VALUATION OF CULTURAL ECOSYSTEM SERVICES IN URBAN PARKS*

teremos um subtitulo?

Abstract

The text of your abstract. 150 – 250 words.

Introduction

The world population may grow 26% by the year 2050, from the current 7.7 billion to 9.7 billion(Nations 2019). This will lead to an even greater increase in the population in urban areas, especially in regions such as Latin America that already have around 81% of their population living in these areas (Nations 2018). This scenario increases the concern with maintaining and / or improving the well-being conditions for this population. And in this regard, it is considered that the well-being of the inhabitants of urban areas depends on an adequate supply of ecosystem services (Keeler et al. 2019).

Understood as nature's contributions to people, ecosystem services are vital for human existence and good quality of life. However, they are generally distributed unevenly in space, time and between different segments of society (Díaz et al. 2019). Of particular interest to the well-being of urban populations, cultural ecosystem services are public goods, produced by ecosystems that affect people's physical and mental states. Cultural services are characterized mainly as environments, places or environmental situations that give rise to changes in people's physical or mental states (Haines-Young and Potschin-Young 2018). And therefore, in a context of greater urbanization, special attention should be paid to urban green spaces as a guarantee of offering this type of ecosystem service, and ensuring the integration of these spaces in city planning (Liu et al. 2020).

These benefits provided by urban green areas are still important when cities seek to offer a variety of services that contribute to increasing the quality of life of their inhabitants. Initiative that already found support in the agenda of the Sustainable Development Goals - SDGs, gains even more momentum with the greater importance given to these spaces after the long period of confinement caused by the Pandemic of COVID-19.

However, unlike developed countries, in Brazil and Latin America, the literature on this issue is still scarce. There are few studies that explore the association between green areas and well-being in urban areas in Brazil (Amato-Lourenço et al. 2016; Camargo et al. 2018; Londe and others 2014; Silveira and Junger 2018). There are also few studies on the economic valuation of these areas. These productions are concentrated in the southern region of the country and focused on individual parks. And in general, cultural ecosystem services are less evaluated or evaluated inappropriately (Ridding et al. 2018) and for this reason they are seldom present in studies in this area (Boerema et al. 2017). This scarcity makes it difficult to understand the potential benefit that urban green spaces can bring to the Brazilian population (Arana and Xavier 2017). And the importance of investments by the government in these areas.

In this article, we seek to contribute to fill this information gap and demonstrate the importance of urban parks as sources of provision of cultural ecosystem services in the city of Recife. As a differential, we do not study only one park, but all urban parks recognized by the city and which had specific equipment for physical activities. We used questionnaires applied to users of all parks to characterize them and we used the contingent valuation method to estimate the monetary value. Among other contributions, the results

*Grants or other notes about the article that should go on the front page should be placed here. General acknowledgments should be placed at the end of the article.

demonstrate that the parks in Recife have a greater coverage than usual and that users with lower income groups value these areas more than users with lower income.

Methodology

Study Area

The place of study was the Municipality of Recife, capital of the state of Pernambuco, in the Northeast region of Brazil. The municipality has 10 public parks and countless squares spread over the 94 neighborhoods that compose it. The area covered by the squares parks is equivalent to 8.2% of the municipal territory. These 10 areas have structures known as city gyms, spaces with equipment and classes of different modalities, in addition to other leisure equipment (Figure 1).

inserir figura do mapa

Survey methods and questionnaire design

We conducted the survey between December 2018 and March 2019 among the local residents of the city of Recife that uses at least one of the 9 parks of the city. The survey method was face-to-face personal interviews by means of a structured questionnaire and was applied to 1281 questionnaires. All procedures were according to the rules of resolution 510/1617 (BRASIL, 2016), the opinion survey format was prepared and did not request any identification.

We gathered data among the Recife users population's universe, configuring a non-probabilistic sample with a convenience bias. We recognize the sampling scheme has not achieved a representative sample of the city's households. All the analyses and estimates were performed with the R Studio 4.0 software. The dataset is available in csv format at a Github repository [https://github.com/cccneto/valuation_urbanParks].

The current survey was tested through a pilot study/previous survey in one of the city parks (CITAR ARTIGO DO ARACA). We have constructed the bid vector for the dichotomous choice questions based on the analysis of the WTP responses in the previous survey. The questionnaire's structure was based on the NOAA panel recommendations for CVM studies (Arrow et al., 1993). The questionnaire consisted of a set of 17 questions.

