



DOI: <https://doi.org/10.29298/rmcf.v10i54.557>

Article

**Valoración de servicios ambientales y recreativos del  
Bosque San Juan de Aragón, Ciudad de México**  
**Assessment of environmental and recreational services  
of the *San Juan de Aragón* forest, Mexico City**

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**Resumen**

En el presente estudio se realizó una valoración económica, mediante el Método de Valoración Contingente (MVC). Se eligió como caso de estudio el Bosque de San Juan de Aragón (BSJA), que se ubica dentro de la alcaldía Gustavo A. Madero de la Ciudad de México, el cual corresponde a la segunda área verde más grande de la Ciudad. El problema principal del BSJA es el deterioro y mal aprovechamiento de los servicios ambientales y recreativos que provee a la población aledaña y a las personas que lo frecuentan. Se estimó la Disponibilidad a Pagar (*DAP*) de los visitantes por concepto de conservación y restauración, con el objetivo principal de calcular el Valor Económico que proporcionan. Se hicieron 120 encuestas, mismas que se procesaron y se analizaron econométricamente con el programa *NLOGIT* 4.0.1. Los resultados evidenciaron que la *DAP* fue de \$MX7.36 por persona por entrada; el valor económico de los servicios ambientales del BSJA ascendió a \$MX25 620 000.00 anuales. De los encuestados, 61 % están dispuestos a pagar por la conservación y recuperación del Bosque. Las variables significativas fueron: precio propuesto, edad, sexo, estado civil, ingreso familiar, número de integrantes, situación actual y nivel de satisfacción. La posible explicación a una *DAP* baja es la falta de información sobre los beneficios ambientales del BSJA.

**Palabras clave:** Conservación, disposición a pagar, método de valoración contingente, San Juan de Aragón, servicios ambientales, valoración económica.

**Abstract**

In this study an economic valuation was carried out applying the Contingent Valuation Method (MVC). The *San Juan de Aragón* Forest (*BSJA*) was chosen as the case study. The forest is located within the *Gustavo A. Madero* Demarcation of CDMX, and is the second largest green area in the City. The main problem of the *BSJA* is the deterioration and bad use of the environmental and recreational services that this generates to the neighboring population and to the visitors. The Availability to Pay (*DAP*) is estimated by visitors for their conservation and restoration with the main objective of estimating the economic value they provide. There were 120 surveys, which were processed and analyzed econometrically with the *NLOGIT* 4.0.1 program. The results showed that the *DAP* was \$MX7.36 per person per entry, the economic value of the environmental services of the *BSJA* amounted to \$MX25,620,000.00 per year. 61 % of the respondents are willing to pay for the conservation and recovery of the Forest. The significant variables were: proposed price, age, sex, marital status, family income, number of members, current situation and level of satisfaction. The possible explanation for a low *WTP* is the lack of information on the environmental benefits of the *BSJA* by visitors.

**Key words:** Conservation, willingness to pay, contingent valuation method, *San Juan de Aragón*, environmental services, economic valuation.

Fecha de recepción/Reception date: 5 de enero de 2019

Fecha de aceptación/Acceptance date: 30 de junio de 2019

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## Introduction

The need to conserve and maintain natural and artificial recreational spaces in appropriate conditions such as sites that allow recreation, as well as the possibility of having areas that guarantee the development of biodiversity has motivated the conduction of research studies (Tudela *et al.*, 2011; Garzón, 2013; Monroy *et al.*, 2015; Tecpan *et al.*, 2016), whose aim is to know the Willingness to Pay (*DAP*, for its acronym in Spanish) of the walkers or of the inhabitants close to these areas.

There is a perception that the lack of recreational areas of this type in large urban areas, such as Mexico City, should induce the population to assign them a positive value, since they constitute desired areas for the practice of sports activities, outdoor hiking, bird watching, among others.

*San Juan de Aragón Forest (BSJA)* is the second most extensive green area of Mexico City (Conabio, 2016) and, as such, it fulfills a series of important functions for the population, as a source of local oxygen and the presence of relative humidity, which comes from the lake within and the vegetal cover that favor the climatic regulation, since, both, cause an effect of "island of freshness" in relation to the surrounding areas which not have green areas. This huge park suffers from deterioration both in its infrastructure, and in the environmental services it generates, as a result of its misuse and its low or null conservation.

Additionally, the park is a good alternative for family gatherings on weekends. There are three playgrounds distributed around the park and the zoo, which are available to the public.

