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Research Paper

Understanding the value of urban riparian corridors: Considerations in planning for cultural services along an Indonesian river

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HIGHLIGHTS

- Case study of riverside communities and plans to rehabilitate a riparian corridor.
- Mixed-methods approach to assess value of cultural services provided by urban river.
- Evidence of positive willingness-to-pay to include park space and forest conservation in plan.
- Qualitative methods like interviews help identify non-monetary expressions of value.
- Potential for integrating landscape design and social science research to enhance social value of green infrastructure.

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ABSTRACT

Cultural ecosystem services are not easily integrated into planning decisions when rehabilitating urban rivers. Methods exist to characterize the value of these cultural services, but there are methodological challenges to obtaining this information and fitting it to a decision context, particularly when weighed against monetary costs and benefits. In a developing country, these challenges can be magnified and thus the value of cultural services is seldom considered. We illustrate this through a case study of a river in Jakarta, Indonesia, where plans call for widening the river channel, stabilizing the banks with concrete, and restricting access to the river. We employ a mixed-method approach of household surveys, a discrete choice experiment and ethnographic interviews, to ascertain historical and present uses of the river, and residents' preferences for future change to the river. We demonstrate that low-income residents value non- or indirect-use cultural services that the river corridor provides—services that would be lost under the current rehabilitation plan. By assessing residents' willingness to pay for cultural services, we can more easily compare these scenarios to the current plan. We also show how our mixed-methods approach to valuation can help frame and interpret quantitative results, so that decision makers have additional contextual information. We demonstrate that such approaches are feasible and sometimes necessary in complex, data-poor urban environments.

1. Introduction

Water resource managers are slowly embracing nature-inclusive approaches to rehabilitating waterways (Pahl-Wostl, Jeffrey, Isendahl, & Brugnach, 2010), but the full range of benefits to human well-being (Brown & Cummins, 2013; Cattell, Dines, Gesler, & Curtis, 2008; Chiesura, 2004; Groffman et al., 2003) is still not systematically incorporated into integrated water resource management (Burmil, Daniel, & Hetherington, 1999; Chan et al., 2012; Hubacek & Kronenberg, 2013). Climate change presents yet another rationale for incorporating green infrastructure into planning efforts, but institutional barriers have slowed uptake (Matthews, Lo, & Byrne, 2015). Moreover, the subjective and intangible nature of some cultural ecosystem services (ES) provided by green infrastructure makes it even more difficult to integrate into

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planning efforts (Daniel et al., 2012). By cultural services, we mean the nonmaterial benefits people obtain from nature (MA, 2005), especially aesthetic values, recreation, cultural heritage, social relations, and sense of place. Knowledge of the value of these services is important not only in the planning and implementation stage (Daniel et al., 2012; Everard & Moggridge, 2012), but also for the management (Rhoads, Wilson, Urban, & Herricks, 1999) and resilience of an ecosystem over time (Colding & Barthel, 2013). If these cultural services are not considered in the planning process, then their value is implicitly set to zero (NRC, 2004).

There are particular challenges to conducting ES valuations in developing countries, ranging from the validity of monetary techniques to concerns about local research capacity (see Christie, Fazey, Cooper, Hyde, & Kenter, 2012 for a comprehensive review). Recent valuations for the Philippines (Estoque & Murayama, 2013) and South Africa (Schäffler & Swilling, 2013) use land cover data to derive quantitative values of ES, but the authors call for more participatory research into the local validation and expression of these values. Kenter, Hyde, Christie, and Fazey (2011) present a group-based monetary valuation from the Solomon Islands and recommend mixed-methods approaches that can provide additional insight into social processes. Cultural services are often considered incommensurable with marketed (i.e., monetized) goods and services (Martinez-Alier, Munda, & O'Neill, 1998), prompting researchers in developed and developing countries alike to consider alternative, non-monetary or qualitative techniques (Byrne, Lo, & Yang, 2015; Dobbie, 2013; MacKerron & Mourato, 2013). However, there is a lack of guidance on how to incorporate such information into decision making (Chan et al., 2012).

By using ES as a "common language" (Granek et al., 2010) to explicitly link ecosystem functions to human benefits, we can link knowledge from several disciplines and worldviews (Lundy & Wade, 2011) and tailor the research to issues that end-users care about (Chan et al., 2012). This also facilitates a consideration of the less tangible social and cultural benefits alongside more tangible technical benefits related to flood mitigation and climate change adaptation, and thus a full accounting of the potential value of green infrastructure vis-à-vis its alternatives. Information on community attitudes towards the local environment can be employed more effectively if it is developed with knowledge of the socioeconomic variables (Jim & Shan, 2013) as well as cultural and political factors that influence perception and behavior (Harrison & Burgess, 2003). We adopt a perspective of value-pluralism (Gómez-Baggethun & Barton, 2012; Hubacek & Kronenberg, 2013; Lo & Jim, 2010; Lo & Spash, 2013), being mindful that ES values are socially produced, demanding direct social research (e.g., ethnography, interviews) into the articulation of these values (Ernstson, 2012).

We present a case study of a densely settled urban river in Jakarta, Indonesia (Section 2) to illustrate the value of cultural services that could be provided by a riparian landscape. The current central government-backed plan to "normalize" (*normalisasi*) Jakarta's rivers is focused on restoring flood mitigation capacity by dredging and widening channels, stabilizing them with concrete, and fencing off the area. While flood mitigation is an important ES for Jakarta, particularly if future climate change leads to more frequent or intense storms, we suggest that the proposed approach overlooks cultural services important to residents' quality of life, and thus we work with local communities along the Ciliwung River to identify and valuate these services. We employ a mixed-methods approach (household surveys, a monetary choice experiment (CE), interviews, and focus group consultations) to identify residents' values for ecosystem services (ES) within an urban riparian corridor (Section 3), following Chan et al.'s (2012) framework for investigating cultural services. This approach allows us to estimate residents' willingness to pay (WTP) to maintain a rehabilitated river corridor, but also facilitates an understanding of underlying factors that influence their perceptions (Section 4). In this way, we are able to demonstrate how low-income residents value non- or indirect-use cultural services.

