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Examining demand for urban river rehabilitation in Indonesia: Insights from a spatially explicit discrete choice experiment

Derek Vollmer[a,b,*], Andrea Nathalie Ryffel[b], Komara Djaja[c], Adrienne Grêt-Regamey[b]

[a] Future Cities Laboratory, Singapore-ETH Centre for Global Environmental Sustainability, 1 CREATE Way, #06-01 CREATE Tower, Singapore 138602, Singapore
[b] Chair of Planning of Landscape and Urban Systems, ETH Zurich, HIL H 51.4, Wolfgang-Pauli-Str. 15, 8093 Zurich, Switzerland
[c] Graduate Program in Urban Studies, University of Indonesia, Pascasarjana UI Building 4th Floor, Salemba Raya 4 Street, Central Jakarta 10430, Indonesia

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ABSTRACT

The demand for urban river rehabilitation can be measured through stated preference surveys such as choice experiments, providing information on the welfare estimates of a particular approach. We deploy such a technique in the context of plans to rehabilitate a major river in Jakarta, Indonesia. The current plan focuses on widening and canalizing the downstream segment of the river within Jakarta's administrative boundary. We hypothesize that residents would demand (and thus be willing to pay for) additional components of an ecological rehabilitation program in the form of riverside park space and upstream forest conservation outside of Jakarta's jurisdiction. We develop a spatially-explicit discrete choice experiment in which households register their preferences for channel widening, park space, forest conservation, and a monthly fee to fund the rehabilitation. Using mixed logit models we find significant and substantial demand for both park space and forest conservation, with a lower bound on the total willingness to pay (WTP) of greater than US $4 million per year for park space and nearly US $6 million per year to support reforestation in the upper catchment. These estimates are based on households within the catchment, but we find that demand did not seem to decay with distance so the upper bound on total WTP could be substantially higher. We also find that household income level has a strong effect on marginal WTP for forest conservation, minimal effect on marginal WTP for park space, and that location along the river influenced WTP for park space and channel widening. This provides further evidence that there is substantial demand for river rehabilitation in developing world cities, and that choice experiments can provide information relevant to land use planning.

1. Introduction

Rivers and riparian areas provide a range of benefits besides water provision, and although urban residents depend on these services, they are coming under increasing pressure, particularly in less developed countries (Vollmer and Grêt-Regamey, 2013). Urban planners and water managers are increasingly employing ecological concepts to rehabilitate riparian areas as complements or even substitutes for engineered structures such as canals, dams, and treatment plants (Pahl-Wostl et al., 2010). River rehabilitation projects are subject to economic efficiency criteria such as benefit-cost analyses, requiring valuation of the diverse benefits of an ecological approach (Hanley et al., 2009), including non-use values such as biodiversity. A variety of stated preference methods exist for environmental valuation, with choice experiments (CE) being particularly well-suited to revealing the structure of a respondent's preferences and realistically representing the multi-attribute characteristics of complex environmental goods (Adamowicz et al., 1994; Hanley et al., 1998; Farber and Griner, 2000; Louviere et al., 2000; Hanley et al., 2001; Hoyos, 2010). CEs are typically administered to a sample of the population to derive marginal utility estimates for the attributes of a hypothetical project or program. The marginal utility estimates can then be converted into marginal willingness-to-pay (WTP) estimates for a change in the level of a specific attribute.

Aggregation of WTP values for each attribute specified for the good or service under investigation is commonly done in order to inform policy, but WTP values for environmental goods tend to display heterogeneity among individuals (based on personal

* Corresponding author. Current address: Betty and Gordon Moore Center for Science, Conservation International, 2011 Crystal Dr. Ste. 500, Arlington, Virginia, 22202, United States.
E-mail address: dvollmer@conservation.org (D. Vollmer).

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preferences) and spatial heterogeneity (based on individuals' geographic location) (Brouwer et al., 2010). Analyzing heterogeneity is important in order to reduce bias in the parameter estimates (Hensher and Greene, 2003), but it may also offer insight into how individuals' characteristics affect WTP and, by extension, equity considerations (Birol et al., 2006). Spatial heterogeneity is also an important characteristic of WTP because it can determine the economic jurisdiction of an environmental good (Bateman et al., 2006; Bateman et al., 2002). Proximity to rivers has consistently been shown to positively influence WTP for rehabilitation (Zander et al., 2010; Upton et al., 2012; Vecchiato and Tempesta, 2012; Brouwer et al., 2010). This is often estimated as a distance decay effect—individuals residing further from an environmental good place less value on that good, particularly if it has a use value (Bateman et al., 2006). Yet the results of distance decay effects in CEs on environmental goods have been mixed. Distance decay functions varied according to the type of use for the same good (Hanley et al., 2003; Martín-López et al., 2007), and some studies even found that WTP increased with distance (Zander et al., 2013, 2014). The reasons for this variation include the availability of substitutes, use versus non-use values, and the resource system in question, and so examining the distance decay effect is worthwhile to conceptualize who is benefiting (Hanley et al., 2003). Spatial heterogeneity can also exhibit patchiness or clustering that may go undetected through a global analysis such as a distance decay variable (Schaafsma et al., 2012; Johnston and Ramachandran, 2014).