In this regard, the main objective of the present research study was to estimate the economic value provided by the *BSJA* environmental and recreational services, using the Contingent Valuation Method; and, as specific objectives: to estimate the *DAP* by *BSJA* visitors through the MVC; to estimate the Economic Value of the *BSJA* annually; and to determine the socioeconomic variables that influence the willingness to pay of *BSJA* users.

## **Materials and Methods**

### **Study Area**

The Forest is located inside the mayor's office of *Gustavo A. Madero* in Mexico City at an average altitude of 2 240 m (Conabio, 2006). It is surrounded by the following roads: to the north by 412 and 510 avenues; to the west, by *José Loreto Fabela* and 508 avenues; to the south-east by 608 avenue. It is 162 ha, of which 70 % are green areas and 30 % are used for various cultural and recreational activities, which includes: a lake, a children's living center, a track to skate, an outdoor theater, a projection room and a spa. Migratory birds, mainly ducks, go to the lake in their way to their final destination, *Texcoco Lake*, State of Mexico.

Around 3.5 million people visit *BSJA* each year. Every day, hundreds of athletes use the facilities to do their training routines in one of their three outdoor gyms or on a 1 200 m cyclic track.

### **Methods**

MVC is part of the so-called declared preference methods, and consists in raising direct questions from *DAP* for an improvement, or *Willingness to Accept (DAA)*, for worsening of a particular good or service; in both cases the current and final conditions are specified (Valdivia *et al.*, 2011). The MVC has great acceptance, given its ability to generate valuations that are disclosed, if there is a real market (Camargo *et al.*, 2013).

A survey was applied in which detailed what was being valued and under what market context the transaction would be carried out; this implies that the specific aspects of the good should be clearly described, as well as the means of payment (Vásquez, 2007). Referendum-type questions (the most commonly used) involve letting the individual answer yes or not willing to pay a certain amount for accessing the benefits of the conservation program offered (Valdivia *et al.*, 2011).

Azqueta (2007) points out that the main advantage of the MVC is that it is only with it that the non-use values can be quantified. In addition, it does not require any previous assumption, nor to estimate the demand function of the person, and is the only one that allows determining the compensatory variation.

Its disadvantages are based upon the distrust that arises from the answers obtained. The suspicion of a dishonest conduct by the interviewee leaves an essential doubt about the true meaning of his (her) response. The central problem is that there is no way to verify the validity of the results. Also, and given that he (she) works with hypothetical assumptions, in the presence of uncertainty, the utility that a person expects to receive from a particular good before knowing the state of nature that will accompany him (her), may differ greatly from what he (she) will obtain, once this unknown condition is resolved.

### **Method Application**

A questionnaire for *BSJA* visitors was made, which consisted of five components: profile of the respondent, economic variables, description and precept of the site (place of origin, estimated travel time, number of visits to the *BSJA*, most valued attributes, current perception of the park), valuation of the park and conservation of the environment (*DAP*) and level of satisfaction with the visit.

The number of visitors is approximately 3.5 million per year; Therefore, the questionnaire was applied to a sample calculated by sampling for infinite populations (Morales, 2011) with the following model:

$$n = \frac{z^2 pq}{e^2}$$

Where:

$n$  = Number of subjects that make up the sample

$z$  = Value of  $Z$  corresponding to the confidence level

$p$  = Proportion of people who would be willing to pay

$q$  = Proportion of people who would not be willing to pay

$e$  = Sample error or margin of error accepted

By using the following data and replacing in the formula, a 95 % confidence level was determined;  $Z = 1.96$ ,  $p = 0.5$ ,  $q = 0.5$ ,  $e = 10\%$  and  $n = 96$ .

$$n = \frac{(1.96)^2(0.5)(0.5)}{(0.01)^2}$$

Regarding the *DAP*, the interviewer first asked if the visitor was willing to pay a small fee per entry to invest in the conservation of the forest's environment and infrastructure; if the answer was yes, another question was made: if the person would be willing to pay MEX\$ 4, MEX\$ 8, MEX\$ 12 or MEX\$ 16 per entry to the park, in order to improve the current attributes and / or add others. Low amounts were considered given the circumstances and socioeconomic characteristics of the visitors (previously observed).

