Environment and Development Economics (2024), **29**, 19–38
doi:10.1017/S1355770X23000098

EDE

RESEARCH ARTICLE

Nature in the concrete jungle: valuing urban ecosystem services in Costa Rica

Matías Piaggio,* and Juha Siikamäki

International Union for Conservation of Nature (IUCN), Washington, DC, USA
*Corresponding author. Email: matias.piaggio@iucn.org

(Submitted 9 June 2022; revised 25 March 2023, 6 July 2023; accepted 12 September 2023; first published online 9 October 2023)

Abstract

Urban green spaces are primarily recognized for their ability to provide opportunities for recreational activities. However, these spaces also offer a broader range of ecosystem services and benefits, which are often overlooked by city inhabitants and the government. This paper utilizes choice experiments to estimate the benefits derived from ecosystem services provided by undeveloped natural areas and urban parks in San José, Costa Rica. We evaluate three ecosystem services provided by undeveloped natural areas, namely habitats for animals and plants, hydrological control, and recreation. Additionally, we estimate the benefits derived from the restoration and construction of three types of urban parks: neighborhood, metropolitan, and central district parks. The results demonstrate that individuals place significant value on the restoration of undeveloped natural areas and urban parks. The findings also indicate variations in the valuation of ecosystem services between undeveloped natural areas and different park types, as well as among households.

Keywords: choice experiment; ecosystem services; urban green spaces

JEL classification: C25; Q51

1. Introduction

More than half of the world's population currently resides in urban areas, and this figure is projected to reach 60 per cent by 2030 (UN-Habitat, 2016; United Nations, 2019). The expansion of cities has a significant impact on biodiversity, ecosystems, and the benefits that urban dwellers derive from green spaces. The importance of cities in biodiversity conservation has been recognized by international agreements, such as the Convention on Biological Diversity (CBD COP, 2008). Understanding the preferences of urban population for ecosystem services derived from urban green spaces can assist urban planners in creating more resilient and sustainable cities, and thereby contributing to the achievement of the United Nations' Sustainable Development Goal 11 (SDG-11) (United Nations, 2015).

Urban green spaces are primarily recognized for the recreational opportunities they offer in parks and gardens. However, the concept of urban green spaces extends beyond that and can also include undeveloped natural areas, such as riverbanks and shrublands.[1] These spaces offer a multitude of ecosystem services that benefit local residents beyond recreational opportunities. For instance, they play a crucial role in water flow regulation and runoff mitigation, which helps prevent street flooding during heavy precipitation events. However, it is important to note that urban green spaces can also introduce certain drawbacks, such as allergies, accidents caused by falling branches, and potential risks to infrastructure due to root growth that undermines the integrity of paved surfaces.[2]

The objective of this paper is to understand public preferences for the ecosystem services derived from urban green spaces in San José, Costa Rica. This paper contributes to the literature in three main ways. First, it is the first study to estimate the values of a bundle of ecosystem services provided by two types of urban green areas, urban parks and undeveloped natural areas, in a consistent manner. Previous papers that analyzed the value of urban green spaces using stated preference methods primarily focused on implementing choice experiments to analyze individuals' preferences for attributes of green areas used for recreation, such as pathways or trees lining the footpaths (Bullock, 2008; Aspinall *et al.*, 2010; Arnberger and Eder, 2011; Bae, 2011; Basri, 2011; Abildtrup *et al.*, 2013; Traoré and Salles, 2014; Tavárez and Elbakidze, 2019). An exception is the study by Tu *et al.* (2016), which estimates marginal willingness to pay (MWTP) for two environmental aspects of neighborhood parks that provide both recreation and scenic views. A few studies utilize the contingent valuation method to analyze MWTP for a single ecosystem service, such as park proximity (del Saz Salazar and García Menéndez, 2007), conservation of urban green spaces and forest (Lo and Jim, 2010; Tavárez and Elbakidze, 2021), and recreational use value of urban rivers (Kulshreshtha and Gillies, 1993). Furthermore, while the contingent valuation method is useful for estimating the MWTP for a specific ecosystem service or a program involving multiple services, it has limitations in terms of allowing for an understanding of preference tradeoffs between different types of urban green spaces or management strategies for undeveloped natural areas.

Revealed preference methods have also been employed to analyze individuals' preferences for urban green spaces, such as hedonic price models (e.g., Tyrväinen, 1997; Cho *et al.*, 2006; Kolbe and Wüstemann, 2014; Daams *et al.*, 2016; Tuffery, 2017; Piaggio, 2021). However, hedonic price models have limitations in capturing preferences for ecosystem services that were not present at the time of housing market transactions, nor do they typically consider ecosystem services provided in geographically distant locations from the transacted homes. Tuffery (2017) is an exception that uses a hedonic model to try to capture value of non-local amenities. Our study is the first to analyze urban public preferences for six ecosystem services provided by two types of urban green spaces: urban parks and undeveloped natural areas. This approach enables a consistent understanding of tradeoffs across individuals' preferences for a comprehensive bundle of urban ecosystem services.

Second, we establish a connection between the attributes derived from choice experiments and six ecological endpoints specific to urban undeveloped natural areas and parks. Ecological endpoints are a clear manifestation of environmental value, operationally defined as an ecological entity and its associated attributes (USEPA, 2016). An ecological entity, for instance, can represent an ecosystem function performed by urban

[1] See Cvejić *et al.* (2015) for a full typology of urban green spaces.
[2] See Gómez-Baggethun and Barton (2012) for a conceptual framework of the classification and valuation of ecosystem services for urban planning.

green areas, such as water retention or biodiversity support. The utilization of ecological endpoints for two distinct types of urban green areas represents a conceptual and analytical contribution within the field of economics literature. This analysis enables us to identify the MWTP for individual ecosystem services. To our knowledge, this paper is the first to address this issue for ecosystem services derived from urban undeveloped natural areas, and it does so in a consistent manner to facilitate comparability with urban parks. Finally, we assess public preferences for urban nature in a major city within a developing country, while also estimating the aggregate benefits associated with the maintenance and expansion of urban green spaces. The evidence for developing countries is currently scarce, particularly regarding undeveloped natural areas. Enhancing the body of evidence for developing countries contributes to more reliable estimations for the application of value transfer methods in similar contexts.

The rest of the paper is organized as follows. Section 2 presents the theoretical and empirical models and describes the data collection strategy, and section 3 shows the results. The discussion of the results is presented in section 4, and the last section concludes this study.

2. Material and methods

2.1 Theoretical model and empirical strategy

The analysis of responses to a choice experiment is based on the random utility model (RUM). The RUM considers the scenario in which individual i faces J alternatives, and chooses the alternative that maximizes his or her utility (Train, 1998). This is consistent with the choice experiment format where, in our case, respondents chose their preferred undeveloped natural area or park rehabilitation program from a set of alternatives, including status quo. Choice experiments help measure the tradeoffs between attributes in a policy program. The results of the model can be used to estimate respondent willingness to pay (WTP), i.e., how much respondents would be willing to pay for a change in the attribute level, while remaining as well off after the change as they were before the change. This is a measure of the compensating variation. The fact that the choice experiment provides an estimate of the indirect utility function allows us to calculate the WTP for gains or losses relating to any combination of change in the attributes (Holmes *et al.*, 2017). Appendix A shows the theoretical model in detail.

