for eco-compensation. Different types of ecosystem services are consumed by people from different regions. Some are consumed by people living where the services originate, while some are carried by rivers, wind, vehicles or other natural or manmade means to other areas. Thus, the flow and consumption of ecosystem services should be seen as the basis for establishing eco-compensation funds. This paper uses satellite images of the Zhang-Cheng area near Beijing in 2013 to discuss how to establish an eco-compensation fund for stakeholders in this area. Firstly, six important types of ecosystem services in the Zhang-Cheng area were identified based on ecological function zoning, and the value of these ecosystem services was calculated based on ecological pricing methods. Secondly, the field intensity model from physics was used to analyze where Zhang-Cheng area ecosystem services flowed and calculate how much of these services were used by other areas. Thirdly, based on this analysis and calculation, the paper proposes the rates that different stakeholders should invest in the eco-compensation fund, based on their consumption of eco-services.

1. Introduction

During the 1980s, the Chinese government began efforts to implement an ecological compensation mechanism, hoping to protect eco-environments by adjusting benefits among those who protect and those who damage eco-environments (Wunder et al., 2008). In China, eco-compensation is defined as: a type of institutional arrangement to protect and sustainably use ecosystem services, and to adjust the distribution of costs and benefits between different actors and stakeholders, mainly through economic measures (Liu and Yang, 2012; Liu et al., 2014a; Alexander, 1999). It is similar to payment for ecosystem services (PES) measures.

At present, China has developed a preliminary framework for eco-compensation, a framework that is led by the government and depends mainly on financial transfer payments and subsidies from the central government. It consists of key ecological protection and construction projects, including supporting facilities, undertaken by governments at all levels (Li and Liu, 2010). There has been progress and some accomplishments in the ecological functional zones of forests (Li et al., 2015), grasslands (Gao et al., 2016), wetlands (Zhen et al., 2011), drainage basins and water resources (Yu et al., 2016; Guan et al., 2016), seas and other key zones (Rao et al., 2014) as well as in agriculture (Liu et al., 2014a,b) and other fields. Generally speaking, China's ecological compensation system is still in the initial development stage (Zhang et al., 2010). A comprehensive system and methods have not been yet been developed to determine compensation subjects and objects, compensation standards, compensation methods, funding sources and supervisory measures (Zheng et al., 2013).

Eco-compensation can take several forms (Alexander, 1999). Depending on the compensation method, it can be categorized into types: compensation in cash, compensation in kind, compensation via appropriate policies, and compensation via appropriate technologies and knowledge (Blaine et al., 2005) Depending on the spatial distribution of compensation, it can be either horizontal or vertical (Bandara and Tisdell, 2005); and depending on spatial size,

* Corresponding author. Institute of Geographic Sciences and Natural Resources Research, CAS, Beijing 100101, China.
E-mail address: minqw@igsnrr.ac.cn (Q. Min).

https://doi.org/10.1016/j.jenvman.2018.01.037
0301-4797/

it can be environmental elements compensation, or regional or international compensation (Cuperus et al., 2001). The entities that implement compensation and the operational mechanisms they use are key to determining the chief characteristics of the eco-compensation method. There are generally two types, government compensation and market compensation.

Currently, among the various methods for providing ecological compensation in China's different regions, the most popular way to implement compensation payments is to establish an ecological compensation fund that stakeholders contribute to jointly (Li et al., 2007). For instance, China's first national-level inter-provincial water resource compensation pilot project, the Xin'an River Water Resource Compensation, received CNY 0.3 billion in funding from the central government and CNY 0.1 billion each from the provincial governments of Zhejiang and Anhui. However, these investment proportions were based on game playing and the economic capacity of the three parties; a mechanism designed to establish the amounts of funding stakeholders contribute to ecological compensation was not used in this case, nor was there a strong scientific basis for the proportions chosen.

Regarding the consumption of ecosystem services within the area and the "overflow" of services to other areas, the spatial flow of ecosystem services should be the basis for determining the subject, standard calculations, and fund raising (Costanza et al., 1997). Ecosystem services can flow to other areas spatially in various ways and produce dispersal effects (Margaret et al., 2004). Influenced by natural and social factors, the consumption of ecosystem services is distinctively directional and regional (Fisher et al., 2009; Syrbe and Walz, 2012). However, the overflow spans of different types of ecosystem services are not the same (Johnson et al., 2010). For example, the water conservation service is shared by areas along the lower reaches of a river, while the carbon-fixing and oxygen-releasing service is for the entire river basin or even an entire country or the whole world. Moreover, some types of the ecosystem services are consumed by both internal and external consumers (Serna-chavez et al., 2014). For instance, ecosystem services provided by the upper reaches of a river are utilized by internal consumers and shared to even larger areas along the lower reaches of the river.