There is an increasing body of WTP studies from developing countries that address issues related to river and wetland conservation (Rashid et al., 2007; Do and Bennett, 2009, Birol and Das, 2010; Ndunda and Mungatana, 2013; Wang et al., 2013; Kaffashi et al., 2013; Urama and Hodge, 2006). These and similar studies demonstrate a positive, albeit in most cases modest WTP for public environmental goods, and many of the studies conclude that the estimated WTP was sufficient to justify proposed interventions. However, there is still a lack of studies that evaluate the spatial dynamics of these preferences, information that is critical if evidence of a positive WTP is to be translated into an equitable policy, particularly in countries such as Indonesia where rivers are under tremendous pressure from urbanization. Moreover, household income is often positively correlated with WTP for ecosystem services (Bateman et al., 2010), and so income inequality, present in many rapidly urbanizing countries, may bias WTP estimates.

The two objectives of this study are to estimate WTP for scenarios to rehabilitate the Ciliwung River in Jakarta, Indonesia, and to explore the potential sources of heterogeneity in these estimates. We focus on the Ciliwung River because it is one of the most polluted rivers in Indonesia, the main source of fluvial flooding in Jakarta, and thus a prime candidate for rehabilitation. These findings can be of use to the various authorities (Ministry of Public Works, Department of Spatial Planning) in assessing the social welfare implications of a given scenario, particularly the extent to which residents would value ecological rehabilitation attributes. At present, the government's proposal includes widening the river channel and stabilizing the banks with concrete pilings, but we hypothesize that residents would be willing to pay for additional ecological enhancements, namely riverside park space and forest conservation in the upper catchment outside of the city. These two additional attributes mirror current land use debates within Jakarta. The city is required by a national spatial planning law to increase urban green space coverage from 9% to 30% by 2030 and developing riverside park space is one consideration. There is also discussion about whether and how the Jakarta government can incentivize or otherwise influence land use changes outside of the city that affect regional environmental services, particularly in the context of integrated water resources management. Thus, by surveying urban residents about their preferences for paying to conserve upstream forests, we can link services provided outside of the city with downstream demand.

Second, we will examine the spatial and individual preference heterogeneity embedded in the WTP estimates, employing mixed logit models, simulating individual-specific WTP estimates, and using geographic information from respondents. This will permit us to consider the spatial extent of demand for rehabilitating this particular river and analyze the potential welfare impacts across demographic subgroups. With knowledge of the level and location of demand, decision makers could consider whether and where to engage in ecological rehabilitation of the Ciliwung, and at the same time we hope to contribute to the expanding body of knowledge on spatial effects in environmental valuation, particularly in developing countries.

2. Data and methods

2.1. Case study area

The Ciliwung River meanders for 119 km from its source in the forested highlands of Mt. Gede, through urban areas of Bogor and Depok before reaching Jakarta and emptying into the Java Sea. The relatively small catchment area of 384 km^2 is home to approximately 5 million people, including hundreds of thousands living adjacent to the river's edge in informal settlements (Vollmer and Grêt-Regamey, 2013)., with floodwaters in January 2013 inundating the Presidential Palace and other landmarks and causing damages estimated at US $3.3 billion (Sudoyo, 2013).

The Ciliwung River is now part of a pilot project led by the Ministry of Public Works (PU) to "normalize" (*normalisasi*) urbanized rivers in Indonesia. Normalization generally refers to a strategy of dredging, stabilizing banks, and developing flood mitigation infrastructure. Despite being led by PU, a national agency, local authorities are responsible for procuring and managing the land within their riparian corridors. The strategy for the Ciliwung would involve widening the channel to up to 50 m, reinforcing the banks with concrete (though generally maintaining the existing meanders) and creating service roads. At present the riparian corridor has only been canalized in small stretches. Approximately 34,000 households along a 19 km stretch of the Ciliwung within Jakarta have been slated for relocation as of August 2012 (Haryanto, 2012). Around the same time, county-level authorities in the upper catchment area of Kabupaten Bogor announced that 8700 ha of protected forest land would be released for development into additional resort areas, plantations, and production forests, which prompted intergovernmental discussions about how this would impact Jakarta (Saudale, 2012). Within the Ciliwung catchment, there are only about 7300 ha of forest left, and some of this is reserved in national parks outside of Bogor's jurisdiction. Fig. 1 shows the river, catchment area, relevant administrative boundaries, and our survey area within Jakarta.

2.2. Experimental design

We developed a CE to evaluate residents' preferences for riverside park space as an alternative to the proposed canalization, and their WTP for interventions outside of the city, in the form of protecting forests in the upper catchment of the Ciliwung. We selected attributes and levels for the CE (see Table 1) with the help of a small focus group of residents and disciplinary experts familiar with either the government plans for canalization or upstream land use dynamics. We opted to have respondents evaluate "state" rather than "service" attributes (e.g., "a widened river" instead of "less flooding on property") for two main reasons. First, issues such as flooding are influenced by a complex range of factors among