In addition, even though the sample size resulted from 96 surveys, it was decided to apply 120 for greater accuracy. Thus, 30 referred to the amount of MEX\$ 4; 30 to MEX\$ 8; 30 to MEX\$ 12 and another 30 to MEX\$ 16. The people surveyed were the visitors of legal age because their ability to pay is more feasible. The interviews were applied three times, including weekends (due to the greater flow of visitors) and intermediate days of August.

The linear model proposed as well as the variables of interest are described below.

## Econometric Model

Based on the NLogit program, the following linear model was designed:

$$P(SI) = \beta_0 + \beta_1 PP + \beta_2 INGRE + \beta_3 SEXO + \beta_4 ECIVIL + \beta_5 EDAD + \beta_6 INTEGAM + \beta_7 SITUACI + \beta_8 SATISFAC + E$$

Where:

$P(SI)$  = Probability of saying "yes" to DAP

$PP$  = Proposed price to be payed

$INGRE$  = Monthly family income

$SEXO$  = Sex

$ECIVIL$  = Civil status

$EDAD$  = Age

$INTEGFAM$  = Number of family members

$SITUACI$  = Present situation

$SATISFAC$  = Satisfaction level

$E$  = Error

Once the model was specified, each of the variables is described in the Table 1.



**Table 1.** Description of the variables taken for the Contingent Valuation Method

<b>Variable</b>	<b>Representation</b>	<b>Explanation</b>	<b>Quantification</b>
<i>PP</i>	Willingness to pay the proposed price	Hypothetical price to be paid assigned at random	Full number assigned through an Excel data base
<i>INGRE</i>	Family income	Monthly family income	1=0-2 699.00 2= 2 700.00-6 799.00 3= 6 800.00-11 599.00 4= 11 600.00-34 999.00 5= 35 000.00-84 999.00
<i>SEXO</i>	Sex	Sex of the interviewed	1 = Male 0 = Female
<i>ECIVIL</i>	Civil status	Civil status of the interviewed	1 = Married 0 = Single
<i>EDAD</i>	Age	Intervieweds' years old	Full number and recorded in an Excel data base
<i>INTEGFAM</i>	Number of family members	Total number of inhabitants living in the same house	Full number and recorded in an Excel data base
<i>SITUACI</i>	Present situation	Visitor's perception of the current condition of <i>BSJA</i>	1 = Not decayed 2 = Decayed 3 = Very decayed
<i>SATISFAC</i>	Satisfaction level	Satisfaction level of the interviewed after visiting <i>BSJA</i>	1 = Poorly satisfied 5 = Very satisfied

## Results and Discussion

Once the survey information was obtained, the estimation of the model was made in the NLOGIT 4.0 econometric program, in the Table 2 the results can be visualized.

**Table 2.** Admitted maximum likelihood estimators.

<b>Dependent variable</b>	<b>P (SI)</b>
Number of observations	81
Unrestricted likelihood function	-39.93999
Number of parameters	9
<i>aic</i> criterion	1.20839
<i>bic</i> criterion	1.47444
<i>hqic</i> criteria	1.31514
Restricted likelihood function	-56.08935
<i>Mcfadden pseudo R</i> <sup>2</sup>	0.2879221
<i>Chi square</i>	32.29873
Degrees of freedom	8
<i>PROB (chisqd&gt;value)</i>	8.23E-05

Source = Making based upon the NLOGIT software exit.

The model shows a *McFadden* test of 0.2879221, and a *Chi Square* of 32.29873, values within the acceptance ranges in the Logit models (Gujarati and Porter, 2010; Lucich and González, 2015).

Table 3 indicates that, in general, the variables have good acceptance and represent the model well. The most significant are the number of family members and age; some variables were not as statistically significant, but it was decided to keep them for the analysis, based on their



contribution to the model in terms of *Pseudo R*<sup>2</sup> (Lucich and González, 2015). The values corresponding to coefficient and sign are here ordered.

**Table 3.** Coefficients, signs and relevance test of the variables.

<b>Variable</b>	<b>Coefficient</b>	<b>Standard error</b>	<b>b/St.Er</b>	<b>P( Z &gt;z)</b>
<i>CONSTANTE</i>	2.67186253	2.32635607	1.149	0.2508
<i>PP</i>	-0.07221639	0.06700514	-1.078	0.2811
<i>EDAD</i>	0.05765181	0.02266132	2.544	0.011
<i>SEXO</i>	-1.18840832	0.63098165	-1.883	0.0596
<i>ECIVIL</i>	1.02994969	0.62585240	1.646	0.0998
<i>INGRE</i>	0.55132775	0.30212325	1.825	0.068
<i>INTEGFAM</i>	-0.75556308	0.22852353	-3.306	0.0009
<i>SITUACI</i>	-0.70212439	0.55762545	-1.259	0.208
<i>SATISFAC</i>	-0.34602501	0.37452547	-0.924	0.3555

Source= Making based upon the NLOGIT software exit.