We also show how a mixed-methods approach to valuation can be deployed to help frame and interpret quantitative results. Aside from a positive WTP for a rehabilitated corridor, we find evidence of communal investments of time and resources to maintain the local environment, and other expressions of value. We conclude with a discussion (Section 5) of the implications of residents' demand for cultural services, and how this information could be used to influence planning and landscape design decisions.

2. Case study context

The Ciliwung River has long been a key piece of infrastructure for human settlements in what is now the city of Jakarta (Prescott & Girot, 2013). Jakarta's urban beginnings trace back to the 4th century CE (Abeyasekere, 1990), when the Ciliwung formed an axis of the Tarumanagara and later the Sunda kingdom. The Sunda kingdom's main harbor, Kelapa, was located at the mouth of the Ciliwung, which connected the kingdom's center (Pakuan Pajajaran, which is roughly 60 km upstream) to its agricultural hinterlands and the outside world. The Dutch eventually conquered Kelapa in 1617 due to its significance for the region. Colonial rule saw the development of a dense town modeled on Dutch urban design principles, in which water management systems were instrumental. Kooy and Bakker (2008) plot the colonial government's development of hydraulic networks in the late nineteenth and early twentieth centuries, and ensuing attempts of postcolonial governments to 'modernize' particular areas within the city through the delivery of large-scale water supply projects. However, a repetitive lapse in provision and maintenance of infrastructure has provoked the Ciliwung River and Jakarta's other twelve rivers to continue deteriorating in terms of water quality and flood mitigation capacity.

Today the lower stream of the Ciliwung (the portion passing through Jakarta) does not even meet Indonesia's minimum Class IV standards, making it unsuitable for any type of use. It also contributes substantially to seasonal flooding—more than 400,000 city residents were displaced by flooding in 2007 (Texier, 2008) and floods in January 2013 were the first to inundate the central business district and caused estimated damages of at least US $2 billion (beritajakarta.com, 2013). As a partial response, Indonesia's Ministry of Public Works (MPW) has budgeted over US $100 million (Rp 1.2 billion) to normalize the Ciliwung, widening the channel to approximately 50 m (it has narrowed to 10 m in some areas) and building a service road alongside a 19 km stretch of the river. Similar investments are proposed for other rivers in metropolitan Jakarta. In short, the Ciliwung is being treated as an engineering challenge, as typical infrastructure projects are, instead of being viewed as an ecological system capable of providing a range of benefits (Oberndorfer et al., 2007).

Our study area (Fig. 1) represents less than 10 percent of the portion of the river corridor designated for normalization, but it is the pilot site for implementation and so will be the first to be transformed. The Bukit Duri and Kampung Melayu sub-districts are located along the Ciliwung, near the geographic center of Jakarta. These sub-districts are densely and mostly informally settled, housing over 48,000 people within a square kilometer. Residents are typically but not exclusively low-income; about three quarters of surveyed households have incomes around or below Jakarta's minimum monthly wage rate of Rp 2.2 million (~US $190) (see Table 1). Residents are also among the city's most at risk of fluvial flooding—some portions of our study area were under 4 m of water during the January 2013 flood and have experienced dozens

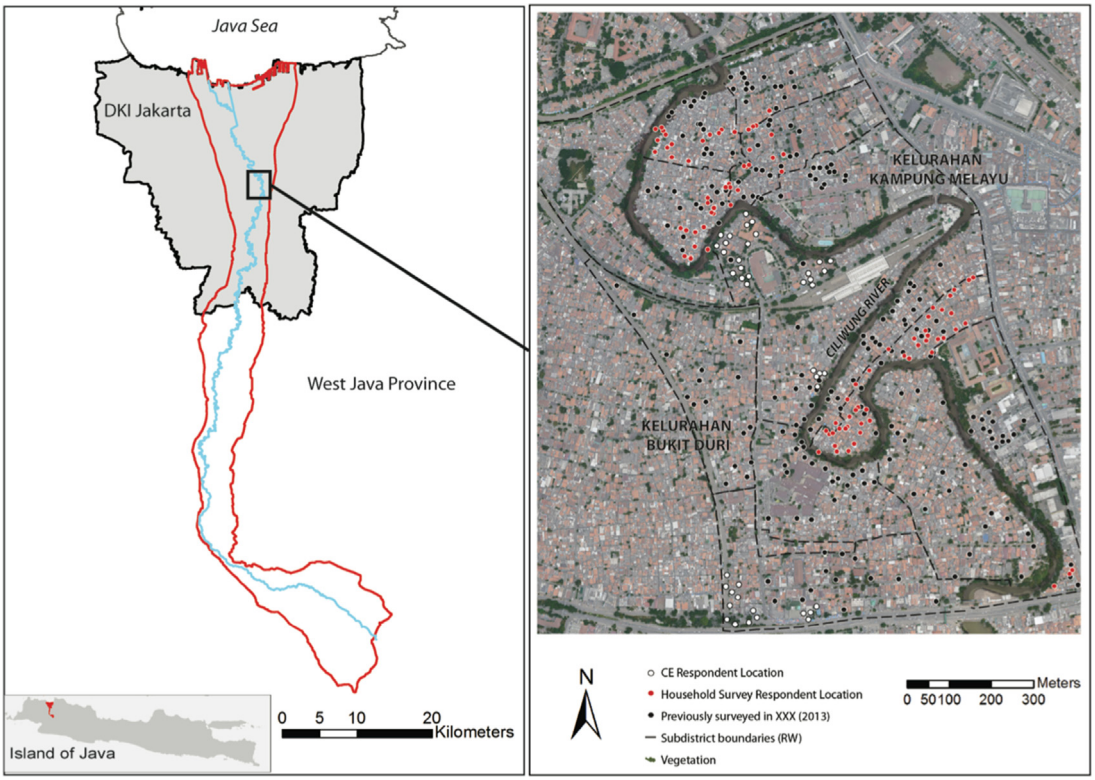

Fig. 1. Left image: Jakarta and the Ciliwung catchment (in red). Right image: Study area and location of respondents for quantitative surveys and interviews. Most remaining vegetation within the site exists along the river.

of subsequent minor floods in 2013. The river is fairly shallow (1–3 m) and self-built homes encroach into the floodplain in many stretches, constraining the river to a typical width of only 10 m. The river banks are a mélange of housing structures, self-built fences, and in a few areas, concrete reinforcement, but significant portions of the banks do have remnant or deliberately cultivated vegetation (Fig. 2). The river can thus be accessed at most points in the study area, and residents have built dozens of bamboo platforms and rafts along the river to facilitate access.