What is most often reported in generic choice experiments is the MWTP, i.e., the rate of substitution between any of the non-monetary attributes and money. Using a linear utility function (V_{ji}), the MWTP for a change in a specific attribute r is the ratio of the coefficient of the attribute ($\partial V_{ji}/\partial z_{ji}^r$) and the marginal utility of money ($\partial V_{ji}/\partial p_j$):

$$\text{MWTP} = -\frac{\partial V_{ji}/\partial z_{ji}^r}{\partial V_{ji}/\partial p_j} = -\frac{\beta_r}{\lambda}\ \forall\ r = 1 \ldots n. \tag{1}$$

The MWTP indicates how much money an individual is willing to sacrifice for a marginal change in the attribute. When attributes are not continuous, equation (1) is not strictly a MWTP, but it can be interpreted as a measure of the amount of money a respondent is willing to pay for a change in the attribute form (e.g., the existence of a new park or not). In the case that the monetary attribute is assumed to be log-normally distributed, the mean marginal utility of income needs to be adjusted as $\exp(\lambda + \sigma_\lambda^2/2)$.

Equations (A4) and (A5) in appendix A show our general empirical specification for undeveloped natural areas and urban parks, respectively. We estimate various empirical

https://doi.org/10.1017/S1355770X23000098 Published online by Cambridge University Press

specifications, starting from a simple model that includes only monetary and non-monetary attributes using the multinomial logit model (Model 1 in appendix C). We then gradually introduce more flexibility and comprehensiveness by incorporating observable characteristics of the respondents and their households (Model 2), accounting for non-observable heterogeneity in individuals' preferences using the random-parameter logit model while keeping the monetary attribute fixed (Model 3). Additionally, we introduce a random element to the monetary parameter to address any remaining heterogeneity after including observed heterogeneity (Model 4), and allow for correlation in the coefficients of non-monetary attributes (Model 5). In this paper, the correlation of attribute coefficients is utilized to enhance the robustness of the MWTP and, therefore, is not interpreted.

2.2 Study site, data collection, and descriptive statistics

San José, the capital city of Costa Rica, serves as the main central business district for the country. It is situated in the central part of the Greater Metropolitan Area (GAM), which encompasses several municipalities across four provinces: San José, Alajuela, Cartago, and Heredia. The GAM has a population of approximately 2.6 million people, with 38 per cent residing in the province of San José proper (INEC, 2011). The municipalities within the GAM are actively implementing policies aimed at enhancing urban parks for recreational purposes and undertaking the rehabilitation of urban rivers (Torres, 2014; MSJ, 2014; AR, 2019; MINAE and GIZ, 2021).

We administered a survey to 769 households in the municipalities in the urban metropolitan area of San José province. The survey was conducted face-to-face between January and March 2017. The sample was drawn in two stages. First, the Costa Rican Statistics and Census National Institute (INEC) randomly selected a sample of 100 Primary Sample Units (PSUs) with an average of 153 households per PSU. The sample size was selected by INEC so that it represented the three socioeconomic levels (low, medium and high) of San José's urban population (26 low, 56 medium, and 18 high socioeconomic level households). Second, homes within each PSU were selected using systematic sampling. Figure 1 shows the distribution of the surveyed units by socioeconomic level. The survey is socioeconomically balanced in reference to the sample benchmark from INEC.

Table 1 shows the descriptive statistics for the most important variables for this study. Continuous and categorical variables were transformed to include them as dummy variables to facilitate the interpretation when including them interacted with choice experiment attributes. Almost half of the sample are active workers (full- or part-time), while 26 per cent were homemakers.

The female employment rate in the study site is between 40 and 48 per cent (INEC, 2011), indicating that the share of respondents that were homemakers in our sample is very acceptable. Fifty-five percent of the respondents were between 35 and 65 years old, and 35 per cent were male. The rate of the population between 30 and 65 years old in the household sample (55 per cent) is slightly higher than in the 2011 census data (46 per cent) (INEC, 2011). The homeownership rate in the sample is 69 per cent, consistent with the homeownership rate in San Jose counties in the GAM in the 2011 census (65 per cent) (INEC, 2011). The population sample in our survey is different in some dimensions from the population of the urban area of San José. The gap between the respondents in our sample and the household characteristics in the census are expectable, because in general older people and women are the ones present in the house during business hours.

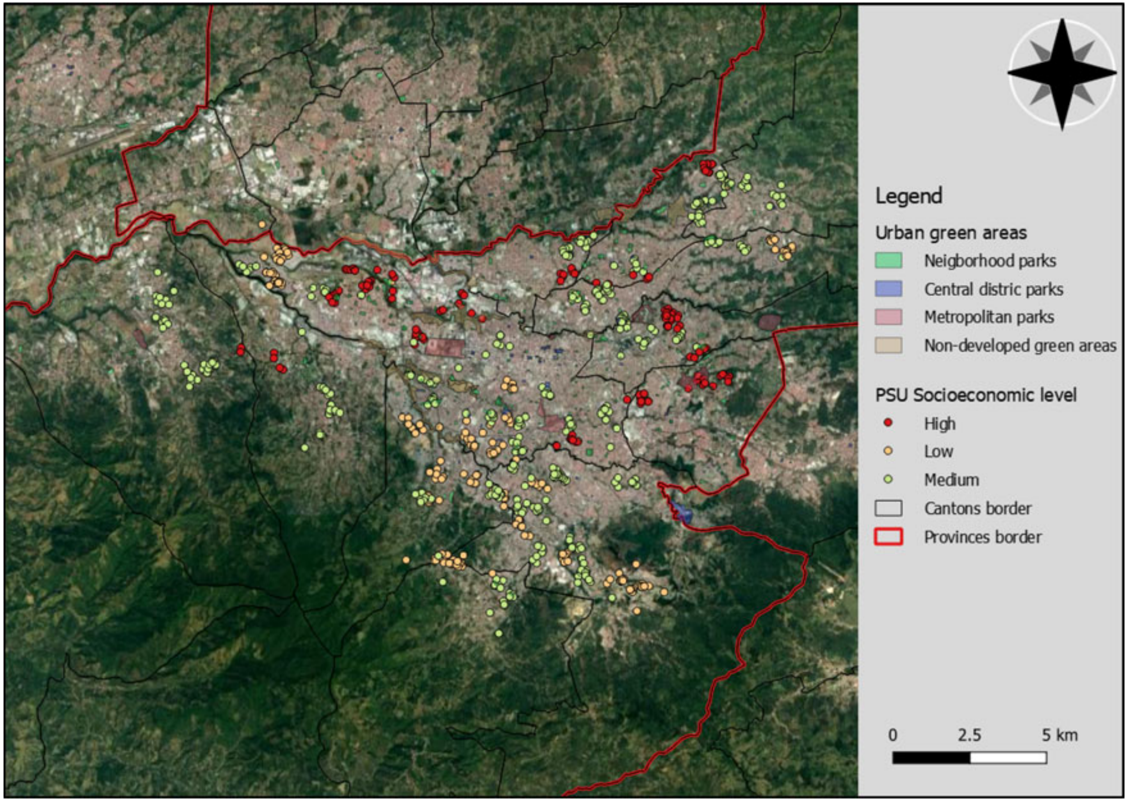

Figure 1. Distribution of households by socioeconomic level interviewed in the Greater Metropolitan Area of San José.
Source: Own elaboration, using data from the survey, Ortiz-Malavasi (2014) and © 2019 Google TerraMetrics.