*CONSTANTE* = Constant; *PP* = Willingness to pay the proposed price; *EDAD* = Age; *SEXO* = Sex; *ECIVIL* = Civil status; *INGRE* = Family income; *INTEGFAM* = Number of family members; *SITUACI* = Present situation; *SATISFAC* = Satisfaction level.

The *PP* variable has a negative sign, which means that at a higher price, a lower *DAP*. The positive coefficient of *EDAD* means that at an older age, greater *DAP*, which contrast with Valdivia *et al.* (2011) findings. The negative sign of *SEXO* means that the male interviewees are less likely to respond "yes" to the proposal of an entry fee,

which disagrees with Lucich and González (2015). In regard to the positive sign of *ECIVIL*, it is interpreted as that married people are more willing to pay than single people.

The family income variable *INGRE* obtained a positive coefficient that corresponds to the theory of higher income higher DAP, which coincides with other authors such as Monroy *et al.* (2019). The negative value of the *INTEGFAM* variable indicates that the greater the number of family members, the less likely it will be to answer “yes” to DAP, as argued by Justes *et al.* (2014)). The negative coefficient of the *SITUACI* variable indicates that the more deteriorated the Forest situation is, the less likely the DAP will be obtained. The negative coefficient of *SATISFAC* is interpreted as follows: the higher the level of satisfaction there is, the less likely it is to answer “yes” to the DAP. A possible explanation for this result is that, although they consider the visit to the *BSJA* satisfactory, many users would not be willing to pay since they think that it is not their responsibility to restore and conserve the Forest, according to their answers, although this type of attitude is not isolated (Camargo *et al.*, 2013).

In short, the model remained as follows:

$$P(SI) = 2.67186253 - 0.07221639 PP + 0.05765181 EDAD - 1.18840832 SEXO \\ + 1.02994969 ECIVIL + 0.55132775 INGRE \\ - 0.75556308 INTEGFAM - 0.70212439 SITUACI - 0.34602501 SATISFAC$$

According to the NLOGIT output, the prediction for this model was 76.5 %.

### **Marginal effects and elasticities**

Since the values of the coefficients of the variables cannot be interpreted directly, as it would be in the case of a linear regression, the marginal effect is sought. The Table 4 shows the results for the marginal effects of each variable used in the final model.

**Table 4.** Marginal effects and elasticities of the variables of the final model.

<b>Variable</b>	<b>Marginal effect</b>	<b>Elasticity</b>
<i>CONSTANTE</i>	0.66748848	
<i>PP</i>	-0.0180412	-0.31932519
<i>EDAD</i>	0.01440266	1.05017513
<i>SEXO</i>	-0.28860935	-0.24292286
<i>ECIVIL</i>	0.25181307	0.2482859
<i>INGRE</i>	0.13773348	0.79826391
<i>INTEGFAM</i>	-0.18875584	-1.51159192
<i>SITUACI</i>	-0.17540571	-0.60742988
<i>SATISFAC</i>	-0.08644446	-0.68810558

Source= Making based upon the NLOGIT software exit.

*CONSTANTE* = Constant; *PP* = Willingness to pay the proposed price; *EDAD* = Age; *SEXO* = Sex; *ECIVIL* = Civil status; *INGRE* = Family income; *INTEGFAM* = Number of family members; *SITUACI* = Present situation; *SATISFAC* = Satisfaction level.

In order to know the real effect of each variable, the respective antilogarithms of each one were obtained. To that result is subtracted 1 and multiplied by 100, to interpret the result in percentage terms (Gujarati and Porter, 2010).