We build on Vollmer and Grêt-Regamey's (2013) study, which assessed environmental infrastructure within the site and documented the high rate of use of multiple ES. Within the present study, we seek to identify the current and potential future value of cultural services that might warrant further consideration by decision makers, and can also be used directly by the communities as they attempt to develop counter proposals to the normalization plan. By the middle of 2013, after our quantitative surveys had been completed, work was underway to implement the normalization plan, beginning in the southernmost portion of our study site where land was already vacant. Concrete pilings have been driven into the river bed to form a base for the widened, reinforced channel. By the end of 2013, more than one thousand households in the study area had been notified that they must evacuate in 2014, although the timing is contingent on the completion of public housing flats.

3. Methods

We draw from Chan et al.'s (2012) framework for valuing cultural services, iteratively involving local experts and stakeholders in order to frame the decision context, the social-ecological context, and identify and evaluate services of interest. As the authors note "[Q]ualitative and quantitative methodologies exist to characterize the sociocultural values associated with ecosystems and . . . employing such methods in real decision contexts will improve

Fig. 2. Left image: Residents build bamboo rafts that facilitate access to the river and also function as a social space. Right image: River banks in the study area are currently being stabilized by makeshift fences or vegetation (cultivated and natural).

Table 1
Descriptive statistics for the study area based on household survey data from Vollmer and Grêt-Regamey (2013).

Variable	Total
Mean household size (persons)	5.4 (2.9)
Mean household tenure (years)	32.1 (20.0)
Monthly household consumption expenditures (% by category, Rp '000)	
<500	5.7 ± 3.1
501–1500	34.6 ± 6.3
1600–2500	36.5 ± 6.4
2600–4000	16.1 ± 4.9
>4000	7.1 ± 3.4
Monthly drinking water expenditures [n = 102] (Rp '000)	72.4 (55.1)
Monthly solid waste disposal fee [n = 125] (Rp '000)	12.0 (15.4)
Share of self-owned homes (%)	77.3 ± 5.6
Households with at least one private toilet (%)	76.0 ± 5.7
Subset [n = 158] with connection to a septic tank (%)	65.8 ± 7.3
Source(s) of water for household use (% by category)	
Vendor & public well	15.5 ± 4.8
Vendor & private well	15.5 ± 4.8
Private well	40.8 ± 6.5
Municipal	16.0 ± 4.9
Municipal & other sources	12.2 ± 4.4
Households disposing solid waste directly to river (%)	48.8 ± 6.7
Households using the river for direct sanitary purposes (%)	12.6 ± 4.4
Households using the river for recreational purposes (%)	39.6 ± 6.5
Households harvesting plants along the river (%)	16.4 ± 4.9

Note: Standard deviations are given in parentheses. A 95% confidence interval range is given for each percentage reported. Sample size n = 213 unless otherwise noted. At time of surveying (March–June 2012), US $1 ≈ Rp 9500.

our understanding of [ecosystem services] and the decision making associated with them (p. 754)." They recommend employing interviews and scenario-based valuation, among other methods, as part of a "value-characterization process, which can inform decision making at several stages (p. 747)." Our specific methods of information gathering included a structured household survey, a discrete choice experiment, and semi-structured, ethnographic interviews, detailed in the following sub-sections. We also benefitted from the qualitative and quantitative data collected as part of Vollmer and Grêt-Regamey's (2013) household survey and interviews from mid-to-late 2012.

All interviewing and surveying was conducted in-person, in the local language (Bahasa Indonesia), generally outside the household or along the river. All field research involved graduate students from the University of Indonesia, some of whom had previous experience conducting interviews in this particular community. We inquired about respondents' ethnic background, since the indigenous Betawi people still constitute a substantial share (~28%) of Jakarta's population. In our initial conversations in the community, those who identified themselves as Betawi suggested that the Ciliwung River was a part of their heritage. Finally, we recorded geocoordinates for each data point so that we could develop a spatially explicit characterization of the site, to reflect the fine scale heterogeneity typical of urban social–ecological systems (Pickett et al., 2001).

3.1. Discrete choice experiment

Despite the difficulties in reducing cultural services into a monetary metric, this information on the economic value of ES is still often sought by decision makers. And despite questions surrounding the relevance of monetary assessment techniques in developing countries (Christie et al., 2012), Pearce, Pearce, and Palmer (2002) argue convincingly that this is a misconception and provide ample case studies demonstrating that willingness to pay (WTP) for environmental improvements is often constrained by an ability to pay, but is not irrelevant or nonexistent. However, methods typically employed in the valuation of green infrastructure—cost-based methods and hedonic regressions—only provide information on current levels of services and values, indexed to market prices (Farber et al., 2006). Therefore, we selected a stated preference method, a discrete choice experiment (CE), so that we could investigate preferences for attributes in hypothetical rehabilitation scenarios.

We opted for a CE instead of the widely used contingent valuation method, because the former offers more flexibility in determining the "part-worths" of individual attributes (Farber & Griner, 2000). In other words, we could estimate a WTP but could also simply evaluate strength of preferences among attributes, excluding the cost attribute. We also elected to conduct the more conventional one-off CE where respondents complete the choice tasks individually, as opposed to a deliberative, group-based CE. Group-based deliberative valuations provide certain advantages, such as eliciting deep-held beliefs, exposing divergent values, and facilitating participants' understanding of complex information (Kenter et al., 2011; Lo & Spash, 2013), but the selection of representative groups is problematic and the deliberation exercise requires skilled moderators. Moreover, group-based decision making may not be a common cultural practice, and public elicitations might diverge from privately elicited responses about what is essentially a private choice (Whittington, 2002).