Table 1. Descriptive statistics

Description			Mean	Std. Dev.
Socioeconomic	Socioeconomic level	Low (=1)	0.274	0.446
		Medium (=1)	0.550	0.498
		High (=1)	0.176	0.380
	Age category	<35 (=1)	0.326	0.469
		[35–49] (=1)	0.285	0.451
		[50–65] (=1)	0.269	0.444
		>65 (=1)	0.120	0.325
	Nationality	Costa Rican (=1)	0.853	0.354
	Gender	Male (=1)	0.354	0.478
	Employment status	Active (full or part time) (=1)	0.493	0.500
		Unemployed (=1)	0.062	0.242
		Other (student, retired, other) (=1)	0.181	0.385
		Housekeeper (=1)	0.264	0.441
	Education level	High school or less (=1)	0.694	0.461
		University or technical (=1)	0.290	0.454
		None (=1)	0.016	0.124
	Household size	≤2 persons (=1)	0.212	0.409
		>2 persons (=1)	0.788	0.409
	Kids	Kids in the house (=1)	0.536	0.499
	House property	Owner (completely paid or mortgage) (=1)	0.687	0.464
		Renter (=1)	0.290	0.454
		Other (slum, or other) (=1)	0.020	0.138
	Vehicle property	Has car (=1)	0.429	0.495
		Has car or motorbike (=1)	0.515	0.500
Parks visits	Metropolitan parks visit	Daily or weekly (=1)	0.075	0.264
		Monthly or sometimes in the year (=1)	0.501	0.500
		Never (=1)	0.424	0.494
	Central district parks visit	Daily or weekly (=1)	0.221	0.415
		Monthly or sometimes in the year (=1)	0.406	0.491
		Never (=1)	0.373	0.484
	Neighborhood parks visit	Daily or weekly (=1)	0.256	0.437
		Monthly or sometimes in the year (=1)	0.231	0.422
		Never (=1)	0.512	0.500

Continued.

https://doi.org/10.1017/S1355770X23000098 Published online by Cambridge University Press

Table 1. continued

Description			Mean	Std. Dev.
Perceptions: environment worry, neighborhood satisfaction, and Survey influence	Worry about the environment	Very or some importance (=1)	0.979	0.143
		Not much or none (=1)	0.021	0.143
	Neighborhood satisfaction	Green areas: satisfied or very satisfied (=1)	0.447	0.497
		Security: satisfied or very satisfied (=1)	0.351	0.477
		Floods in the neighborhood (=1)	0.138	0.345
	Importance of undeveloped natural areas for wildlife habitat	Some/very important (=1)	0.849	0.358
	Importance of undeveloped natural areas for flood control	Some/very important (=1)	0.818	0.386
	Importance of undeveloped natural areas for recreation	Some/very important (=1)	0.766	0.423
	Survey influence their choice	To choose some Program (=1)	0.135	0.342
		To choose SQ (=1)	0.023	0.151
		None (=1)	0.841	0.365

Notes: = 1 means a dummy variable equal to one in the category described in the table. These variables take values equal to zero or one. All variables are computed for the whole sample ($n = 769$).

To design the questionnaire, we first conducted interviews with urban green areas managers in the Municipality of San José. The interviews shed light on the main problems they face when managing urban green spaces and the variety of ecosystem services that urban green spaces can provide. Second, we conducted seven focus groups to get insights into the perception by the local population on the importance of ecosystem services, as well as to test survey comprehensibility.[3]

The survey also gathered information regarding individuals' urban parks visiting frequency, perceptions of environmental and neighborhood problems, the quality of urban green areas in their neighborhood, and the perception regarding the survey influencing their choices. All these variables are later used to control for observed heterogeneity. Around half of the sample visit metropolitan, central district, or neighborhood

[3]We first obtained written informed consent for each focus group and the survey. The informed consent explained that all data are treated confidentially, without identifiable connections between individual responses and survey participants. The focus group participants were also informed that they could, at any point in time, withdraw from the survey.

https://doi.org/10.1017/S1355770X23000098 Published online by Cambridge University Press

Table 2. Attributes and levels for the undeveloped natural areas rehabilitation program choice questions

Attributes	Description	Levels
Green dense areas	Green dense areas to improve animal, birds, insects, and plants habitat	5.3 km (15%)/8.8 km (25%)/10.5 km (35%)/17.5 km (50%) of total area to restore
Flood control	Rehabilitation of specific areas that diminishes the number of days that the streets are flooded	2 (5%)/7 (20%)/10 (25%)/12 (35%)/20 less days of streets flooded per year (50% less than the average in the last 15 years)
Recreation	Green areas bordering urban rivers, made up of paths, benches, & trash bins	5.3 km (15%)/10.5 km (35%)/17.5 km (50% of total de area to restore)
Cost	Increase in monthly electricity bill	₡250/₡500/₡1,000/₡1,500/₡2,000/₡2,500/₡3,000/₡3,500/₡5,000

Note: ₡550 (colones) ≈ USD1.

parks once a month or more frequently (table 1). In addition, almost all the respondents declared being worried about environmental problems. Forty-four per cent of the respondents declared being satisfied or very satisfied with the green areas in their neighborhood. However, the level of satisfaction is lower for security (35 per cent) and floods (13 per cent). Undeveloped green areas are recognized to be important by the respondents for species habitat (84 per cent), flood control (82 per cent), and recreation (76 per cent). Eighty-five per cent of the respondents declared that their responses were not influenced by the survey.

2.2.1 Undeveloped natural areas

The choice questions section in the survey about undeveloped natural areas began by explaining its definition and showing figure A1 in appendix B. Next, we introduced the program using text jointly with maps and pictures (figures A2 and A3 in appendix B). Using a voting format, the respondents were given four choice questions concerning restoration programs for undeveloped natural areas. The choice questions were similar in structure to those generally used in stated preference choice experiments for environmental valuation (Louviere *et al.*, 2000; Holmes *et al.*, 2017). Each choice question described alternative rehabilitation plans for urban hydrological basins and biological corridors. The alternatives show attributes describing how much of the restoration program is dedicated to dense green areas, recreational areas, and to diminishing the number of days of streets flooding; and an attribute showing a cost to be assumed by the households in order to finance the program (table 2, see appendix B for a detailed explanation). The respondents could also choose to keep things just as they were at the time of the survey by using the status quo option.

Each choice alternative also described how much it would cost to the household. The payment vehicle is a monthly increase in the electricity bill. The amounts and vehicle payments were discussed during the focus groups, resulting in a high level of agreement. Participants of focus groups did not raise concerns regarding the payment being unfair, or the vehicle inappropriate (see appendix B for a detailed explanation).