This paper holds that the proportion of the funding that each stakeholder contributes to an ecological compensation fund should be based on the flow and consumption of ecosystem services. The paper discusses how the proportions stakeholders contributed to the Beijing-Zhang-Cheng Ecological Compensation Fund were based on the inter-regional flow and consumption of different types of ecosystem services.

2. Material and methods

2.1. Studied area

Zhangjiakou city and Chengde city (the Zhang-Cheng area) are located in the northern part of Hebei Province, China, lying within 39°18′-42°37′ N and 113°50′-119°15′ E and having a total area of $7{,}63 \times 10^4$ km^2. The area's elevation descends step by step from northwest to the southeast (Fig. 1).

The Yongding River, the Chaobai River, the Daqing River, the Luan River and inland rivers, all of are part of the Haihe River system and lie within the boundaries of Zhangjiakou city. The Luan River, the three northern rivers (the Chaobai River, the Baihe River, the Jiyun River), the Liaohe River and the Dalin River are within the boundaries of Chengde city. The total volume of water resource reaches 5.497 billion m^3.

This region is located upwind and upstream from the cities of

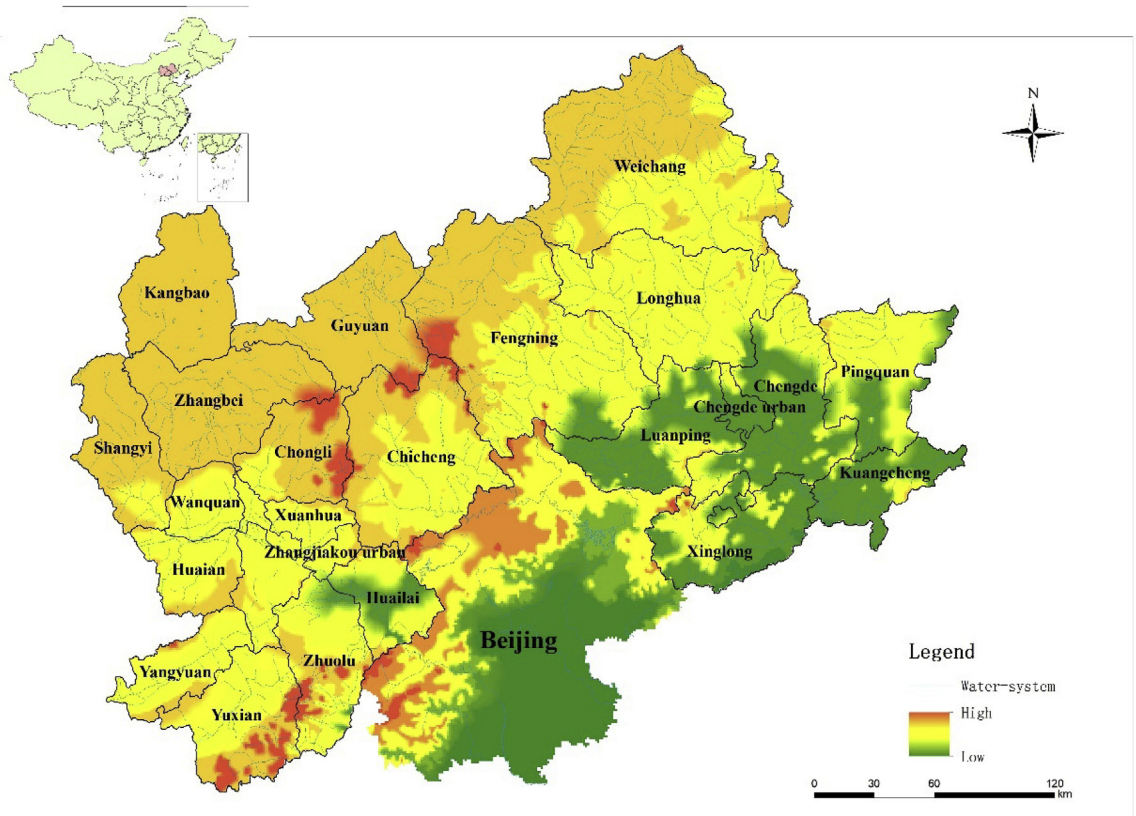

Fig. 1. The Zhang-Cheng area.