Based on information gathered through Vollmer and Grêt-Regamey's (2013) household survey and interviews, we hypothesized that residents within our study area would exhibit a positive WTP for park space along the river as an alternative to the canalization planned. We observed that many households pay a monthly fee to their neighborhood (*Rukun Tetangga*, or RT) leader, which is dedicated to waste collection and other local public goods such as security, and so we determined that we could index a new hypothetical fee to that existing fee. We also observed that many residents attribute flooding, at least partially, to heavy rains and land conversion in the upper catchment (~60 km upstream from the study area). We developed a CE instrument in which respondents made pair-wise choices among hypothetical scenarios with four varying attributes, based on ES that would be affected by interventions within the Ciliwung catchment:

- channel width modification [provides flood mitigation];
- park space provision [provides recreation and other cultural services];
- forest protection in the upper catchment [provides erosion control, flood mitigation, and biodiversity protection]; and
- a monthly river maintenance fee so that we could estimate a marginal WTP from the resulting parameters.

We prepared a brief set of introductory slides with basic information on major ES in the Ciliwung catchment and graphic illustrations that were shown on tablet computers to each respondent before taking the CE. Riverside parks have few precedents in Southeast Asia, and can be difficult to envision within our study site characterized by informal housing and inadequate public space. Therefore, with input solicited during interviews regarding what residents might like to see in a riverside park, we devised an illustration of park space that was designed to offer comparable flood buffering capacity (accounting for cross-sectional area and surface roughness) as a canal similar to what is presently being proposed (see Fig. 3). Commonly cited attributes were that the space be green and the river accessible. At this stage we did not engage residents in designing a park, merely a generic conceptual illustration, to help survey respondents envision park space as a realistic alternative to the proposed normalization of the Ciliwung. The CE itself included text descriptions as well as pictograms for each attribute, and respondents selected among Scenario A,

Fig. 3. Left image: Sketch of riverside park space presented to choice experiment respondents, based on input from focus group. Right image: Sketch of the proposed canal under the normalization plan, as presented to respondents.

Scenario B, or a "neither scenario" option, all by touching the tablet screen.

The CE was stratified at the sub-district (*kelurahan*) level, so that we randomly selected Bukit Duri from our study site (Kampung Melayu) is the other *kelurahan* within the site. To have a larger sample and compare responses from our study area to other segments of the river, we randomly selected two additional *kelurahan* from the twelve which border the portion of the Ciliwung slated for normalization. Two community associations (*Rukun Warga*, or RW, an administrative unit) were randomly selected within each *kelurahan*, and surveyors randomly selected households. Surveying was carried out over three days in April 2013. In total we administered the choice experiment to 44 households within our focal study site, and 69 from the other two sites, for a total of 113 respondents. Each respondent completed eight choice tasks, yielding 352 observations for our study site and 904 observations when including all three sites. Parameters were estimated with main effects multinomial logit models using Biogeme 2.2 software (Bierlaire, 2003). We were able to obtain statistically significant results with such a small sample size because we relied on a D-efficient design as suggested in Bliemer, Rose, and Hensher (2009). One of the reasons that this sample size was small was that it was being used to generate prior parameter values for a catchment-wide choice experiment documented in Vollmer et al., (2013). A further description of the methodology is provided in Appendix A.

3.2. Household survey

The dataset compiled by Vollmer and Grêt-Regamey (2013) also provided us a baseline understanding of residents' interactions with the river corridor. From this survey, it was apparent that there were "hotspots" of engagement with the river, and that activities such as recreation (defined as fishing, swimming, or passive recreation along the water) and harvesting plants were more common than might be inferred from casual observation. To further investigate these cultural values we developed a survey instrument with SurveyToGo software (Dooblo, Inc.) so that we could conduct offline computer-assisted personal interviews in two RWs of the Kampung Melayu sub-district, where interactions with the river were particularly prevalent. The use of tablet computers allowed us to communicate information visually, and also to capture the precise geocoordinates of respondent households.

In total 99 household surveys were conducted—in Kebon Pala ($n = 47$), the northern portion of our study area, Kampung Pulo ($n = 49$) in the central portion, and 3 surveys in a small neighborhood where the normalization works are now underway. This survey was stratified at the RT level. Three to five households per RT were randomly selected by the surveyor, and efforts were made to sample from the core and periphery of each RT to ensure adequate spatial distribution. Though the survey was structured to provide quantitative information, it was designed to be flexible so that the surveyor could solicit and record qualitative information at any point. The surveys were conducted over two weeks in May 2013 and an additional week in October 2013. These surveys focused on three aspects relevant to cultural services—common-use space, vegetation and river use—and the functional, social, or even spiritual motivations of users. Each survey took approximately 25 min and was conducted in, or in front of, the home, and concluded with an opportunity for the respondent to provide comments. Most surveys often led into longer conversations and, depending on the willingness and availability of the respondent, into semi-structured interviews described below. There was no pre-determined strategy for selecting or screening interviewees from households, rather it was based on opportunity, and so surveyors were equipped with a short set of questions that could guide conversations. These conversations often involved input from friends, relatives, or neighbors who had been observing the process.

3.3. Ethnographic interviews and group discussions

While our quantitative surveys were designed to help identify statistical relationships, the rigidity of such an approach means that we miss contextual information, and the pre-determination of questions does not allow us to adapt to new information. Ethnography, or an attempt to observe the world from the research subject's point of view, provides one means of obtaining cultural familiarity (Emerson, 2001; Spradley, 1979) which in turn helps us interpret the qualitative and quantitative data we collect. We conducted semi-structured interviews during and at the location of daily activities, including community meetings, informal gatherings, and convivial interactions. The timing and subjects of interviews were based on residents' interest—most were simply an extension of the household survey, but interviewees frequently would introduce us to other individuals willing to engage in our research. Interviews were conducted during the same time period that the household survey and choice experiment were conducted, so over the course of about 4 weeks in April, May, and October 2013.