Choice questions vary the rehabilitation attributes (e.g., green density, flood control, recreation) and cost outcomes across the program alternatives that different respondents are presented with. Eliciting many choices from many different sets of programs generates data on how choices vary with program attributes, thereby revealing tradeoffs between different conservation outcomes and individuals' WTP (Siikamäki *et al.*, 2019). We constructed twenty designs with eight choice questions per design (four focused on undeveloped natural areas and four on parks). That is, we developed 80 different potential instrument designs for each attribute for each of the two choice experiments (constructing in total 160 different designs). These twenty designs were rotated between respondents to have a balanced sample both across choice sets and socioeconomic level. The choice sets utilized for each treatment were constructed using Bayesian methods for statistically efficient experimental design (Ferrini and Scarpa, 2007; Kessels *et al.*, 2012, 2018; Sándor and Wedel, 2018), because the statistical efficiency of discrete choice models is not guaranteed by the orthogonality of experimental design, but also depends on the underlying choice probabilities. We used a computerized instrument design which enables using a large number of choice set variations. To identify them, we developed a GAUSS program for using a Monte Carlo Modified Fedorov algorithm (Kessels *et al.*, 2012, 2018) to construct our overall experimental design to maximize the statistical efficiency (D-efficiency) of the parameter estimates. See Newell and Siikamäki (2014) for a detailed description of the experimental design we followed in this paper.

2.2.2 Urban parks

The choice questions section about preferences for urban parks starts by showing the respondent an urban parks typology by using pictures (figure A4 in appendix B). The urban parks in San José are mainly used for recreational activities. However, within the larger designation of all city parks and general recreational use, there are different categories useful for further classification of a specific type of park: (i) large metropolitan parks, (ii) parks in the center of individual local districts, and (iii) neighborhood parks with children's playgrounds, sometimes with a soccer or basketball field, and some green area around them. Large metropolitan parks are parks where people gather from all over the city for activities locally unavailable to them because of the lack of large open space.

We introduced to the survey participants a parks rehabilitation program (or a construction program, if there were no parks in their neighborhood) in the same way as we did the program for undeveloped natural areas (see appendix B). We emphasized that this program is independent from the undeveloped natural areas programs they had been asked about before. The attributes and levels of the choice sets for this program are shown in table 3. All the respondents faced similar choice sets concerning the attributes of neighborhood parks, as well as the parks in the center of the district. Respondents were asked to choose between rehabilitating a park or constructing a new park if one does not exist, whichever choice allocated a specific walking distance from their home.

Two versions of the choices about the metropolitan park rehabilitation/construction program were used. Almost half of the sample was asked to choose between building a new metropolitan park or not building any. The rest of the sample was asked about rehabilitating a metropolitan park at a certain walking distance from their home. This approach allowed us to understand how credible the construction of a new metropolitan park in the city is for the individuals; given space limitations to construct a new metropolitan park within city boundaries. Tables A2 and A3 in appendix B show examples of the choice cards used for each of the designs. In addition, all the respondents first reply to the questions regarding undeveloped urban areas, and next to the questions for urban parks. This can potentially represent a bias in the estimation because of order effect. However, because both designs were non-related, a priori we think this effect might be not large.

Table 3. Attributes and levels for urban park rehabilitation /construction choice questions

Attributes	Description		Levels
Neighborhood parks	Rehabilitate (or construct one, if none exist) a park in your neighborhood with soccer/basketball fields and children's playgrounds		Less than 5/15/30 min walking from your house
Metropolitan parks	Design 1	No of metropolitan parks in the city (like La Sabana, de la Paz, del Este, etc.)	No new park/One new park
	Design 2	Rehabilitate (or construct one, if none exist) a metropolitan park in the city (like La Sabana, de la Paz, del Este, etc.)	Less than 15/30/45 min walking from your house
Central district parks	Rehabilitate (or construct one, if none exist) a central district park, and turn them more lively with organized activities		Less than 15/30/45 min walking from your house
Cost	Increase in monthly electricity bill		₡500/₡1,000/₡1,500/₡2,000/₡2,500/₡3,000/₡3,500/₡5,000

Note: ₡550 (colones) ≈ USD1.

3. Results

In the empirical analysis, our first step is to estimate the MWTP for the various attributes of the two urban green space rehabilitation programs. Secondly, we examine the observed heterogeneity in individual preferences by considering how the attributes interact with socioeconomic, geographic, and individual perception variables. Subsequently, we conduct robustness checks by utilizing the entire sample without controlling for an individual's perceptions of a program. Finally, we use the estimation results for policy analysis by comparing the benefits of different policy scenarios constructed using our models versus the opportunity cost of developing the urban land.

We obtained the GIS location for 99.4 per cent of the respondents; however, we encountered difficulties in gathering geographical coordinates for a few surveys due to issues with the global positioning system (GPS) devices used during the survey. This poses a challenge when incorporating variables constructed using the GIS location. In such cases, we imputed the average distances of the PSUs to their respective places of interest.

3.1 Marginal willingness to pay for urban ecosystem services

Estimated MWTP results are based on the random parameter logit model (RPL) controlling for observed heterogeneity in the alternative-specific constant (ASC) and using correlated parameters (Models 5 in tables A4 and A5 in appendix C). All the models here and in the following sections are estimated using clustering standard error at the respondent level.[4]

[4]Because errors are clustered, LR tests are manually computed by LR $= -2\ln(L(m1)/L(m2)) = 2(ll(m2)-ll(m1)) \sim \chi^2(q)$. The LR test is only computed for these models with an equal number of observations.

https://doi.org/10.1017/S1355770X23000098 Published online by Cambridge University Press

Table 4. MWTP per attribute for undeveloped natural areas

Attribute	MWTP	Lower bound 90% confidence interval	Upper bound 90% confidence interval
Green dense (₡ per km)	81.13	26.38	135.87
Flood protection (₡ per day decrease flood)	38.10	−7.47	83.66
Recreation (₡ per km)	87.51	35.75	139.27

Note: MWTP computed using Model 5 in table A4 in appendix C.

Model 1 in tables A4 and A5 estimates a conditional logit model with the inclusion of ASC for the status quo (SQ) alternative. Model 2 incorporates observable heterogeneity in the SQ variable. Model 3 estimates the RPL considering the SQ and the non-monetary attributes to be random, and controlling for observed heterogeneity in the SQ variable. Model 4 extends Model 3 by considering the monetary attribute to be random (and its parameter to be distributed log-normal). Model 5 extends the previous model by using correlated coefficients.[5] Every additional step from Model 1 to 5 significantly improves the goodness of fit for both programs. At the end of tables A4 and A5 in appendix C we list the log-likelihood value of each model, as well as the log-likelihood ratio (LR) test to evaluate each model's fit to its closest comparable and relevant, but more restricted, alternative.

3.1.1 Undeveloped natural areas

The estimation results show that individuals have significant WTP for rehabilitating undeveloped natural areas (table 4). The results show patterns consistent with economic theory, not to mention common sense. For example, the MWTP for an increase of the surface that is rehabilitated with dense green or recreational area is positive and significant. The amount is quite similar for both attributes (between ₡81.13 and ₡97.51 per km per month).[6] The MWTP for diminishing the number of days of flooded streets is also positive, though not significant. However, in this setting, non-significance can simply mean heterogeneity in the preference of the individuals. All the model specifications for undeveloped natural areas restoration program in table A4 in appendix C show similar coefficients in sign and magnitude.

