Article

Valoración Económica del Servicio Ambiental a través del modelo tipo subasta en los Prismas Basálticos, Hidalgo

Economic valuation of environmental service through an auction-type model in Basaltic Prisms, *Hidalgo*

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Resumen

La historia de la utilización de los recursos naturales con fines turísticos en los Prismas Basálticos (PB), ubicados en el ejido Santa María Regla, municipio Huasca de Ocampo, estado de Hidalgo, México inicia en 1975, cuando los abuelos de sus actuales administradores vieron una oportunidad de autoempleo, mediante el uso de este recurso. Actualmente, el problema que se presenta en las aguas de la presa San Antonio y, en consecuencia, en los PB, es que en ella se vierten aguas residuales de los drenajes de la población denominada Huasca de Ocampo. Se observaron de forma directa daños en las áreas verdes, algunos árboles con plagas y enfermedades, razón por la que requieren tratamiento especializado; también, muchos individuos necesitan podas, o dicho de otra forma la práctica de dasonomía urbana. El lugar, además demanda acciones de reforestación, estos son elementos importantes que justifican el cálculo del valor del medio ambiente. Para este estudio se utilizó el método de valoración contingente (MVC) con formato de subasta. La mayoría de las variables del modelo-subasta planteado tuvieron baja significancia estadística, las que registraron relevancia fueron: edad y estado civil; el resto de las variables pueden tener un comportamiento distinto. Se estimó el precio de subasta a partir de la edad y estado civil; su monto ascendió a $13.78 M.N. como disponibilidad a pagar (DAP) por entrada para realizar mejoras al ambiente.

Palabras clave: Disponibilidad a pagar, economía de los recursos naturales, economía del bienestar, ecoturismo, método de valoración contingente, subasta.

Abstract

The history of the Basaltic Prisms (BP) begins in 1975, when the grandparents of the current managers of this natural resource saw a self-employment opportunity in its use for touristic purposes. Today, the problem affecting the waters of the *San Antonio* Dam, and therefore the BP, is caused by the sewage being poured from the drains of *Huasca de Ocampo*. Damages have been observed in the green areas; some trees suffer from pests and diseases. These issues call for specialized treatment; besides, many trees require pruning, in other words, the practice of urban forestry. The location also demands reforestation. These elements justify the assessment of the value of the environment and, therefore, are highly important. For this study the contingent valuation method (CVM) with a bidding format was used. Most of the variables of the auction-type model exposed have low statistical significance. The two with statistical relevance are age and marital status; all other variables may behave very differently from the established point of view. The bidding estimated the price, taking into consideration the variables age and marital status, with a willingness to pay (WTP) of 13.78 MXN for the aim to improve the environment, as part of the entrance fee.

Key words: Willingness to pay, economy of natural resources, welfare economics, ecotourism, contingent valuation method, bidding.

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Introduction

The contingent valuation method (CVM) with a bidding referendum design is used to find out the economic value of changes in welfare that result from the presence of tourists and are produced by a qualitative or quantitative change in the offer of a commodity without a market. It focuses on the valuation of commodities without a direct market by the people, based on a set of hypothetic or experimental data (Randall, 1985).

Structured questionnaires with direct questions on the assumption of the existence of a separate market for these goods, simulating a hypothetical market, are applied. The management of these markets is considered to be fully comparable to the individual responses in real markets (Mitchell and Carson, 2005).

Some recent studies, such as those made by Sandoval *et al*. (2018) and Borrego (2018) to estimate the economic value of different natural resources, do not use the bidding format. Usually, people have a monetary offer for a good or service that generates benefits; this is why the bidding format is proposed for its calculation.

The tourist complex known as Basaltic Prisms (BP), located in *Huasca de Ocampo* municipality, in *Hidalgo* State, Mexico, comprises water systems that descend from the *San Antonio* dam, which has extensive green areas, microclimates, scenic beauty, flora and tamed fauna, trails and reading areas. This combination constitutes a *sui generis* landscape. Furthermore, various services and products are offered at the site: zip line, ATVs, cabins, swimming pools, hanging bridge, viewpoints, restaurants, boats, sports fields, grills, camps, crafts, horseback riding, restrooms and parking.