While this was a less formal approach to gathering community input, it did offer some important advantages to a more conventional facilitated workshop or quantitative study. The research could be conducted in settings familiar to community members, and we were able to view first-hand the home gardens, recycling programs, and other activities residents discussed. Initial interviewees played a role in facilitating community acceptance and organizing subsequent meetings with other community leaders and residents who take an active role in managing the local

environment. We were also better able to engage female community members in our research. This is critical because they tend to have much more frequent interactions with the river, thus have a wealth of knowledge, and they also tend to be under-represented at official meetings, where males as the head of household attend and do most of the speaking.

Semi-structured interviews with community leaders were planned in advance but conducted in the same manner as interviews with residents (in or outside the home, in a conversational style). Meeting with community leaders was also important in establishing acceptance of the research activity within individual RWs and RTs and securing active and open participation from households. In total we interviewed four community (RW) and fifteen neighborhood (RT) leaders, who provided information on community organization and environmental planning and initiatives. These were often extended discussions, commonly lasting as long as an hour, and we generally met with leaders at least one additional time, to probe deeper into particular issues. We also interviewed staff from Ciliwung Merdeka, a local NGO, to refine our understanding and abilities to interpret responses from the communities in our surveys and observations.

4. Results

In the following sub-sections we present an integration of our results from the household survey, interviews, and CE. We have organized the results according to three key aspects of Chan et al.'s (2012) framework for characterizing cultural services: determining the decision and social–ecological context; determining ES and beneficiaries; and determining ES values.

4.1. Determining the decision and social–ecological context

4.1.1. Decision context

Based primarily on information obtained during our interviews, we were able to refine and deepen our understanding of the decision and social–ecological contexts presented in Section 2. We must clarify that the most important decision for many residents has to do with how the government will relocate households, in terms of timing, location, and compensation, and these issues are beyond the scope of our research but are of course critical to the context. Relocations will be a part of any rehabilitation plan, and most residents expressed hope that compensation would be "fair" or "adequate" and that the reclaimed land could contribute to an improved river corridor.

Attitudes towards the government with regard to river normalization seem to have become more positive between our interviews in 2012 and those in 2013, which may be explained by Jakarta's new governor taking office in October 2012. Flooding, river normalization, and resident relocation were central topics in the gubernatorial debates, with the eventual winner emphasizing an intent to minimize resettlements and take into consideration the context and characteristics of neighborhoods marked for relocation. We did not directly solicit residents' perception of the normalization plan, but many interviewees in 2013 offered optimistic comments about the prospects of a fair relocation strategy under the new governor, and hope that the Ciliwung River could finally be rehabilitated.

Though we have not been directly involved in meetings between community leaders and local government officials, we have learned that the final normalization plan is more malleable than residents initially understood, meaning that there is an opportunity for both sides to negotiate the width of the channel and the amount of vegetated area within the river corridor. Within the study area, Ciliwung Merdeka is leading efforts to develop alternative scenarios for riverfront housing that minimizes relocations while still allowing for aspects of the normalization plan to be implemented. Therefore the information we have developed (and continue to develop in cooperation with community and government partners) can be directly used in these discussions.

4.1.2. Social–ecological context

Characterizing the social–ecological context of a study area requires integrating information from the biophysical context (i.e., state of resource[s]) with the social context, and then identifying interactions between the two (Ostrom, 2009). As shown in Table 1, residents typically have a long (often multi-generational) association with the study area, and the historical accounts they provided during interviews suggest that the downstream portion of the Ciliwung has experienced a slow decline in its condition since the 1970s, when local flooding became more prevalent and trees were cleared to accommodate settlement. Prior to this time, the riparian area was characterized as being rich in natural vegetation and aquatic species. Some residents reported that by the early 1980s (which corresponds to the peak of Jakarta's urban growth rate) they no longer considered the river suitable for fishing or swimming due to a perceived decline in water quality associated with the increase in turbidity, odor, and floating solid waste. Some residents also reported that community gardens which had existed along the river have largely disappeared due mainly to recurrent flooding.

According to interviewees, flooding and poor solid waste management seem to be the two most critical environmental threats along this portion of the river, but they are issues that require a catchment-wide solution. In both cases residents acknowledge settlement encroachment as an important pressure on the river, but most residents also note that encroachment has occurred upstream as well, and that unregulated domestic waste dumping is a problem in each of the municipalities bordering the river, beginning with Bogor some 50 km upstream. The two issues become linked during rainstorms in the upper catchment, where higher runoff and river water levels appear to carry solid waste from illegal riverside landfills along the river, collecting at the Manggarai Barrage just upstream of our study area.

Improving solid waste management was not initially considered as a pillar of the normalization plan, but the Jakarta government now cites it as part of the overall strategy, and is directing funding to its municipal sanitation agencies to clear illegal riverside landfills and provide additional waste collection services. It also became clear that residents' understanding of ES within the river corridor is closely linked to the level of solid waste management. In the open-ended commentary portion of the CE, some respondents stated that riverside park space should not be a prioritized over improved waste management. Within our study area, several RW leaders reported having composting machines provided by the local government, and women's education programs on *biopori* (a local method of using shallow bore holes filled with organic matter to increase groundwater recharge and reduce storm run-off). Efforts to apply these are inhibited however, by a lack of equipment and/or space to make use of them.

Residents' perception of the need to rehabilitate the river was likely influenced by the substantial flooding that occurred in January 2013 and affected many of our interviewees. Prior to that, the last major flood had occurred in 2007, so most interviewees in 2012 had not experienced flooding of their property for at least five years. Thus, in 2012 interviewees expressed concerns about flooding but were more likely to suggest that they had personal and/or neighborhood-based coping mechanisms in place; by 2013 we perceived more interviewees to be resigned to some form of government intervention within their neighborhoods, to rehabilitate the Ciliwung. In the Kampung Pulo portion of

our study area, which floods as often as once a month nearest the banks, community leaders and residents welcomed government intervention to reduce local flooding. There was a general belief that the planned normalization would alleviate flooding problems, although it would necessitate relocating hundreds of households from that particular neighborhood. The most common aspirations residents shared during interviews were for a "clean and green" environment, as well as a "secure" or "flood-free" community. We did not ask specific questions about goals for river water quality, but note that several residents hope that the Ciliwung could once again be swimmable, a condition closely associated with the amount of solid waste floating in the river.