3.1.2 Urban parks

Access to rehabilitated/constructed parks is measured in 'minutes walking' from the respondent's home. To account for variations in the walking distance to the currently available parks, we determined the status quo for each respondent based on the nearest specific type of park to their home. To achieve this, we adjusted the baseline by subtracting the minutes walking to the closest park of each type, as determined by GIS data, from

[5] We run the RPL using the level of the quantitative variable as the code in the routine written for Stata by Hole (2007). We used coefficients from a conditional logit model using the same data set as starting values for the means of the coefficients, and the starting values for the standard deviations are set equal to 0.1. We used the coefficients of the RPL model with non-correlated coefficients as starting values of the RPL with correlated coefficients. We approximated the RPL using 500 Halton sequences. The parameters for the non-monetary attributes are assumed to be normally and independently distributed, while the parameter corresponding to the cost of the program is considered log-normally distributed.

[6] ₡ denotes colones, the national currency of Costa Rica. ₡550 (colones) ≈ USD1.

https://doi.org/10.1017/S1355770X23000098 Published online by Cambridge University Press

Table 5. MWTP per attribute for urban parks rehabilitation/construction

Attribute	MWTP	Lower bound 90% confidence interval	Upper bound 90% confidence interval
Neighborhood parks (₡ per min)	−28.22	−43.18	−13.27
Metropolitan (₡ per 1 new)	475.72	17.25	934.18
Metropolitan (₡ per min)	−23.08	−42.27	−3.89
Central district (₡ per min)	−6.56	−18.72	5.60

Note: MWTP computed using Model 5 in table A5 in appendix C.

the corresponding attribute presented to all individuals for each program option. This adjustment brings the baseline for all choices to zero. For example, if the closest neighborhood park to the house of a respondent is located 10 min away, and the attribute for the distance to the closest neighborhood park is 15 min away, the adjusted attribute is equal to 5 min away (15 min 10 min away), and shall be interpreted as the distance to current closest neighborhood park.

Additionally, there may be cases where the walking time to the park presented as an option on the choice card is shorter than the time required to reach the closest park from the individual's dwelling. In such instances, the adjusted attribute values become negative. This adjustment ensures that an increase in the attribute value always signifies the option to rehabilitate or construct a new park farther away from the respondent's current closest park. This transformation allows us to compute the marginal utility of changing the distance from the closest park, which is consistent with the assumption of a linear utility function. Furthermore, this transformation assumes that the marginal utility is independent of the distance to the closest park. We test this assumption later by examining the interaction between the park distance variable and the distance to the closest park.

We computed the minutes walking to that nearest type of park by using the Open Street Maps (OSM) layer for San José.[7] OSM contains a complete dataset of urban green spaces. We select all those parks relevant for our analysis, and complement the data with additional urban park layers supplied by the Housing Ministry of Costa Rica and the Parks Division of San José Municipality. To calculate the minutes walking to the nearest park of each type, we first measured the distance to the closest park of each type from each household using the GIS coordinates. Next, we compute the minutes walking to the closest park of each type by assuming that individual time by walking is 0.0123 min per meter. The walking speed was estimated by averaging 30 trips computed using Google Maps (© 2017 Google) in different parts of San José.

The MWTP for the different types of parks is significant and consistent with economic theory (table 5). People's WTP is diminished if the distance to the park that is rehabilitated/constructed is farther than the closest park to their homes. Moreover, rehabilitating neighborhood parks that are closer to people's homes is perceived as a higher benefit than the rehabilitation of the other kind of parks.

Constructing a new metropolitan park in the city, independent of its location, significantly increases the population's well-being, while the MWTP for the distance to metropolitan parks decreases, the farther away the park is from the respondents' home.

[7] © 2017 OpenStreetMap contributors https://www.openstreetmap.org/

https://doi.org/10.1017/S1355770X23000098 Published online by Cambridge University Press

The MWTP for the distance to the central district park to be rehabilitated is not significant, but as in the previous case, this can be the result of individuals' heterogeneous preferences. Estimated coefficients are similar across model specifications in table A5 in appendix C.

3.2 Heterogeneous preferences in non-monetary attributes

To understand which observed characteristics of the population drive the preferences for the different attributes, we interact each attribute with variables describing individual characteristics and beliefs (table 1). The results testing heterogeneous preferences are shown in appendix D, for the sake of space. For the RPL model specification, we keep only the main attribute level as random, but not the interactions. This means that for the RPL models, the variance of the MWTP is the same for the main attribute and for the interacted variables.

The estimation results for the undeveloped green areas are shown in table A6 in appendix D. The RPL model with correlated coefficients is extended by sequentially including interactions of the attributes with geographical, socioeconomic, and environmental beliefs and neighborhood satisfaction variables. Model 3 in table A6 show that individuals that are active workers have a significantly larger MWTP for all the attributes than the individuals in the reference group when considering the 90 per cent confidence interval. In addition, individuals with a higher education level show a significantly lower MWTP for flood protection than the reference group, while individuals between 50 and 65 years old have a significantly larger MWTP than the reference group.

The estimation results for the urban parks are shown in table A7 in appendix D. The interactions are included sequentially in four groups: distance to the different kinds of parks, socioeconomic level, environmental beliefs and neighborhood satisfaction, and frequency of visiting parks. Model 3 in table A7 show that individuals between 50 and 65 years old and living less than 15 min walking distance from central district parks have a significantly larger MWTP for rehabilitating central district parks. In addition, individuals who mention being very or somewhat worried about the environment show a significantly lower MWTP for central district parks. However, this result must be taken with caution, because the reference group of individuals who do not mention being worried about the environment has few observations. Finally, males have a significantly larger MWTP for constructing a new metropolitan park. All the other interactions are non-significant at the 90 per cent confidence level. The results for central district parks are interesting, because this was the only attribute that was non-significant in Model 5 in table A5. This means that preferences observed heterogeneity is important when considering the population's well-being.

3.3 Robustness check

To understand the robustness of our results, and how they can be extrapolated to the whole population, we estimated all the models using the full sample (appendix E). The whole dataset has 3,076 choices for the undeveloped natural areas analysis, while the number of choices considered in the parks analysis is 3,058, because a few respondents did not answer all the choice questions. The process for selecting the observations used for the main estimates is explained in appendix E.

The 90 per cent confidence intervals for all the attributes are overlapped for the analysis controlling for program perception and when using the full sample (figures A8 and

https://doi.org/10.1017/S1355770X23000098 Published online by Cambridge University Press

Table 6. Aggregate WTP and opportunity cost per policy scenario (in 2016 USD)

Scenario	Urban green area	Population	Aggregate WTP (USD)	Opportunity cost (USD)	Aggregate WTP over opportunity cost (%)
1	Undeveloped green areas	San Jose GAM	21,455,653.2 30,973,061.3	91,070,118.9	23.6 34.0
2	Eliminate all neighborhood parks	San Jose GAM	76,106,607.0 109,866,364.0	61,903,915.9	122.9 177.5
3	Construct one new metropolitan park (41.3 ha)	San Jose GAM	3,349,887.1 4,835,847.1	19,948,692.7	16.8 24.2

A9 in appendix F). This indicates that the main estimates are robust to being extrapolated to the whole sample. As expected, mean MWTP is consistently lower when not controlling for cold factors.

