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Prioritising ecosystem services in Chinese rural and urban communities

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ABSTRACT

Identifying ecosystem services that are important to society can help decision-makers to prioritize specific services for protection. However, ecosystem services may be valued differently by different sections of society. This study sets out an approach for assessing the use and prioritization of freshwater ecosystem services by people in rural and urban areas in China. Face-to-face interviews were conducted with 30 rural and 30 urban respondents in the same region of Shandong province. Respondents were asked about how they used their local river and to prioritize ecosystem services provided by the river. In addition, respondents were asked to state whether they would be prepared to pay to protect their local river. The rural community used more ecosystem services and prioritized them more highly than the urban community; probably because they interacted with them more frequently. The results of this study raise the question of whether there should be different ecosystem services protection goals for rural and urban regions, as well as highlighting potential trade-offs between ecosystem services prioritized by different sections of society.

1. Introduction

The ecosystem services framework combines ecology, economics and sociology into one unified idea and its central goal is to benefit human society (Costanza et al., 2014). It has the potential to bridge the gap between scientific research and policy by promoting increased public participation in environmental decision-making (Diaz et al., 2015). Interactions and trade-offs between ecological processes and functions mean that not all ecosystem services benefits can be delivered simultaneously at the same location and at the same time (Martin-Lopez et al., 2014). Furthermore, managing ecosystems for the delivery of some ecosystem services may alter the provision of other services (Spash, 2015). Such trade-offs require decisions to be made regarding which ecosystem services are prioritized and protected where. However, how should ecosystem services be prioritized and whose prioritization should be used?

Ecosystem valuation can identify ecosystem services that are appreciated by the public and evaluate the cost of ecosystem services loss to current and future generations (Kenter et al., 2015). Valuation helps decision-makers prioritize ecosystem services for protection and encourages them to consider the sustainable use of ecosystem services (Geijzendorffer et al., 2015). Ecosystem valuation should consider both use and non-use values (Corbera, 2015). Market prices can provide measures of use values but other approaches, such as the contingent valuation method, are needed to measure non-use values (Laurila-Pant et al., 2015). The contingent valuation method, which asks respondents for their willingness to pay for ecosystem services, has been widely used in developed countries but less frequently used in developing countries (Donfouet et al., 2015). For instance, the rapid economic development and urbanisation in China poses a major risk to ecosystems and the ecosystem services that they provide and there is an urgent need to identify ecosystem services for protection (Deng et al., 2015). Using contingent valuation to analyse the perspectives of different stakeholders on ecosystem services could provide important information for setting environmental protection goals and help to link scientific research and policy (Liu and Costanza, 2010). However, few ecological studies have used contingent valuation in China because incorporating public opinions into environmental decision making has only been promoted recently (Li et al., 2015).

The perceived value placed on specific ecosystem services is linked to the opinions of stakeholders, defined as “groups or individuals that affect or are affected by ecosystem services” (Suwarno et al., 2016). Stakeholders include different sections of society whose perceived value of ecosystem services can vary. For example, ecosystem values can be affected by an individual's

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disposable income or by their previous encounters with nature (Soga et al., 2015). One important factor that may affect ecosystem interactions is whether an individual lives in a rural or urban community. In general, urban populations live further away from green spaces compared to rural populations and as a result they have fewer interactions with nature (Skandrani et al., 2015). Therefore, urban populations may be less emotionally attached to ecosystems and may consider ecosystem services to be of relatively low value. Although previous studies have explored the values of some urban and rural ecosystem services in China, few studies specifically compare the differences between rural and urban communities (Wang et al., 2013; Zhao et al., 2013; He et al., 2015).

This analysis compares the perceived value of freshwater ecosystem services in rural and urban communities in China. We investigated freshwater ecosystem services because they provide irreplaceable services to benefit human well-being but also suffer from severe anthropogenic threats (Strayer and Dudgeon, 2010). To investigate whether different sections of society differ in their perceived values of freshwater ecosystem services, a questionnaire survey was conducted in a Chinese village and a city situated within the same region. Although the study uses contingent valuation methodology to estimate respondents' perception of ecosystem services, the purpose is to prioritize ecosystem services and not to assign a monetary value to them (Damschroder et al., 2007).