However, there is a set of issues related to water pollution and to pests and diseases detected in the tree mass. In the first case, sewage drains of the households of *Huasca de Ocampo* municipality were observed to discharge into the *San Antonio* dam; therefore, it is important to keep the water clear of pollutants due to the use assigned to the BP. This health situation affects the level of well-being of the tourists.

The forestry issue requires the attention of specialists in plant health; therefore, it is imperative to carry out urban forestry practices and even cover areas with grass.

The central objective of the present study was to calculate the willingness to pay for conservation and improvements of the environment, specifically the value of tourism services that are generated from the concatenation of natural resources.

Materials and Methods

The study was carried out in the eco-tourism complex of the Basaltic Prisms (PB), *Santa María Regla ejido*, in *Huasca de Ocampo*, State of *Hidalgo*, where the tourist activity dates back to 1975, as a result of the publicity of a brewery, which used the BP location to advertise its beer products in the 1970–1975 period.

In recent years, there has been a large number of economic valuation methodologies to calculate the monetization of biodiversity and guide the public environmental policy (Lienhoop *et al*., 2015). In this regard, Börger *et al.* (2014) suggest that the economic valuation of ecosystem services can be proposed for marine planning, based on the experiences in the United States and the United Kingdom, as well as for designing public policies.

CMV provides the valuation of the resource directly; it is also compatible with the Hicksian welfare measures, widely accepted in the economic literature as accurate estimates of the change in the welfare of individuals (Vásquez *et al*., 2007).

Compensating variation is given by the monetized amount which, in the face of the change occurred, the person would have to pay in order for his or her level of welfare to remain unchanged (Azqueta, 1994).

The choice of a policy depends on the magnitude of the gains of the winners and the costs of the losers. These measures appear because profit is an immeasurable variable (Mendieta, 2007). However, the issue of optimal choice (Azqueta, 1994), on the part of the consumer is stated in general terms, such as:

$$MaxU\ (X)$$

$$s.a: Q - P'X = 0$$

Where:

P = Profit of the person in question

Q = The person's monetary income

$$X(X = X_1, \ldots X_n)$$

$$P(P = P_1, \ldots P_n)$$

i.e. the minimum amount of money needed to achieve that level of profit, given the structure of prices.

The activities of this project included unstructured interviews, firstly with the manager of the BP. Three interviews were conducted to favor a first approach with a research purpose, which generated an *a priori* diagnosis; the times and ways of collecting the information on the economic value of natural resources and its relationship with tourist activities were also agreed upon.

Subsequently, two meetings were carried out with the partners of the tourist complex in which it was reported that the participation would be assisted by the working group. The pollsters were introduced; their entry to the whole complex was facilitated, and, collaterally, they began to obtain data, based on a structured questionnaire applied to the tourists. Once the phase of the interviews was completed, the information was analyzed by using the methodologies of the economic theory (Mitchell and Carson, 2005).

In the referendum design, the interviewees were simply asked to answer yes or no, in a stylized manner. Would you be willing to pay "this sum in MXN" for improvements and conservation of the environment (quantitative or qualitative) changes? (Haab and McConnell, 2002).

As for the auction-type design, the relevant questions was asked through payment cards in the CVM, the format in each interview consisted in choosing the willingness to pay (WTP), in estimated points, based on a list of predetermined values.

The interviewee had two choices: yes or no (*referendum*). The corresponding predetermined values were written on the blank space of the question: $10.00, $20.00, $30.00 or $40.00. If the answer was affirmative, the interviewee was questioned about the rising values (bids), *i.e.* if the blank space had a predetermined value of $20.00, the value would be raised to $21.00, $22.00, $23.00, $24.00 and so on, all the way to the highest figure; such was the auction-type procedure. If the answer was negative, the interviewee was asked about decreasing values —*e.g.* $19.00, $18.00, $17.00, etc.—, until the maximum willingness to pay (WTP) eliciting an affirmative answer was reached.