3.4 Policy analysis

In this section, we show how the results of this study can inform policy planning. We designed three policy scenarios for the enhancement and rehabilitation of various types of urban green spaces (table 6). Scenario 1 estimates the change in the population's well-being when implementing a program to restore 35 km of riverbanks with green dense areas. Scenario 2 estimates the change in well-being resulting from the removal of all the neighborhood parks in the GAM. Scenario 3 estimates the change in well-being if a new metropolitan park is constructed in the city.

The individual household well-being increase for each scenario is computed using the RPL model controlling for observed heterogeneity, and assumes that the parameters are correlated (Model 5 in tables A4 and A5 in appendix C). We compute the results in annual terms and convert them into US dollars (USD) using the 2016 official exchange rate of the Central Bank of Costa Rica (₡536 per USD).

Total annual WTP for scenario 1 is USD21,455,653 for the population of San Jose (table 6). If we scale it up to the whole population of the GAM, the total annual WTP is USD30,973,061.[8] The 35 km of urban rivers to be restored by the program will probably benefit the entire metropolitan region, i.e., not just the population in San José proper, but the total population of the GAM; thus, this is a consideration relevant to all GAM residents.

Seventy-nine percent of households showed an increase in their well-being when told 35 km of riverbanks with dense green areas would be restored (figure A5 in appendix C shows the distribution of the coefficient between households). The remaining households showed a decrease in their well-being when this program was implemented.

The upper panel in figure A10 in appendix F shows the geographical distribution of household annual WTP for Scenario 1. The WTP values are uniformly distributed across the map. The highest values are scattered in the central area of the city, between the Torres river and the María Aguilar river basins.

[8]The national census of households indicates that the number of households in the metropolitan area of San José is 307,082, and in the greater metropolitan area is 443,299 (INEC, 2011).

We compare these results with the opportunity cost of developing the land. The area to be restored by the program is a buffer of 30 m on each side of the river stream, stretching a distance of 35 km, equivalent to $2.1 \times 106\,\text{m}^2$. To estimate the annual opportunity cost of developing this land, we calculate the Equivalent Annual Annuity (EAA) of an alternative use of the land, which usually is commercial or residential.[9] The EAA describes a land lot for which the value is equally spread over its lifespan. To compute the EAA, we use the average value of land homogeneous zones (computed by the Finance Ministry of Costa Rica), which is equal to USD408.8 per m^2 (ONT, 2014). Firstly, for general land plots in the city, it can be seen as a minimum value as it solely represents the land itself, excluding any structures or buildings on it. Secondly, undeveloped natural areas may be situated in marginal lands, which could exhibit systematically lower values due to the risk of floods, landslides, and other negative externalities associated with such areas (see Piaggio (2021) for an analysis of the distance to undeveloped urban natural areas to house values using the hedonic approach). Thus, the average value of land in homogeneous zones can serve as an upper limit for the opportunity cost of undeveloped natural areas. For simplicity of interpretation across scenarios, we utilize the same value per square meter to assess the opportunity cost in all scenarios. To calculate the Economic Equivalent Area (EEA), we consider a 30-year time frame and apply a discount rate equivalent to the average mortgage rate in Costa Rica (10 per cent). The annual opportunity cost of not utilizing the restored land for housing amounts to USD91,070,119. Consequently, the aggregate WTP of the population in San José represents 23 per cent of the opportunity cost. When considering the population of the GAM, the aggregate WTP rises to 34 per cent of the total annual opportunity cost (table 6).

Scenario 2 estimates the WTP for not closing all neighborhood parks in the metropolitan area. To construct this scenario, we calculated the distance from each household in our sample to every neighborhood park in the GAM using the cartography described in section 3.1 (Marginal willingness to pay for urban ecosystem services). Next, we determined the additional walking time that households would face if the nearest neighborhood park to their homes were to be closed. We repeated this step until the farthest neighborhood park for each household was removed. It is important to note that we used individual marginal values to compute the removal of each park, one by one. This approach does not account for the potential increase in marginal value when park scarcity increases, thus serving as a lower bound estimate of the aggregate WTP. Additionally, this estimation is equivalent to assessing the welfare loss that households would experience if they had to walk to the park farthest from their homes.

The median WTP per household for avoiding the closure of all the neighborhood parks is USD248 per year. The middle panel in figure A10 in Appendix 6 shows the WTP per household to avoid the closure of all the neighborhood parks in the city (Scenario 2). A cluster of households in the southern part of San José shows a higher WTP. The number of parks in this area of the city is lower. This means that every time a neighborhood park is closed, these households might have to travel farther to reach the next closest park. Other factors that can explain this result is that households in the southern part of San José have a larger WTP per minute they have to walk to reach a rehabilitated park. However, when mapping the households' WTP, these do not look to be different from the ones in other parts of the city. In addition, the well-being of 11 per cent of

[9] $\text{EAA} = \frac{r*\text{price}}{1-(1+r)^{-n}}$, where r is the mortgage rate, *price* is the real estate market selling price, and n is the life span of the building.

https://doi.org/10.1017/S1355770X23000098 Published online by Cambridge University Press

households in the sample increases because of the closure of neighborhood parks. This is explained by the existence of heterogeneous preferences (figure A6 in appendix C shows the distribution of the coefficient between households).

We considered the closure of all neighborhood parks in the GAM because, even though some households are located in specific provinces, they may be willing to substitute the closure of the closest neighborhood park with a park in another province within the GAM simply because it is closer than other parks in different parts of the city. Using the cartography described in section 3.1, we estimate that there are 566 neighborhood parks in the GAM. Based on this, the aggregated annual WTP for not closing all the neighborhood park in the GAM is USD76,106,607 in San José and USD109,866,364 when considering the population of the metropolitan area (table 6). The EEA of a neighborhood park with a size equal to the median in our cartography (2,522 m^2) is USD61,903,916. The aggregate WTP in San Jose represents around 123 per cent of the opportunity cost of developing the neighborhood parks (table 6). This percentage increase to 178 per cent when considering the population in the GAM.

Median households WTP for an additional metropolitan park is USD10.90 per year (figure A6 in appendix C shows the distribution of the coefficient between households and lower panel in figure A10 in appendix F show the geographical distribution). The aggregate annual WTP per household for an additional metropolitan park is USD3,349,887 for San José's population, and USD4,835,847 when considering the whole population of the metropolitan area (table 6). We compute the opportunity cost of transforming 46 ha into a metropolitan park using the same assumptions as before.[10] The EEA is USD19,948,693. The increase in well-being of the population through developing a metropolitan park represents between 16.8 and 24.2 per cent of the opportunity cost, depending on the aggregation level (table 6).