The objectives of this study were to address the following questions:

(1) Do rural and urban communities use and prioritize different freshwater ecosystem services?
(2) Is there a rural and urban divide between whether respondents are prepared to pay or not to save protect local river, and thus a difference between the perceived value of freshwater ecosystem services?

2. Methods

2.1. Study area

The study areas consisted of Dukou village and Fushan district of Yantai city in the northeast of Shandong province, China. Dukou village is 30 km away from Yantai City. There are approximately 250 households in the village (information from the village head) and most inhabitants are farmers. The River Baiyang runs through the village and is connected to the Menlou Reservoir nearby, which supplies drinking water to Yantai. Fushan is one of the four

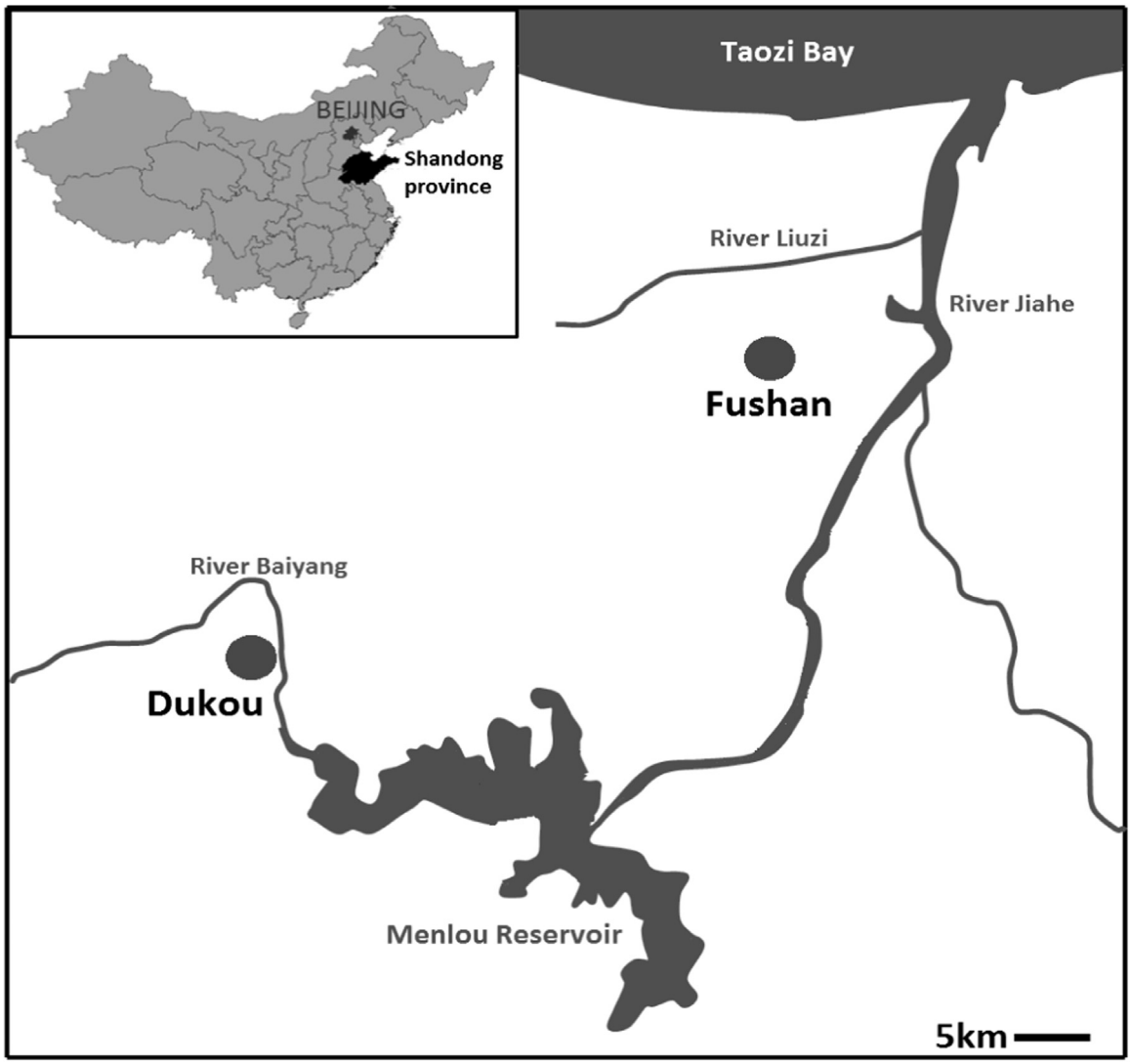

Fig. 1. The position of Shandong province within China (top left) and the position of the study areas.

urban districts in Yantai, with a population of approximately 280,000 people. Two rivers run through Fushan district: River Jiahe, which flows from the Menlou Reservoir, and its tributary River Liuzi (Fig. 1). All urban respondents visited the River Liuzi rather than the River Jiahe as it was closer to them.

2.2. Questionnaire survey

Sixty community-based interviews were conducted by one interviewer, who is a native speaker of Mandarin Chinese, in July 2014: 30 interviews in Dukou and 30 in Fushan. Interviews were only conducted after the respondent consented verbally and respondents were interviewed individually to avoid the influence of others.

In the village, the interviewer started at one end of the main street in the village and knocked on every third household door. One person from each household was interviewed, and this was usually the person who was the decision maker for the household. In the city, every third person encountered by the interviewer was approached in two residential districts. Females and males were approached in equal proportions, but females were generally more willing to answer resulting in a higher proportion of females in the dataset (Table S1). Interviews were conducted over a period of six days, in the morning and the afternoon to allow for temporal differences and reduce potential biases.

The questionnaire was in Chinese (see Supplementary Material for English translation) and respondents were assured of their anonymity. The questionnaire took 25 min and contained sections that asked for the information below:

i) Demographic information: age, gender, education, income.
ii) Interactions and attitudes towards the local river: how frequently they interacted with the local river, which river-related ecosystem services they used and prioritized.
iii) Whether the respondent was prepared to pay to save the local river.

Respondents were asked the hypothetical question:

> "If the local river (River Baiyang in the rural community and River Liuzi in the urban community. All urban respondents visited the River Liuzi as it was closer to them.) will disappear completely in one year's time but the Ministry of Environmental Protection can save the river from disappearing, will you be willing to donate money towards this project? Please take your income and expenditures into account."

The local river disappearing completely represents an extreme case scenario where all ecosystem services provided by the river will disappear. This scenario was chosen because it impacts all respondents, irrespective of which ecosystem services they use. Donation was selected as the payment vehicle because a pilot study demonstrated that some respondents can become angry if the payment vehicle is forced upon them, such as the payment being included in their tax. Respondents felt more comfortable with donation as the payment vehicle.

Respondents were then asked what percentage of their annual income they were willing to donate for the next five years using a bidding amount method, which started at 30% and was lowered to 20%, 10%, 5%, 1% and $<1\%$ respectively. The bidding amount method and the percentage values were selected based on a pilot study where the bidding amount method elicited more responses compared to an open ended question. Percentage income values rather than monetary values were used because this study is not a monetary valuation of ecosystem services (Damschroder et al., 2007). The study aims to compare the perceived value of services by people with very different incomes and therefore a relative measure of values is more appropriate that an absolute measure of value.

Following this hypothetical question, debriefing questions asked why respondents were willing to pay or not. In addition, respondents were asked how confident they felt about their answer and how difficult they thought it was to make the decision. These questions aimed to improve the quality of the study.