Likewise, questionnaires were applied to tourists, using the simple random sampling (SRS) design. In the following equation, the sample size was represented with the letter *n*, which was subjected to variance, confidence interval and error (Santos *et al.*, 2003).

$$n = \frac{z^2 * \sigma^2}{d^2}$$

Where:

n = Sample Size

z = Confidence interval

σ^2 = Variance

d = Limit of sampling error, desired precision (standard error)

The variance was estimated with a pilot sample of 32 interviews. The value of *z* was determined based on the confidence interval of the sample; therefore, the cumulative

tables were used (Infante and Zárate de Lara, 2003; Greene, 2006) of the standard normal distribution with a 95% confidence interval. The table provides the area at the left of a *Z* value, *i.e.:*

$$\int_{-\infty}^{z} \frac{1}{\sqrt{2\pi}} e^{-t^2/2} dt$$

The sample size was estimated through a simple random sampling, for a total of 289 interviews of tourists who visit the site; the utilized model for estimating the parameters had a bidding format; however, seven observations were lost due to protest responses of zero.

The LIMDEP econometric software version 9.0 was used to calculate the economic valuation of natural resources in the BP. The regression model in general is expressed as follows:

$$WTP_{(bid)} = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \dots \beta_i X_n + \mu$$

Where:

WTP*(bid)* = Dependent Variable

β = Estimated parameters

X = Independent Variables of the logistic model

μ = Error term

Based on the general model, a specific model based on the hypotheses of the present research is proposed*, i.e.*

$$WTP_{(bid)} = \beta_0 + \beta_1 FINC + \beta_2 SCH + \beta_3 FS + \beta_4 AGE + \beta_5 SEX + \beta_6 MS + \mu$$

Where:

$WTP_{(bid)}$ = Continuous dependent variable (due to improvements in the projects)

$FINC$ = Family income

SCH = Years of schooling

FS = Family size

$EDAD$ = Years

SEX = Gender

MS = Marital status

β = Parameters to be estimated

Once the parameters and their respective means were estimated, the LIMDEP Econometric 9 software was used to estimate new values based on the original data and on those of this list which are equivalent to the former values whereby the bidding price was estimated.

Results and Discussion

Currently, there are 18 partners of the tourist complex, benefiting from the company, through the generation of attractive profits; 46 permanent employees and 10 employees with temporary jobs also depend on the organization.

The installed capacity, according to the environmental health parameter of the World Health Organization (WHO) and to the 10-hectare polygon, has a maximum value of congestion of approximately 10 000 tourists. The recommendation issued by the WHO indicates that every citizen must have at least 10 m^2 of green areas, in order to enjoy environmental health (Frutos, 2004).

It is relevant to consider the point of congestion in each holiday season. In the BP, the most crowded season corresponds to the Holy Week, followed by the summer holidays and, finally, by Christmas.

A reference to the arithmetic mean of the fee for environmental improvements is the average of the maximum willingness to pay (bid), which amounts to 23.54 MXN per entry to the BP, according to the estimated data (Figure 1); however, the formal methodology suggests calculating through the compensating variation via the econometric estimation of socio-economic variables of the tourists, as proposed in the Materials and Methods section and in Figure 4.

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=============================================================================
Variable     Mean        Std.Dev.       Minimum       Maximum       Cases Missing
=============================================================================