4. Discussion

The results of this paper demonstrate that individuals perceive an improvement in their well-being when rehabilitating undeveloped natural areas and urban parks. On average, households are willing to pay USD32 per year to rehabilitate 17.5 km of urban rivers with densely vegetated areas.[11] On average, the annual WTP amounts to USD35 for constructing paths and benches along 17.5 km of the riverside, enhancing recreational opportunities for the three main urban rivers in San José, Costa Rica. Moreover, although diminishing the number of days of flooding through interventions at the riverbanks was on average insignificant, we can robustly confirm that some individuals' welfare increases when modeling heterogeneous preferences. On average, individuals are willing to pay USD8.50 per year to reduce the number of flooded street days by 10 days per year, representing a 25 per cent decrease compared to the fifteen-year average. These values reflect the substantial importance that people attribute to the ecosystem services provided by the river banks of San José.

When considering the restoration and/or construction of urban parks, households, on average, are willing to pay USD3.50 per year for rehabilitating a park that is 5 min closer in walking distance to their homes compared to another park to be rehabilitated/constructed. Additionally, individuals are willing to pay USD10.70 per year, on average, for the construction of a new metropolitan park. These results highlight two

[10] 46 ha is the average size of the city's four metropolitan parks.

[11] Our selected model is Model 5 in tables A4 and A5 in appendix C.

https://doi.org/10.1017/S1355770X23000098 Published online by Cambridge University Press

important facts. Firstly, people place value on having shorter travel times to well-maintained urban parks. Secondly, people appreciate the expansion of large green areas within the city, potentially as a counterbalance to the prevalence of concrete, cars, and the resulting human-made problems, such as traffic congestion.

The increase in the well-being of the population resulting from the construction of a new metropolitan park, regardless of its location in the city, is equivalent to restoring 5.9 km of undeveloped green areas for biodiversity habitat or 5.4 km of undeveloped green areas for recreational use. Alternatively, it is comparable to rehabilitating or constructing a new neighborhood park that is 17 min closer in walking distance to residents' homes compared to another park. We utilized the coefficients obtained from our estimations to analyze three policy scenarios: (i) the restoration of 35 km of riverbanks with dense green areas, (ii) the prevention of closure of all neighborhood parks in the GAM, and (iii) the construction of one new metropolitan park. In each scenario, we compared the increase in the population's well-being with the opportunity cost of not developing the corresponding land. For Scenarios 1 and 3, the increases in well-being range from 17 to 35 per cent of the opportunity costs associated with developing the plots. The well-being increases resulting from the avoidance of closure of all neighborhood parks are 1.2 to 1.8 times the opportunity costs of developing that land.

However, it is important to carefully consider these results for several reasons. First, the lack of accurate cartography of urban green areas and reliable housing market values for San José introduces potential sensitivity to the policy analysis results. Second, in the case of riverbank restoration, households exhibit a higher MWTP when these areas are restored for recreational purposes. Third, the current undeveloped natural areas may be situated on marginal lands, which could significantly reduce their value compared to the average price of plots used in this study. Fourth, while the scenario of removing all neighborhood parks in the GAM is not realistic, it serves as a benchmark for assessing the benefits associated with such areas. Moreover, this scenario represents a non-marginal change, and thus, the interpretation of MWTP in this context requires careful consideration. However, the analysis presented above provides insights into the potential future trends, where increasing incomes and evolving preferences of future generations may lead to a higher demand for urban green areas and parks.

Finally, some predictors used to model preference heterogeneity may be endogenous, such as variables related to environmental care preferences. In such cases, hybrid models may be more appropriate (Abou-Zeid and Ben-Akiva, 2014). It is worth noting that the issue of not using hybrid models is less prominent when analyzing data from stated preference experiments, where it is reasonable to assume that people's attitudes influence their choices in the stated preference experiment (Abou-Zeid and Ben-Akiva, 2014). Future developments in this field could explore the differences across estimation methods.

5. Conclusions

Urban green spaces are primarily recognized for the recreational opportunities they provide to the population. However, urban green spaces is a broader concept, including other type of green spaces, like riverbanks, green belts, shrublands, forests, and wetlands. Urban green spaces bring many other ecosystem services to the population besides just recreational activities, e.g., water flow regulation and runoff mitigation; air purification; or vistas and aesthetic benefits from parks, landscapes or street trees. The population and the authorities often ignore these benefits.

In this paper we showed that individuals assign substantial value to the restoration of undeveloped natural areas and parks rehabilitation/construction in San José, Costa Rica. This information can help to prioritize urban green space policies and to estimate values for different urban green spaces to be included in benefit–cost analyses when proposing alternatives for urban development. Moreover, the results can help to better frame green area conservation policies, in the service of getting greater public acceptance.

This is one of the first papers, to our knowledge, to try to link ecological endpoints from urban green spaces and changes in the population's well-being, considering both undeveloped green areas and urban parks. However, there is still a long way to go to better understand how to increase conservation of urban green areas. The population does not easily recognize many of the ecosystem services that urban green spaces provide, and it is not easy for individuals to understand the benefits accruing to them from nature. In that sense, this paper can help to better frame policies supporting co-produced ecosystem services to increase public acceptance of such policies.

Supplementary material. The supplementary material for this article can be found at https://doi.org/10.1017/S1355770X23000098.

Acknowledgements. This paper is an output of the *Ecosystem Services Accounting for Development* (ESAfD) project, conducted together by the Environment for Development initiative and the Swedish Environmental Protection Agency, and funded by the Swedish International Development Cooperation Agency (Sida). We are grateful to the whole ESAfD team for their comments and suggestions during all the meetings we held in 2015–2017. We are also grateful to Jessica Chu (RFF) for her work in processing the GIS data, and to Marisol Guzmán and Eduardo Pacay for research assistance. Also, this paper has benefitted from the help and feedback in the phase of experiment design by Gabriela Sánchez, Jenaro Campos, Alfonso Salas, Alexander Cortes, Sussy Salazar (MSJ), Sergio Feoli (CNFL), and Geovanny Sanabria (MIVAH), and from useful feedback during the XI EfD Annual Meeting.

Competing interests. The authors declare none.

References

Abildtrup J, Garcia S, Olsen SB and Stenger A (2013) Spatial preference heterogeneity in forest recreation. *Ecological Economics* **92**, 67–77.

Abou-Zeid M and Ben-Akiva M (2014) Hybrid choice models. In Hess S and Daly A (eds). *Handbook of Choice Modelling*. Cheltenham, UK: Edward Elgar Publishing, pp. 383–412.

AR (2019) MINAE planea replicar el parque La Sabana en ocho puntos de la GAM. Available at https://www.ameliarueda.com/nota/4.500-hectareas-urbanas-area-metropolitana-seran-parques-recreativos (in Spanish).

Arnberger A and Eder R (2011) The influence of age on recreational trail preferences of urban green-space visitors: a discrete choice experiment with digitally calibrated images. *Journal of Environmental Planning and Management* **54**, 891–908.

Aspinall PA, Thompson CW, Alves S and Sugiyama T (2010) Preference and relative importance for environmental attributes of neighbourhood open space in older people. *Environment and Planning B Planning and Design* **37**, 1022–1039.

Bae H (2011) Urban stream restoration in Korea: design considerations and residents' willingness to pay. *Urban Forestry & Urban Greening* **10**, 119–126.