*PP* = -1.78 % indicates that for each peso the proposed entrance fee is increased, the probability of responding yes to the *DAP* decreases by 1.78 %. *EDAD* = 1.4506 %, it is interpreted that, for each year that age increases, the probability of answering "yes" to the *DAP*, (keeping everything else constant) would increase by 1.45 %. *SEXO* = following the same procedure as in the previous cases, -25.0695 % would indicate that if the person is male, the probability of responding "yes" to *DAP* decreases by 25.07 %. *ECIVIL* = 28.6355 % indicates that when the person is married increases the probability of answering "yes" to the *DAP* by 28.63 %. *INGRE* =

14.7669 % means that for each level of additional income, keeping everything else constant, people they would probably be 14.76 % more willing to pay for the entrance to the Forest. *INTEGFAM* = -17.2011 % means that for each additional member of their family, people decrease their probability of being willing to pay by 17.21 %. *SITUACI* = for this variable a result of -16.0883 % was obtained, which is interpreted as, for each level of additional degradation perceived by visitors, 16.08 % would be less willing to pay for the entry to *BSJA*. *SATISFAC* = - 8.28 % means that if the level of user satisfaction increases by one unit, the probability of responding "yes" to the *DAP* would decrease by 8.28 %.

It can be observed that the variables that have the greatest effect (whether positive or negative) on the probability of responding "yes" to the availability to pay are: sex, civil status, family income, family members and current situation. For other authors, the level of education was important (Tudela and Leos, 2017); however, this variable was not significant in this study and it was discarded.

### **Estimation of the Willingness to Pay (*DAP*)**

Valdivia *et al.* (2011) suggested the following formula for the calculation of *DAP*:

$$DAP = \frac{\alpha}{\beta}$$

Where:

*DAP* = Willingness to Pay

$$\alpha = \beta_0 + \sum_{i=1}^N \beta_i Z_i$$

$\beta$  = Coefficient of *PP*

When clearing the *DAP* (or *PP*) of the *P* (*SI*) model:

$$DAP = (2.67186253 + 0.05765181 EDAD - 1.18840832 SEXO + 1.02994969 ECIVIL + 0.55132775 INGRE - 0.75556308 INTEGFAM - 0.70212439 SITUACI - 0.34602501 SATISFAC) / 0.07221639$$

When replacing the parameters that resulted and calculating the average, the result was MEX\$ 7.32. That is, on average, visitors to the Forest of *San Juan de Aragón* would be willing to pay MEX\$ 7.32 per ticket, under the condition that the money collected is used for environmental conservation and infrastructure maintenance. The Table 5

shows the results that were obtained when running the NLOGIT program.

**Table 5.** Willingness to Pay.

<b>Variable</b>	<b>Mean</b>	<b>Standard deviation</b>	<b>Minimum</b>	<b>Maximum</b>
<i>DAPR</i>	7.36036	7.49609	0.206627	28.0941

Source= Making based upon the NLOGIT software exit.

If this value is multiplied by the number of visitors (3.5 million), the Economic Value of environmental services of the Forest of *San Juan de Aragón* amounts to MEX\$ 25 620 000.00 per year, considering only the use value.

Surveys reveal that many visitors are not aware of the environmental services that *BSJA* provides, which could explain the low *DAP*. However, when asked about infrastructure and additional recreational services, walkers were more willing to cover a fee on the condition that the money be invested in proposing more activities or restoring some others such as the train, the spa and additional ones, which suggests that visitors value *BSJA* more for recreational activities than for environmental services.

Another possible explanation is that variables such as “the level of knowledge of environmental services” or “place of residence” were not included, which González (2009), for example, did take into account. These variables are important since there could be a positive relationship with the DAP. Valdivia *et al.* (2011) and González (2009) consider the number of dependents or children instead of the number of family members, but did not take into account the level of satisfaction of the visit to the place of study or the services they receive.

## **Conclusions**

The econometric model explains the behavior of the variables related to the *DAP*, whose average value was MEX\$ 7.36, which in turn favors the estimation of the economic value that visitors grant to the *Bosque San Juan de Aragón* for environmental and recreational services, which amounts to \$ 25 620 000.00. In addition, 88.9% of the surveyed population states that the quality of environmental services is impaired and negatively affects their level of satisfaction.

## **Acknowledgements**

The contribution of the interviewers who, with good intentions, helped in the field work is appreciated. Also, to *CONACyT* and to *Universidad Autónoma Chapingo* for the financial support provided for the execution of the original research.

## **Conflict of interests**

The authors declare no conflict of interests.

## **Contribution by author**

Miriam Susana Hernández Valdivia: study planning, development of methodology, field work, data analysis and writing of the manuscript; Ramón Valdivia Alcalá and Juan Hernández Ortiz: advice on the accomplishment of the research study review and correction of the manuscript.

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