4.2. Determining ES and benefits

We focused our research on cultural ES because it was apparent that these services and their benefits were being overlooked in favor of a plan to maximize flood mitigation. Based on observations, interviews, and the household survey, we identified three services (outdoor recreation, aesthetics, and cultural heritage) as prominent ES for the community. Based on the household survey we were also able to rule out subsistence and spiritual significance as relevant services within the study area. The three prominent services overlap (e.g., aesthetics affect enjoyment of outdoor recreation), making it challenging to assess them separately (Daniel et al., 2012), but the distinction can be useful when it comes time to create refined scenarios and manage the site. It is also difficult to isolate the benefits of these services—social relations was the most frequently cited benefit of outdoor recreation, but many residents also noted the increased thermal comfort along the river, or the sense of calm imparted by the greenery and moving water. Knowledge of the precise composition of benefits is not likely to shift the balance one way or the other when compared against the current normalization plan, though at a later stage it may be useful to further elucidate these individual benefits.

Our first indication that residents valued recreation options along the river was the fact that nearly 40% of households initially surveyed in 2012 reported recreating in or along the river, and more than half of those households engaged in fishing and/or swimming despite the poor water quality. The bamboo platforms along the river, ostensibly used for domestic chores, also function as social spaces. Community leaders, particularly in Kampung Pulo, indicated interest in having more accessible green spaces along the riverbank but identified space availability as a challenge. They were also concerned with the potential impacts of future floods, based on their experience with losing community-cultivated green infrastructure (mostly small-scale gardens) in previous floods. Thus, while the aesthetic quality of the corridor appears to be important, particularly in attracting more residents to enjoy cultural services in the future, it may be less important than having additional open space for residents to recreate.

There are at least two important issues pertaining to the desirability or potential disservices of urban green space along the Ciliwung, highlighting the importance of cultural perceptions that draw people to, or prevent them from visiting green spaces (Hitchings, 2013). First, like most of Jakarta, residents in our site are concerned about the *Aedes aegypti* mosquito as a vector for tropical viruses such as dengue fever and some respondents reported avoiding the riverfront (or even cultivating plants near their own homes) as they considered it a habitat for mosquitoes. Second, given Jakarta's presently low level of green infrastructure, combined with poor air and water quality, it is possible that residents associate the urban outdoors with pollution, heat, and chaos, while climate-controlled malls and other large property development projects are on the increase (Padawangi, 2012b; Rimmer & Dick, 2009). We did find that the likelihood of households recreating decreased with distance from the river, and that some neighborhoods in the study area appeared to have no interaction with the river. Interviewees in these neighborhoods were much more likely to describe the river as polluted, inaccessible, and otherwise unpleasant to visit.

We refer to Tengberg et al.'s (2012) definition of landscape cultural heritage as "features within landscapes significant in some way to the present, including not only historical objects or landscape features (cultural and natural) but also intangible aspects such as stories, knowledge systems and traditions... (p. 17)." Within our study area, there are not necessarily any historical objects of significance along the river, but the Ciliwung's historical significance for Jakarta is well known. In fact, residents that identify themselves as the Betawi ethnicity, indigenous to what is now Jakarta, sometimes asserted that they cared about the Ciliwung because of their long association with the river and landscape. However, we did not find any statistically significant differences among preferences or practices based on ethnic identity. We did find that residents still cultivate and harvest medicinal plants, in addition to productive fruit and seed-bearing plants near the river, as is commonly practiced in more rural settings. We did not encounter any residents engaging in this activity as a means for their livelihood or food security, and so we interpreted this behavior as a continuation of cultural practices from the past.

4.3. Determining associated values

Based on the results of our CE, we find evidence that residents would be willing to make (monetary) tradeoffs in order to safeguard and enhance cultural services along the river. We estimate a WTP (in the form of a monthly fee) for each of three attributes of the rehabilitation plan: channel width (for flood mitigation), park space (a proxy for recreation and aesthetics), and upstream reforestation. We can also use the marginal parameter estimates to compare the strength of preferences among our attributes. Table 2 displays the parameter estimates from the MNL models, and a calculation of WTP (converted to US $) for the three attributes posed to respondents. As noted earlier, we do not consider this sample as representative of residents living throughout the Jakarta portion of the Ciliwung corridor, but merely an indicator of residents' preferences from within our study site ($n = 44$, n obs = 352), compared against a larger sample which includes riverside communities further upstream and downstream of our study area ($n = 113$, n obs = 904). The relatively high rho-square values (Louviere, Hensher, & Swait, 2000 suggest a value between 0.2 and 0.4 as a good model fit) and statistical significance of our parameters give us confidence in interpreting the results as representative of the study area.

We see that the status quo, i.e., the conditions today and in the future assuming no rehabilitation, yield a strong negative utility. In other words, residents would associate rehabilitation with gains in utility, and this is consistent with information residents shared during interviews, about their hopes for improved conditions in and along the river. The channel widening parameter was only statistically significant in the subsample from our study site, but did suggest that respondents might associate a wider river with a small gain in utility. This result is hardly surprising considering the concerns many interviewees voiced about the relocations necessitated by widening the river, even given their desire for flood mitigation measures. Preferences for park space were positive as expected and yielded a fairly substantial indicator of WTP, when measured against the mean monthly fee households currently pay for waste collection (~US $1.24, see Table 1). The WTP to protect forests in the upper catchment (60 km upstream of our study site) was also positive, suggesting that respondents within the site were not only concerned with their immediate environment, and they valued the

Table 2
Parameters and estimates of willingness to pay for three attributes of rehabilitation scenarios.