Basri BK (2011) Valuing the attributes of Malaysian recreational parks: a choice experiment approach. PhD thesis, School of Agriculture, Food and Rural Development, Newcastle University.

Bullock CH (2008) Valuing urban green space: hypothetical alternatives and the status quo. *Journal of Environmental Planning and Management* **51**, 15–35.

CBD COP (2008) Report of the conference of the parties to the Convention on Biological Diversity on the work of its ninth meeting. Available at https://www.cbd.int/decisions/cop/?m{\mathsurround=\opskip$=$}cop-09

Cho S-H, Bowker JM and Park WM (2006) Measuring the contribution of water and green space amenities to housing values: an application and comparison of spatially weighted hedonic models. *Journal of Agricultural and Resource Economics* **31**, 485–507.

Cvejić R, Eler K, Špela Železnikar MP, Haase D, Kabisch N and Strohbach M (2015) A typology of urban green spaces, ecosystem services provision services and demands. Report D3.1, Work package 3 of EU FP7 (ENV.2013.6.2-5-603567) GREEN SURGE project (2013–2017).

Daams MN, Sijtsma FJ and van der Vlist AJ (2016) The effect of natural space on nearby property prices: accounting for perceived attractiveness. *Land Economics* **92**, 389–410.

del Saz Salazar S and García Menéndez L (2007) Estimating the non-market benefits of an urban park: does proximity matter? *Land Use Policy* **24**, 296–305.

Ferrini S and Scarpa R (2007) Designs with *a priori* information for nonmarket valuation with choice experiments: a Monte Carlo study. *Journal of Environmental Economics and Management* **53**, 342–363.

Gómez-Baggethun E and Barton DN (2012) Classifying and valuing ecosystem services for urban planning. *Ecological Economics* **86**, 235–245.

Hole AR (2007) Fitting mixed logit models by using maximum simulated likelihood. *The Stata Journal* **7**, 388–401.

Holmes TP, Adamowicz WL and Carlsson F (2017) Choice Experiments. In Champ PA, Boyle KJ and Brown TC (eds), *A Primer on Nonmarket Valuation*, 2d Edn. Netherlands: Springer, pp. 133–186.

INEC (2011) X Censo Nacional de Población y VI de Vivienda: Resultados Generales. San José, Costa Rica. Available at https://www.cipacdh.org/pdf/Resultados_Generales_Censo_2011.pdf (in Spanish).

Kessels R, Jones B, Goos P and Vandebroek M (2012) An efficient algorithm for constructing Bayesian optimal choice designs. *Journal of Business & Economic Statistics* **27**, 279–291.

Kessels R, Goos P and Vandebroek M (2018) A comparison of criteria to design efficient choice experiments. *Journal of Marketing Research* **43**, 409–419.

Kolbe J and Wüstemann H (2014) Estimating the value of urban green space: a hedonic pricing analysis of the housing market in Cologne, Germany. *Folia Oeconomica Stetinensia* **5**, 43–58.

Kulshreshtha SN and Gillies JA (1993) The economic value of the South Saskatchewan River to the city of Saskatoon: (II) estimation of the recreational use value. *Canadian Water Resources Journal* **18**, 369–383.

Lo AY and Jim CY (2010) Willingness of residents to pay and motives for conservation of urban green spaces in the compact city of Hong Kong. *Urban Forestry & Urban Greening* **9**, 113–120.

Louviere J, Hensher DA and Swait J (2000) *Stated Choice Methods: Analysis and Applications*. Cambridge: Cambridge University Press.

MINAE and GIZ (2021) Corredor Biológico Interurbano Río Torres | Biodiver_ City San José. Available at http://biocorredores.org/biodiver-city-sanjose/sobre-el-proyecto/el-proyecto (in Spanish).

MSJ (2014) Corredor biológico. Available at https://www.msj.go.cr/informacion_ciudadana/ambiente/SitePages/corredor_biologico.aspx (in Spanish).

Newell RG and Siikamäki J (2014) Nudging energy efficiency behavior: the role of information labels. *Journal of the Association of Environmental and Resource Economists* **1**, 555–598.

ONT (2014) Guía Técnica Actualización de las Plataformas de Valores de Terrenos por Zonas Homogéneas. Órgano de Normalización Técnica (in Spanish).

Ortiz-Malavasi E (2014) Atlas de Costa Rica 2014. Available at https://repositoriotec.tec.ac.cr/handle/2238/6749

Piaggio M (2021) The value of public urban green spaces: measuring the effects of proximity to and size of urban green spaces on housing market values in San josé, Costa Rica. *Land Use Policy* **109**, 105656.

Sándor Z and Wedel M (2018) Heterogeneous conjoint choice designs. *Journal of Marketing Research* **42**, 210–218.

Siikamäki JV, Krupnick A, Strand J and Vincent JR (2019) International willingness to pay for the protection of the Amazon Rainforest. World Bank Policy Research Working Paper No. 8775, Washington DC.

Tavárez H and Elbakidze L (2019) Valuing recreational enhancements in the San Patricio Urban Forest of Puerto Rico: a choice experiment approach. *Forest Policy and Economics* **109**, 102004.

Tavárez H and Elbakidze L (2021) Urban forests valuation and environmental disposition: the case of Puerto Rico. *Forest Policy Economics* **131**, 102572.

Torres J (2014) Corredor biológico río Torres sería el primer corredor interurbano del país. Available at https://archivo.crhoy.com/corredor-biologico-rio-torres-seria-el-primer-corredor-interurbano-del-pais-u4l7x/nacionales/ (in Spanish).

Train KE (1998) Recreation demand models with taste differences over people. *Land Economics* **74**, 230–239.

Traoré SAA and Salles J-M (2014) Urban park's ecological and recreational aspects in developing country: evaluating the Bãngr-Weoogo park in Ouagadougou. In Conférence annuelle de la FAERE, 18 p.

Tu G, Abildtrup J and Garcia SS (2016) Preferences for urban green spaces and peri-urban forests: an analysis of stated residential choices. *Landscape and Urban Planning* **148**, 120–131.

Tuffery L (2017) The recreational services value of the nearby periurban forest versus the regional forest environment. *Journal of Forest Economics* **28**, 33–41.

Tyrväinen L (1997) The amenity value of the urban forest: an application of the hedonic pricing method. *Landscape and Urban Planning* **37**, 211–222.

UN-Habitat (2016) *World Cities Report 2016: Urbanization and Development – Emerging Futures*. United Nations Human Settlements Programme (UN-Habitat).

United Nations (2015) Transforming our world: the 2030 Agenda for Sustainable Development. Available at https://sdgs.un.org/2030agenda

United Nations (2019) The sustainable development goals report, 2019. Available at https://unstats.un.org/sdgs/report/2019/The-Sustainable-Development-Goals-Report-2019.pdf

USEPA (2016) Generic ecological assessment endpoints (GEAEs) for ecological risk assessment: second edition with generic ecosystem services endpoints added. U.S. Environmental Protection Agency, Washington, DC.

Cite this article: Piaggio M, Siikamäki J (2024). Nature in the concrete jungle: valuing urban ecosystem services in Costa Rica. *Environment and Development Economics* **29**, 19–38. https://doi.org/10.1017/S1355770X23000098