In the first part, we surveyed respondents' socio-economic and household characteristics from age at least 18 years. In the second part we asked about: a) the visit purpose to the park, b) the frequency visits to the park, c) the main criteria determining the decision to visit a park, d) their perceptions about the park characteristics (e.g. infrastructure, maintenance, size, security), finally, e) their perception about the presence of ecosystem services in the park.

The final part we described the hypothetical scenario and the valuation questions. In this scenario, we presented a change in the park's vegetal cover to the respondents, focusing on the transformation of the environmental quality of the area. It is important to say the interviewer did a relevant visual presentation of the changes in the scenario presented (i.e. images before and after the park development).

In the approach to respondents on the park, we asked residents if they wanted to participate in this research (i.e., if they agree to respond to the survey questions). After the two initial parts of the questionnaire, we asked how much they would be willing to pay for the changes presented to them. The interviewer explained their answers would be useful to the decision-making and planning process. About the WTP question, we adopted a close-ended format to better approximate real market transactions (i.e., take-it or leave-it decisions). We have have adopted the a double-bounded (DB) dichotomous choice format following the recommendations of the NOAA panel (Arrow et al., 1993) and Hanemann (1984). The procedures presents to respondents an initial bid value, randomly selected from a set of 70 bid levels - R$ 1 to R$ 70. If the response was "yes" a follow-up question with a higher bid was asked, while a "no" response led to a lower bid level. The value amount would be annually collected by the municipal authority and would be exclusively devoted to cover the development costs of the park.

Theoretical Model

According to Groothuis and Whitehead (2002), econometric models of dichotomous choice have been an instrument widely used to address issues related to contingent valuation. O Modelo de utilidade randômica fornece as bases teóricas para a análise de Métodos de Valoração Contingente.In this model an individual could choose to pay a donation fee for the conservation of the services provided by the studied area if the following conditions are met (Hanemann, 1984):

$$u(y, X) = u(y - t, q, X) \tag{1}$$

$$u(y, X) = u(y_j X_j) + \epsilon_{0j}) \tag{2}$$

$$v(1, y - t; X) + \epsilon_1 \geq v(0, y, X) \tag{3}$$

Where u is the respondent's utility function, v is the indirect utility function, 1 represents the donation payment and 0 represents the non-payment, y is the respondent's individual income, the amount of the bid made to the respondent, X represents other socioeconomic characteristics that affect the respondent's preferences. The difference between the utilities Δv determines the payment or not of the donation:

$$\Delta v = (1, y - t; X) - v(0, y, X) + \epsilon_1 + \epsilon_0 \tag{4}$$

The MVC dichotomous choice format requires a qualitative choice model. The use of a linear distribution of the WTP and a Bivariate Probit Model (BPM), was developed based on the model by Cameron & Quiggin (1994). It is assumed that the error of the second dichotomous question is correlated with the error of the first question. For this reason, we follow Alberini's (1995) recommendation for the choice of bivariate dichotomous models, because if the coefficient correlation, $\rho \neq 1$, it is clear that, in general, the second WTP does not perfectly match the first and can be interpreted as a revised version of the amount of the first WTP. If WTP values are independently determined, then $\rho = 0$. For all other values of the correlation coefficient, the interval $0 < \rho < 1$ is valid, which implies that the correlation between the two WTP values is less than perfect.

Considering these aspects, the modeling of the data generated by the questions in the double limit dichotomous choice format was achieved by the following formulation:

Linear Model

$$\Delta Y_i(yes|no) = \alpha_0 + \alpha_1 Age + \alpha_2 D_{1i} + \alpha_3 D_{2i}$$
$$+\alpha_4 D_{3i} + \alpha_5 D_{4i} + \alpha_6 Tempo_i + \beta_1 Bid_{12i} + \epsilon_i$$

Y_i is the dependent variable and reports the respondent's answer ($yes = 1$ or $no = 0$) to the Bid, Age_i is the age of the respondent, D_{1i} is the dummie variable for the Sex of the respondent (man = 1, woman = 0), D_{2i} is a dummie for the respondent's education (complete higher education = 1), D_{3i} is a dummie for respondent assessing regarding the temperature in the park (good / excellent = 1), D_{4i} is a dummie for assessing the respondent regarding of the park's infrastructure (good / great = 1), Bid_i are the variables for the values drawn as bids to respondents.