Using logistic regression, a generalised linear model (GLM) with a binomial family error was fitted to investigate the factors that affected whether respondents were willing to pay or not. A binomial family error was used because the dependent variable has one dichotomous outcome (yes or no). The maximal model used to predict whether respondents were willing to pay or not to save their local river was fitted first. This included six factors: the place where they lived (rural or urban), did they visit the river, their satisfaction level with local river protection, respondent's age, maximum education level, and gender. The minimally adequate model was selected based on Akaike's information criterion (AIC), where the model with the smallest AIC value was selected. Statistical analysis was carried out in R 3.0.2 (R-Core-Team, 2015).

3. Results and discussion

Rural and urban respondents used and prioritized different ecosystem services. Only rural respondents used the river for washing clothes and to cool down (Fig. 2a). Rivers have a cooling effect on the local microclimate and a temperature difference of 2 °C has been reported between the banks of the Yangtze River and the centre of a community (Ganbo et al., 2011). The average summer temperature in the study area is 28 °C and the lower income of rural respondents (Table S2) meant that they were less likely to purchase air conditioning than urban respondents. Therefore, rural respondents used their local river to cool down. Rural women regularly washed their clothes in the local river. They gave two reasons for this practice: river water is "free" and it is a sociable activity. Apart from China, the importance of social interactions associated with washing clothes in local water bodies has also been reported for rural women in Brazil and Tanzania

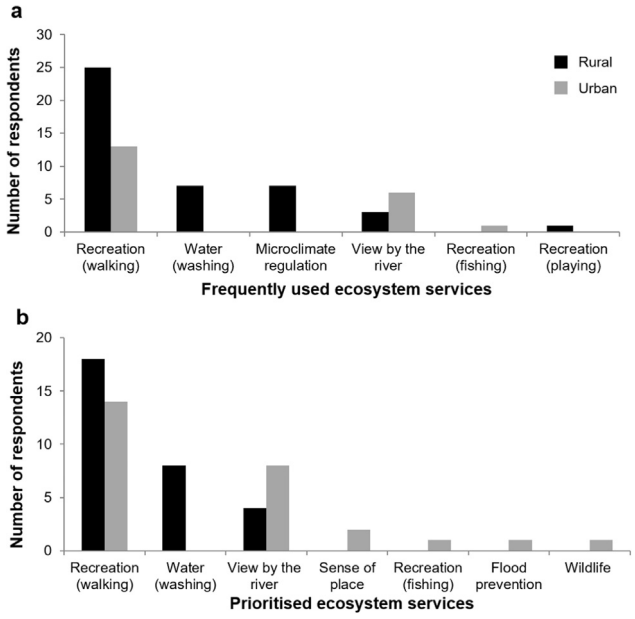

Fig. 2. Most frequently used and prioritized ecosystem services of the local river by rural and urban respondents. Some respondents listed two frequent activities and others listed one.

(Kloos et al., 2006; Mwanga and Lwambo, 2013).

The most popular activity undertaken was walking by the river (Fig. 2a). It was most popular with older respondents in the age group 51–60. A possible reason is that in traditional Chinese culture, water bodies are believed to bring good aura and a source of yin energy (Sun et al., 2015). Similar results were reported for previous studies in China (Shang et al., 2012) and India (Imandoust and Gadam, 2007). Other river-based recreational activities mentioned by respondents were fishing (urban only) and playing (rural only).

Whereas urban respondents prioritized six ecosystem services, rural respondents only prioritized three (Fig. 2b). Urban respondents valued ecosystem services with either direct (recreation and view) or indirect (flood prevention and wildlife) uses, whereas rural respondents only valued services with direct uses (recreation, washing and view). A possible reason is differences in education levels. On average, rural respondents had a higher education level than urban respondents. The maximum education level for the majority of urban respondents was an undergraduate degree (63.3%), whereas the maximum education level for the majority of rural respondents was only secondary school (86.7%). Previous studies have found a positive association between education levels and environmental awareness (Arcury, 1990; Abdul-Wahab and Abdo, 2010), which suggests that respondents with higher education levels (i.e. urban respondents) may be more knowledgeable about the environment, and could recognise a wider range of freshwater ecosystem services.

