Science of the Total Environment 646 (2019) 821–831

Contents lists available at ScienceDirect

Science of the Total Environment

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

Water resource management and public preferences for water ecosystem services: A choice experiment approach for inland river basin management

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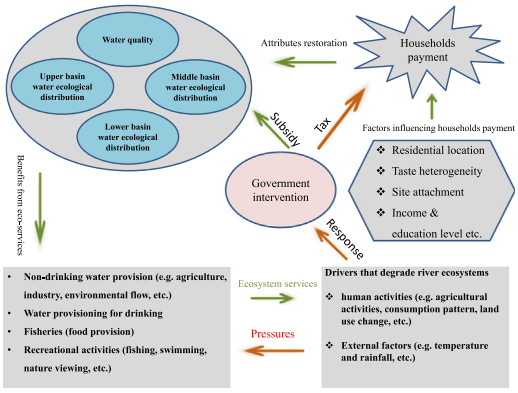
HIGHLIGHTS

- Preference heterogeneity exists among respondents living in different localities of the basin.
- Water quality is the most preferred attribute that derives the highest marginal value.
- Human activities are the major drivers that destroy ecosystem services.
- RPL models had considerably more explanatory power than MNL models.
- Residential location, income and education significantly influence household WTP for improvement.

GRAPHICAL ABSTRACT



ARTICLE INFO

Article history:
Received 6 May 2018
Received in revised form 19 July 2018
Accepted 24 July 2018
Available online 25 July 2018

Editor: R Ludwig

Keywords:
Assessment of river ecosystem
Willingness to pay
Choice experiment
Mixed logit model
Multinomial logit model

ABSTRACT

The concept of ecosystem services provides a valuable approach for linking humans and nature and for supporting the protection of natural ecosystems. River water services, which influence public health and daily routines, have both social and ecological benefits to a surrounding area. However, river networks and their services have suffered extensive destruction due to urbanization and industrialization, especially in China. An assessment of river system benefits and recognition of public preferences are crucial for sustainable river management and effective river system restoration. The objective of this study was to assess a household's willingness to pay using a choice experiment (CE) with mixed logit and multinomial logit models. This technique was applied to evaluate a respondent's preferences regarding water service attributes such as upper basin, middle basin and lower basin ecological water distribution; water quality; and payment and the possible source of heterogeneity in these attributes. The estimated likelihood ratio test demonstrated that random parameter logit model (RPL) models had considerably more explanatory power than multinomial logit (MNL) models. It was also revealed that the RPL-II model was the most powerful among all the models, demonstrating the capability of that model to predict the choices of the respondents. Furthermore, the findings show that water quality was the most preferred river attribute, and households were willing to pay more for the water quality attribute that derives the highest marginal value. Household income level, residential location, education level, and sex were the main factors influencing willingness to pay. These assessments provide guidance, policy recommendations and a reference for researchers and policy makers to improve and enhance current river water services in the future.

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https://doi.org/10.1016/j.scitotenv.2018.07.339
0048-9697/

1. Introduction

Ecosystem services refer to the benefits that people attain from ecosystems (Alcamo, 2003; Grizzetti et al., 2016) and the direct and indirect contributions of ecosystems to human well-being (Kumar, 2012). Ecosystem services are natural assets produced by the environment and utilized by humans (Maltby and Acreman, 2011). They contribute to social and cultural well-being (Fisher et al., 2009) and have high economic value ((Barbier et al., 1997; Georgiou and Turner, 2012). The basic concept of ecosystem services is connecting people to the nature. Ecosystem services demonstrate the key role of ecosystem functioning and biodiversity to support numerous benefits to humans. Understanding the linkages between natural and socioeconomic systems can lead to improved and more sustainable management of ecosystems (Guerry et al., 2015).

Generally, river basins provide a wide range of ecosystem services that are the source of various economic benefits, including products such as timber, medicinal plants and fuelwood, and provide wildlife habitats and spawning grounds (Groot et al., 2002; Knüppe and Knieper, 2016; Rouquette et al., 2011; Sarukhan et al., 2005). Moreover, rivers are considered to be one of the most important pathways for material cycling and provide a wide range of services and functions, such as conservation of biological diversity, flood management, and regulation of climate.