The WTP_{ij} component represents the respondent's $j - th$ willingness to pay and $i = 1, 2$ denotes the first and second questions, respectively.

$$WTP_{ij} = X'_{ij}\beta_i + \epsilon_{ij} \tag{5}$$

The WTP depends on a systematic component given by the observed characteristics of the interviewee ($X'_{ij}\beta_i$), as well as a random random component ($ij \sim N(0, \sigma^2)$).

$$Pr(yes, no) = Pr(WTP_{1j} \geq t^1, WTP_{2j} < t^2) \tag{6}$$

$$Pr(yes, no) = Pr(X'_1\beta_1 + \epsilon_{1j} \geq t^1, X'_2\beta_2 + \epsilon_{2j} < t^2) \tag{7}$$

Since the other sequence of possible responses can be constructed in an analogous way, which allows building the likelihood function:

$$\begin{aligned} L_j(\mu|t) = Pr(X'_1\beta_1 + \epsilon_{1j} \geq t^1, X'_2\beta_2 + \epsilon_{2j} < t^2)^{yn} * \\ Pr(X'_1\beta_1 + \epsilon_{1j} < t^2, X'_2\beta_2 + \epsilon_{2j} \geq t^2)^{ny} * \\ Pr(X'_1\beta_1 + \epsilon_{1j} > t^1, X'_2\beta_2 + \epsilon_{2j} \geq t^2)^{yy} * \\ Pr(X'_1\beta_1 + \epsilon_{1j} < t^1, X'_2\beta_2 + \epsilon_{2j} < t^2)^{nn} \end{aligned}$$

Given a sample of n respondents, we have that the function of logarithmic probability of the responses to the first and second moves of the dichotomous choice with double limit is:

$$\begin{aligned} Ln(L_j(\mu|t)) = yn \ln((X'_1\beta_1 + \epsilon_{1j} \geq t^1, X'_2\beta_2 + \epsilon_{2j} < t^2) * \\ nyPr(X'_1\beta_1 + \epsilon_{1j} < t^2, X'_2\beta_2 + \epsilon_{2j} \geq t^2) * \\ yyPr(X'_1\beta_1 + \epsilon_{1j} > t^1, X'_2\beta_2 + \epsilon_{2j} \geq t^2) * \\ nnPr(X'_1\beta_1 + \epsilon_{1j} < t^1, X'_2\beta_2 + \epsilon_{2j} < t^2)) \end{aligned}$$

Once the regression is estimated, the estimated WTP is calculated as:

$$\widehat{WTP} = \frac{\hat{\alpha}\overline{X_i})}{\hat{\beta}} \tag{8}$$

Results

After processing the data, 1144 questionnaires were used. Considering the estimated population of 1,653,461 inhabitants of the city, and the distribution between age groups, income, sex and place of residence, the data are representative for the city. Among the interviewees, 51.68% were female; 48.32 male. The vast majority of respondents 92.82% were young adults (<65 years), living in 94 neighborhoods in the city (Table 1).