Rural respondents were more prepared to pay, and to pay proportionally more of their income, to save the local river. Ninety percent of rural respondents were prepared to pay money to save the local river from disappearing compared to only 53.3% of urban respondents. In the minimally adequate model, only 'place' (i.e. whether the respondents were from a rural or urban community) significantly affected whether respondents would pay or not (Tables S3 and S4), with urban respondents significantly less prepared to pay to save their local river than rural respondents ($t=2.86$, $df=59$, $p < 0.01$).

In addition to being more likely to pay to save the river, rural respondents would pay proportionally more of their annual income. The modal amount that rural respondents were prepared to pay was 10% of their annual income, whereas the modal amount for urban respondents was only 1% (Table S5). This may be because rural respondents had a greater physical and emotional connection to the river (Restall and Conrad, 2015). Most rural respondents (86.7%) lived within 10 min walking distance of the river and 65.5% visited the local river daily. In contrast, only 26.7% of urban respondents lived within 10 min walking distance and only 11.8% visited the local river daily (Table S6). Moreover, for urban respondents there was a spatial disconnect between where the ecosystem services were produced and where they are ultimately used (e.g. drinking water brought through pipes). Urban respondents did not physically see the benefits provided by ecosystems whereas rural respondents did.

The current study is concerned with the perceptions of different stakeholders and uses contingent valuation methods to analyse the perceived relative values of ecosystem services (i.e. prioritization approach) rather than to estimate their monetary value. Interestingly, a study of payment for river ecosystem services in Shanghai also found that the mean amount that suburban respondents were willing to pay was higher than that for the urban respondents and this was attributed to the greater river access by suburban respondents (Shang et al., 2012).

The potential existence of a rural-urban divide in the prioritization and perceived value of ecosystem services raises important questions for the setting of environmental protection goals. Whereas both rural and urban respondents prioritized direct recreation uses (walking by and view of the river), only rural respondents prioritized the river as a water source (for washing) and only urban respondents prioritized flood prevention. One way of reducing flooding is to slow the downstream movement of water by increasing connectivity between the river and its upstream floodplain (Ward et al., 1999). Storing water in wetlands may make the river less accessible and reduce its utility for washing clothes, keeping cool or recreation. In this study, the rural population was upstream of the urban population so setting protection goals that prioritized flood prevention in urban areas may reduce the delivery of ecosystem services prioritized by the rural community. Understanding how different stakeholders use and value ecosystem services enables potential trade-offs in ecosystem service delivery to be identified and considered in policy and decision making. This study contributes to the analysis of different stakeholder perspectives on river ecosystem services, which is important for effective river management.

4. Conclusion

Clear differences between the uses and perceived values of ecosystem services between a rural and an urban community in China have been identified. Rural respondents made more frequent use of river-based ecosystem services and more respondents were prepared to pay to protect them. The different prioritization of services by urban and rural communities could result in decisions to protect ecosystem services prioritized by urban communities having an adverse effect on the supply of ecosystem services prioritized by rural communities. In addition, the lower perceived value of ecosystem services by urban respondents may result in lower levels of environmental protection and an impairment of ecosystem services to both urban and rural communities. Although this study is based on a relatively small sample size, and the valuation method used has its limitations, it does illustrate an approach for investigating perceived ecosystem values in different communities in a developing country. Moreover, it has identified a potentially important difference in the prioritization of ecosystem services by different sections of society and raises the question: If decision-makers use public opinions to inform policy, whose ecosystem values should count?

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Appendix A. Supplementary material

Supplementary data associated with this article can be found in the online version at http://dx.doi.org/10.1016/j.ecoser.2016.07.011.

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