Unfortunately, human activities threaten river networks and cause multiple pressures (Fig. 1), affecting the biodiversity and physical status of rivers that result in decreases in the economic value of a river ecosystem (Grizzetti et al., 2016). Globally, most of the rivers in the biosphere have been altered or nearly destroyed due to human activities and destruction (Mauerhofer et al., 2018; Yuan et al., 2005), which is now a major issue and has become a focus of attention (Allan et al., 1997; Hong et al., 2009; Karr, 1991). Human activities such as industry, farmland irrigation, and residential development have disturbed river ecosystems, water quality, fish passage, bank stability and riparian zones of rivers. The overexploitation of river ecosystem services has created pressures for an ecosystems (Grizzetti et al., 2016).

Increasing concerns about the river health and adverse impacts on river conditions have made it crucial to restore and/or protect current river ecosystems. Restoring ecological conditions at the river level can mitigate human pressures on natural ecosystem of the rivers and promote a healthy ecological environment (Boekhorst et al., 2010; Song et al., 2010). It is broadly acknowledged that it is necessary to expand restoration and management of river attributes from basic water quality improvements to restoration and functioning of ecological systems (Bash and Ryan, 2002; Che et al., 2012a). In terms of ecological goals, the implementation of certain restoration policies is projected to provide considerable environmental benefits (Bateman et al., 2007; Brouwer, 2008).

The Shiyang River has gained public attention due to the increasing stresses being placed on its water resources and the resulting environmental degradation (Khan et al., 2018; Ma et al., 2009). Rapid population growth and economic development have results in excessive water demand for the Shiyang River under critical ecological conditions (Khan et al., 2018). The growing ecological crisis in the region is worsening due to the existing imbalanced distribution of water among the upper, middle and lower basins (Zhao et al., 2015). Consequently, the ecological environment of the basin has been degraded because of the drying of some of its tributaries, which has decreased the area of the river's estuaries. In addition to the water shortage, deforestation and increased desertification are the main environmental issues causing the SRB to be one of the most ecologically degraded and overexploited inland river basins in the country (Danfeng et al., 2006).

With an increase in public concern and regulatory requirements, it is expected that more attention will be given to improving this river network, which will require substantial financial assistance. The assessment and valuation of payments for ecosystem services have become the focus of intensified research by economists, particularly in the field of ecological and environmental economics (Bartczak and Metelska-Szaniawska, 2015). Thus, an assessment of benefits derived from restoring river ecosystems and public support serves as a basis for making an effective decision on river system management.

Several methods can be employed to value ecosystems and the public willingness to pay for the restoration of degraded ecosystems (Nicosia et al., 2014). We apply a spatially explicit choice experiment (stated preference survey) method that estimates the economic values of ecosystem services by asking individuals how much they would be willing to pay to improve ecosystem services (Follain and Jimenez, 1985; Malpezzi, 2008), and this method exclusively allows for the estimation of non-use values (Martinortega et al., 2012). The choice experiment (CE) is based on Lancaster's characteristics theory of value, and random utility theory is becoming more common valuation technique for ecological and environmental research (Lancaster, 1966; Manski,

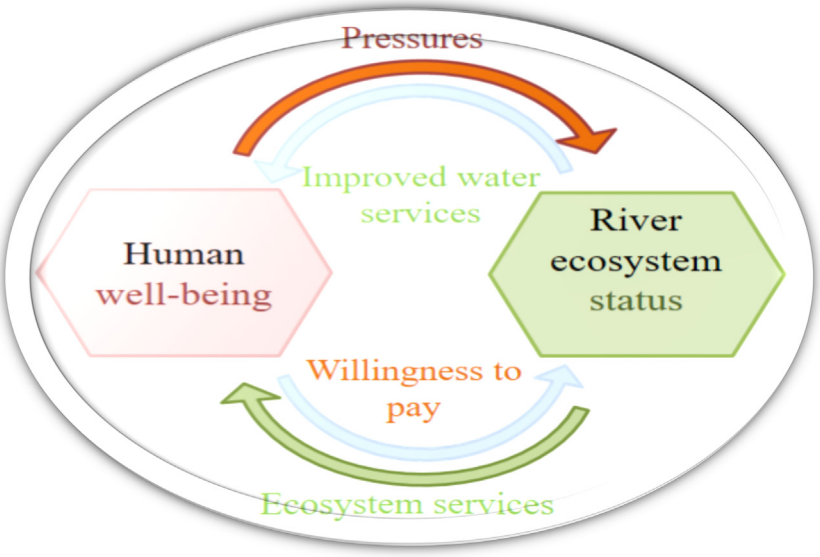

Fig. 1. The linkage between human- well-being and river ecosystems under present and future scenarios.