Full sample $N = 904$, adjusted rho-square: 0.235			Bukit Duri & Kampung Melayu subsample $N = 352$, adjusted rho-square: 0.297		
Attribute	Parameter value	WTP ($/mo)	Attribute	Parameter value	WTP ($/mo)
Status quo	−2.00** (0.211)	–	Status quo	−2.37** (0.434)	–
Channel widening (m)	0.0077 (0.0044)	0.02	Channel widening (m)	0.0195* (0.0072)	0.04
Park space	0.639** (0.095)	1.53	Park space	0.668** (0.153)	1.37
Protected forests (%)	0.0118** (0.0027)	0.03	Protected forests (%)	0.0260** (0.0050)	0.05
Monthly cost	−0.404** (0.100)	–	Monthly cost	−0.473* (0.177)	–

Note: Willingness to pay (WTP) figures have been translated from Indonesian Rupiah (Rp) to US $ using the historical exchange rate from July 2013 of US $1 ≈ Rp 10,300.
* $p < 0.05$.
** $p < 0.01$.

ecosystem services upstream forests currently provide. Recall that the future scenarios included a possible 20% increase in upstream forest cover; we cannot be certain that demand for this service is linear, but a simple extrapolation suggests that WTP for that amount of reforestation would be in the range of US $ 0.60–1.00 per household per month. Again, this information is consistent with what we learned from interviewees about their hope for a catchment-wide strategy to rehabilitating the river, their knowledge of the link between deforestation upstream and erosion, and the fact that many respondents reported having visited the upper catchment area, a popular domestic tourist destination for outdoor recreation.

We can supplement this monetary valuation information with the nonmonetary valuation information obtained through our interviews. Our CE focused on individual preferences (and implicitly, individual utility) and thus cannot adequately capture the communal value of group activities, of which there are many, focusing on improving the local riparian corridor. Furthermore, many community members may prefer to invest their time in ongoing activities that reflect their appreciation towards the river, such as *kerja bakti* (communal clean-up), organic waste composting, riverbank greening, and community gardening, rather than paying a monthly fee. The lack of disposable income is not the only explanatory factor in such initiatives. Existing community networks and kinship may make these activities more meaningful than paying a monthly maintenance fee, and most of these activities have the added benefit of bringing residents in more frequent contact with nature. Therefore, a seemingly low WTP should not be interpreted as a low valuation of cultural ES within our study area.

5. Discussion and conclusions

In Jakarta, like many developing world cities, urban riparian areas are often home to low-income communities and informal settlements with limited municipal infrastructure. These areas offer great potential to help mitigate certain climate change risks within the city, but rather than pursue a purely technical rehabilitation we argue that the overall welfare benefits of a rehabilitation program can be substantially enhanced if cultural services are taken into consideration in the planning stage. Developing world cities, and particularly the urban poor, are among the most at risk in terms of climate change (Campbell-Lendrum & Corvalán, 2007), and so ecological rehabilitation projects will only become more common in the future (McGranahan, 2007). The question is, how, if at all, will rehabilitation plans incorporate existing knowledge and aspirations, particularly among these typically marginalized groups of residents (Padawangi, 2012a, 2014)? It is clear from our results that even in its current degraded conditions the Ciliwung corridor provides cultural services that residents value, and these services (and their value) have diminished due to inadequate management of the riparian area. Understanding this offers us insight into residents' aspirations for a rehabilitated corridor. With this knowledge as a basis for discussion, we are now in the process of distilling and disseminating it to stakeholders as the more detailed plans for the river's normalization are developed. In this section, we discuss two general insights from our experience thus far: the need to assess demand for cultural services, and the opportunity for "designed" natural landscapes in rapidly urbanizing regions. We close with a brief discussion of the merits of employing a multidisciplinary, mixed-method approach in an informal urban environment.

5.1. Assessing the demand for green infrastructure

Re-naturing urban waterways may be a low priority in developing countries, if the projects are seen as costly "luxuries" for a revenue-constrained city when compared to hard engineering approaches. This also reflects the prevailing institutional biases that inhibit planners from considering green infrastructure as an alternative way to manage climate change risks (Matthews et al., 2015), such as flooding or heat stress. Even ecologically "successful" urban river rehabilitation can still fail to deliver on social benefits if it is approached as a technocratic, top-down solution (Eden & Tunstall, 2006) The proposed approach for the Ciliwung's normalization is being prioritized through conventional hydraulic engineering measures with limited consideration of the social–ecological context of the river. At the opposite end of the spectrum, if residents do not attribute an increase in ecosystem services to improvements in their quality of life, then ecological rehabilitation would be frivolous (Wohl et al., 2005). However, our research suggests a fuller exploration of the benefits (and beneficiaries) of a nature-inclusive approach is warranted in this case.

Without some indicator of demand for the additional ecosystem services we evaluated in this study, it would be difficult to argue that the current normalization plan is missing an opportunity to enhance the total value of the river. Monetary valuation techniques afford a comparatively large range of information for decision makers, relative to non-monetary techniques (Christie et al., 2012). Our results suggest that residents would not only prefer a more ecologically oriented rehabilitation plan, but also be willing to make a modest monetary contribution to realize such a plan and its benefits. We believe this information on WTP best fits the decision context of having to compare a (likely) more costly rehabilitation plan providing cultural services against the proposed normalization. Our qualitative information on the specific benefits can then be used in a complementary way, explaining more precisely what it is residents are willing to pay for. This information might also be obtained in a quantitative manner, but would involve a much larger sample size, more complex survey design, and provide more specificity with regard to part-worths of, for example, the thermal comfort benefit of riverside vegetation, than is necessary.

Developing an appropriate value elicitation mechanism required a detailed understanding of the communities' engagement with the river, information which was only accessible through interviews and focus group consultations. The official

narrative of the river is that it is a tragedy of the commons, degraded by irresponsible squatter settlements. However, this narrative is partially countered by the evidence we find of communal efforts to reduce environmental degradation and make investments of time and money into small-scale rehabilitation. These investments suggested to us that residents would in fact be amenable to an additional monthly fee to further improve conditions in the long-term. Also, by recognizing the historical and current cultural services the river provides, we were more confident in proposing a rehabilitation scenario that restores at least some of these services. Such an optimistic proposal is based more on residents' stated aspirations than external researchers' biased assumptions.