Regarding the profile of respondents, 45.9 of the respondents are female, the average age is about 41.3 years (sd = 14.8). The average monthly income is R\$1.800, and the median income was estimated to be between R\$41 and R\$61.200. Only 25.9 hold a degree from a university or from a technological educational institute.About the use of dummy variables, we focused on respondents assessing their self-perception on the temperature in the park, and regarding the park's infrastructure. About 31.8 beliefs that the park has a nice temperature because of the natural cover to the park. And 55.4 evaluated the "infrastructure as good/great. These variables were included in the analysis because it was expected to affect positively the probability to participate in the project, as well the respondent's WTP.(ver tabela x)

```
# Proporção de respostas por parque
resp_parq <- base %>%
  group_by(parque) %>%
  na.omit() %>%
      mutate(resp1 = as.numeric(resp1),
             resp2 = as.numeric(resp2)) %>%
      summarise(yy = sum(resp1==1 & resp2==1),
                yn = sum(resp1==1 & resp2==0),
                ny = sum(resp1==0 & resp2==1),
                nn = sum(resp1==0 & resp2==0)) %>%
    group_by(parque) %>%
    summarise(freq_yy = yy / sum(yy, yn, nn, ny)*100,
            freq_yn = yn / sum(yy, yn, nn, ny)*100,
            freq_ny = ny / sum(yy, yn, nn, ny)*100,
            freq_nn = nn / sum(yy, yn, nn, ny)*100,
            total_quest = sum(yy, yn, nn, ny))  %>%
    arrange(desc(freq_yy, freq_yn))

resp_parq
```

```
## # A tibble: 9 x 6
##   parque            freq_yy freq_yn freq_ny freq_nn total_quest
##   <chr>               <dbl>   <dbl>   <dbl>   <dbl>       <int>
## 1 jaqueira             69.7     0      7.75   22.5          142
## 2 macaxeira            50.5     0     13.5    36.0          111
## 3 santosdumont         48.4    36.7    6.25    8.59         128
## 4 santana              40.5    13.7   19.6    26.2          168
## 5 lindu                37.4    21.5   11.2    29.9          107
## 6 13demaio             34.8    23.2    6.52   35.5          138
## 7 sitio da trindade    21.1    56.6    9.21   13.2           76
## 8 lagoaaraca           18.9    21.6    2.63   56.8          190
## 9 caiara               15.9    18.3   23.2    42.7           82
```

Inserir detalhamento das respostas por parque e geral

```
# respostas por parque
num_total <- base %>%
  na.omit() %>%
  mutate(resp1 = as.numeric(resp1),
         resp2 = as.numeric(resp2)) %>%
  summarise(yy = sum(resp1==1 & resp2==1),
            yn = sum(resp1==1 & resp2==0),
            ny = sum(resp1==0 & resp2==1),
            nn = sum(resp1==0 & resp2==0))

num_total
```

```
##    yy  yn  ny  nn
## 1 438 224 119 361
```

```
# frequencia das respostas - todos parques
freq_total<- num_total %>%
  summarise(freq_yy = yy / sum(yy, yn, nn, ny)*100,
            freq_yn = yn / sum(yy, yn, nn, ny)*100,
            freq_ny = ny / sum(yy, yn, nn, ny)*100,
            freq_nn = nn / sum(yy, yn, nn, ny)*100) %>%
```

```
  arrange(desc(freq_yy, freq_yn)) %>%
  round(digits = 2)

freq_total
```

```
##   freq_yy freq_yn freq_ny freq_nn
## 1   38.35   19.61   10.42   31.61
```

WTP results

The results from the BP regression for the general sample are shown in Table x. The estimations for Eq. (1) are shown in the upper part of the Table, while the estimation for Eq. (2) in the lower part. The probability that WTP be equal or higher to the two bids amount is influenced by the respondent's own characteristics and by a series of independent variables that reflect her/his preferences for the ES being valued. The coefficient on the bid was negative and significant in both equations, which indicates as the price increased the probability of a positive answer to the WTP question decreased.

```
##
## COPULA:   Gaussian
## MARGIN 1: Bernoulli
## MARGIN 2: Bernoulli
##
## EQUATION 1
## Link function for mu.1: probit
## Formula: resp1 ~ lance1 + idade + sexo + escolar + temperatura + infraestrutura
##
## Parametric coefficients:
##                 Estimate Std. Error z value Pr(>|z|)
## (Intercept)     0.635419   0.144080   4.410 1.03e-05 ***
## lance1         -0.020311   0.002000 -10.154  < 2e-16 ***
## idade          -0.006643   0.002616  -2.540  0.01109 *
## sexo            0.073047   0.077620   0.941  0.34666
## escolar         0.216602   0.091525   2.367  0.01795 *
## temperatura     0.270258   0.086305   3.131  0.00174 **
## infraestrutura  0.503613   0.080887   6.226 4.78e-10 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##
## EQUATION 2
## Link function for mu.2: probit
## Formula: resp2 ~ lance2 + idade + sexo + escolar + temperatura + infraestrutura
##
## Parametric coefficients:
##                 Estimate Std. Error z value Pr(>|z|)
## (Intercept)     0.528728   0.141845   3.728 0.000193 ***
## lance2         -0.015654   0.001999  -7.832 4.79e-15 ***
## idade          -0.010806   0.002530  -4.272 1.94e-05 ***
## sexo            0.172253   0.074038   2.327 0.019989 *
## escolar        -0.067069   0.086997  -0.771 0.440745
## temperatura    -0.025151   0.083284  -0.302 0.762659
## infraestrutura  0.651171   0.077040   8.452  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
##
##
## n = 1144  theta = 0.787(0.716,0.841)  tau = 0.577(0.508,0.636)
## total edf = 15
```