5.2. Informing the design of natural landscapes

In the event that the information on demand for cultural services is compelling enough to warrant a reconsideration of the normalization plan, our results can also provide insight into priorities for an alternative plan. We suggest that landscape design, properly informed by social and cultural circumstances (Opdam et al., 2013), could help restore urban rivers to multifunctional landscapes (Lundy & Wade, 2011). Landscape design is increasingly recognized as providing a common ground for scientists and practitioners to improve the impact of scientific knowledge in decision-making about landscape change (Nassauer and Opdam, 2008). We see an opportunity for what Felson and Pickett (2005) refer to as "designed experiments" involving scientists cooperating with landscape architects, only in this instance, the goal is not to increase our understanding of urban ecology, but to increase the value of cultural ecosystem services, testing new methods and evaluating the social outcomes of green infrastructure projects (Grêt-Regamey et al., 2014).

Communities have a strong impact on the degree to which urban riparian landscapes can be rehabilitated, meaning that a suitable goal might be a "created" or "modified" ecosystem that matches community values (Findlay & Taylor, 2006). Whereas native riparian vegetation would be preferable from an ecological habitat perspective, there would need to be tradeoffs with residents' preferences for open space, shade trees, and productive communal garden space. Accessibility is also an important factor in determining the overall value of green space, and it encompasses proximity as well as equality of access (Moseley, Marzano, Chetcuti, & Watts, 2013). Removing the last vestiges of green space along the banks of the Ciliwung would forfeit the opportunity to enhance this value by making the riverfront even more accessible to more residents in a characteristically underserved part of the city. Inequitable access may become an even more salient issue in the future if climate change increases heat stress in cities like Jakarta, and parks are viewed as a low-cost means to mitigate this stress (Byrne & Wolch, 2009). Brown et al. (2015) suggest that parks with shade trees could substantially reduce local vulnerabilities to heat stress in tropical climates such as Jakarta's.

5.3. Conducting mixed-method research in an informal urban setting

We have demonstrated that an iterative mix of quantitative and qualitative methods to value cultural services is feasible, and indeed may be necessary in a complex, data-poor environment like our study area in Jakarta. It required flexibility on the part of researchers, in terms of (1) accepting the legitimacy of multiple disciplinary techniques, (2) forging partnerships with diverse (and unavoidably biased) stakeholders, and (3) conducting field research when and where residents were most comfortable. Collectively, it yielded fruitful results. We were able to challenge many prevailing assumptions about the conditions along the river and attitudes of residents. The quantitative analysis allowed us to identify spatial patterns of behavior and put a monetary figure on some aspect of the cultural benefits of a rehabilitated river, while the qualitative analysis provided a fuller context within which we could interpret these results.

Taken together, we believe that this integration of information from qualitative and quantitative methods provides a more complete understanding of the potential value of rehabilitating the Ciliwung. Such mixed-method techniques do not have to be high-cost. We made use of ultra low-cost tablet computers, graduate student field surveyors, and in-kind support (facilities and facilitation) from community leaders and the local NGO. The latter support was likely offered because of our demonstrated willingness to delve into the context of the study area, when contrasted with a one-off questionnaire. Advances in visualization and interactive procedural modeling make it increasingly feasible to engage stakeholders in exploring and even creating future scenarios for green infrastructure (Grêt-Regamey, Celio, Klein, & Wissen Hayek, 2013). Based on the partnerships we have established thus far with the communities in the study area, the next logical step in our research will be to jointly develop landscape scenarios within the site, as a way to continue refining our mixed-method approach delivering relevant information to decision makers at higher levels of governance.

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Appendix A. Detailed methodology for choice experiment and choice model estimation

We selected three ecosystem service attributes and levels for the choice experiment with the help of a small focus group of residents and disciplinary experts. The park space attribute was a binary option, while other attributes were assigned four levels each in order to maintain attribute balance in the experimental design (Bliemer et al., 2009). We decided upon a payment mechanism for our cost attribute that was indexed to the existing monthly environment and security fee (*uang keamanan*) that most residents pay, and that is collected at the neighborhood level. We explained that the hypothetical new fee would go towards maintenance of the river corridor, particularly solid waste management which was the issue most frequently cited by respondents in the pre-test as being critical to the Ciliwung's rehabilitation.

We used Ngene 1.1.1 software (Choice Metrics, 2012) to develop a D-efficient design, which has been shown to yield more statistically efficient results than the more common orthogonal design, allowing us to obtain stable parameters with a smaller sample size (Bliemer et al., 2009; Rose, Bliemer, Hensher, & Collins, 2008). We deployed the survey instrument in April 2013, with a global choice set of 32 choices separated into four blocks, so that each respondent would face only eight choice sets. We also included an opt-out or "status-quo" alternative to be consistent with consumer theory. Surveyors used a scripted introduction, aided by

the visuals, so that each respondent received the same amount of introductory information. Administering the surveys in person by computer ensured survey completion, immediate data availability, reduced interviewer bias, and allowed us to obtain precise location coordinates.

Choice modeling was done using the open-source software Biogeme 2.2 (Bierlaire, 2003). Formally, the underlying utility function for the jth alternative for individual i out of choice set C_i is modeled as a linear additive combination of an observable deterministic component V_{ij} and an unobservable random component ε_{ij}:

$$U_{ij} = V_{ij}(x_{ij}, \beta) + \varepsilon_{ij} \quad \forall j \in C_i \tag{1}$$

where x is the observed vector of attributes and β represents a vector of marginal utility parameters. The observed utility V_{ij} can further be specified as including an alternative specific constant *ASC* to account for the utility of the status quo. The marginal WTP of any attribute can then be calculated as the negative ratio of its utility parameter β and the parameter from the cost attribute (which should be negative and thus a disutility). We estimated main effect multinomial logit models with a utility function that was an additive combination of the four attributes from Scenarios A and B:

$$U_{ij} = \beta_{channel} * \text{CHANNEL} + \beta_{banks} * \text{BANKS} + \beta_{forest} * \text{FOREST} + \beta_{cost} * \text{COST} + \varepsilon_{ij} \tag{2}$$

The *ASC* was set to zero in the utility functions for the two hypothetical options, but set to one for the status quo alternative so that β_1 represented the utility of the status quo.

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