The results for the general sample indicate that WTP from the first equation (Eq 1) was influenced positively by the level of education, and by the respondent's perceptions about infrastructure and temperature of the park, while was negatively affected by the respondent's age. The variable gender wasn't statistically significant.

in the second equation, the results for the general sample indicate that WTP wasn't influenced positively by the age of respondents, but does by respondent's perceptions about infrastructure. Opposite to the first equation, the level of education and the respondent's perceptions about the temperature of the park weren't statistically significant.

inserir tabela com proporcao das respostas y e n's

Discussion

Conclusions

Policy implications

Verificar texto do D. Latinopoulos et al. 2016

Amato-Lourenço, Luís Fernando, Tiana Carla Lopes Moreira, Bruna Lara de Arantes, Demóstenes Ferreira da Silva Filho, and Thais Mauad. 2016. "Metrópoles, Cobertura Vegetal, áreas Verdes e Saúde." *Estudos Avançados* 30 (86): 113–30.

Arana, Alba Regina Azevedo, and Fernanda Berguerand Xavier. 2017. "Qualidade Ambiental e Promoção de Saúde: O Que Determina a Realização de Atividades fisicas Em Parques Urbanos?" *Geosul* 32 (63): 179–201.

Boerema, Annelies, Alanna J Rebelo, Merche B Bodi, Karen J Esler, and Patrick Meire. 2017. "Are Ecosystem Services Adequately Quantified?" *Journal of Applied Ecology* 54 (2): 358–70.

Camargo, Diana Marina, Paula Camila Ramírez, Vanesa Quiroga, Paola Ríos, Rogério César Férmino, and Olga L Sarmiento. 2018. "Physical Activity in Public Parks of High and Low Socioeconomic Status in Colombia Using Observational Methods." *Journal of Physical Activity and Health* 15 (8): 581–91.

Díaz, Sandra Myrna, Josef Settele, Eduardo Brondízio, Hien Ngo, Maximilien Guèze, John Agard, Almut Arneth, et al. 2019. "The Global Assessment Report on Biodiversity and Ecosystem Services: Summary for Policy Makers."

Haines-Young, Roy, and Marion Potschin-Young. 2018. "Revision of the Common International Classification for Ecosystem Services (CICES V5. 1): A Policy Brief." *One Ecosystem* 3: e27108.

Keeler, Bonnie L, Perrine Hamel, Timon McPhearson, Maike H Hamann, Marie L Donahue, Kelly A Meza Prado, Katie K Arkema, et al. 2019. "Social-Ecological and Technological Factors Moderate the Value of Urban Nature." *Nature Sustainability* 2 (1): 29–38.

Liu, Hongxiao, Roy P Remme, Perrine Hamel, Huifu Nong, and Hai Ren. 2020. "Supply and Demand Assessment of Urban Recreation Service and Its Implication for Greenspace Planning-a Case Study on Guangzhou." *Landscape and Urban Planning* 203: 103898.

Londe, Patrícia Ribeiro, and others. 2014. "A Influência Das áreas Verdes Na Qualidade de Vida Urbana." *Hygeia-Revista Brasileira de Geografia Médica e Da Saúde* 10 (18): 264–72.

Nations, United. 2018. "World Urbanization Prospects: The 2018 Revision (ST/ESA/SER.a/420)."

———. 2019. “World Population Prospects 2019.”

Ridding, Lucy E, John W Redhead, Tom H Oliver, Reto Schmucki, James McGinlay, Anil R Graves, Joe Morris, Richard B Bradbury, Helen King, and James M Bullock. 2018. “The Importance of Landscape Characteristics for the Delivery of Cultural Ecosystem Services.” *Journal of Environmental Management* 206: 1145–54.

Silveira, Ismael Henrique da, and Washington Leite Junger. 2018. “Espaços Verdes e Mortalidade Por Doenças Cardiovasculares No Município Do Rio de Janeiro.” *Revista de Saúde Pública* 52: 49.