-----------------------------------------------------------------------------
All observations in current sample
-----------------------------------------------------------------------------
SUBASTA |   23.5426      22.6161       .000000       200.000          282        0
INGF    |   9862.41      10447.0       800.000       90000.0          282        0
ESC     |   13.6844      4.19579       .000000       23.0000          282        0
TF      |   3.92908      1.71510       1.00000       13.0000          282        0
EDAD    |   36.6702      12.6657       15.0000       84.0000          282        0
SEX     |   .546099      .498755       .000000       1.00000          282        0
EC      |   .602837      .490180       .000000       1.00000          282        0
```

Figure 1. Descriptive statistics of the model variables.

The average income of the visitors to the BP is asymmetric, in comparison to the average income in the country, as it is above 19 724.82 MXN per month; considering the Lorenz curve for Mexico, there are institutions that document, implicitly, that income distribution has a tendency to 1 in the Gini Coefficient, in which 1 is the maximum income concentration, and 0, the maximum income distribution. The Gini index in Mexico (World Ban, 2019) was 0.43 in 2016, the most recent year for which records are available; this value is higher than that of developed countries like Denmark, which has a Gini coefficient of 0.28 in the same year, or that of the United States of America, whose Gini coefficient is 0.41.

The data matrix showed that low or medium revenues (compared to the national income) are practically not represented in the Basaltic Prisms.

The average schooling showed a *sui generis* behavior, as it is 13.68 years; i.e. graduates from college or technical careers. The tourists had a high income and a high schooling; this segment contributed valuable suggestions. This layer of people, according to the 2010 National Population and Household Census, represents only 16.5 % of the total population aged above 15 years; furthermore, it excludes those visitors who did not specify their educational level (Inegi, 2011). According to the characteristics described above, a valuable vein was identified, i.e. the potential market in Mexico consists of approximately 12 939 850 tourists, according to data provided by Inegi.

In relation to the longevity of the visitors, they are mainly adults, aged in average approximately 36 years; this accounts for the specialization of the tourist complex, which, therefore, in general, it provides services for people with adult needs. Based on the interviews, the nuclear family has an average of four members.

Figure 2 shows that, although the tourists have a high income, their WTP (bid) for improvements and for the conservation of the environment does not increase, which evidences a "paradox". Other observations show that people with lower income have a higher WTP (bid), i.e. In terms of money, they express a higher level of awareness of the need to conserve and improve the natural resources. Finally, tourists in general tend to accept the bid in the first four deciles (0-40).
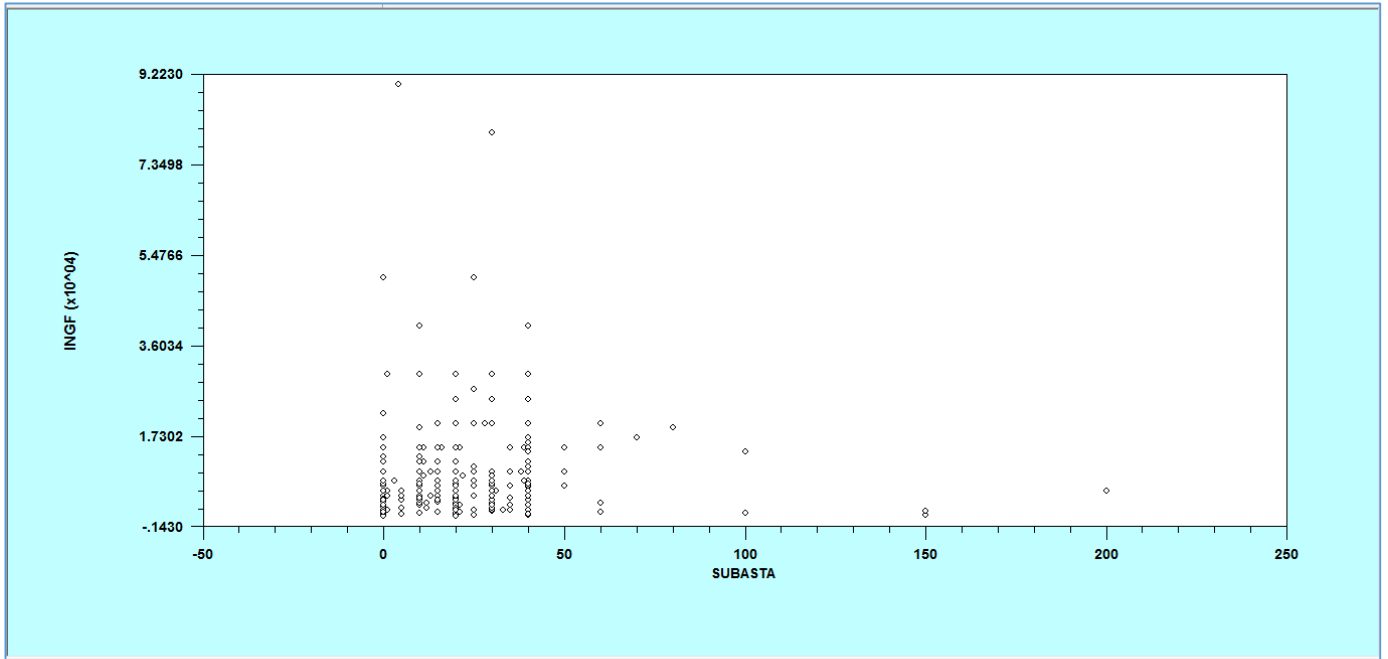
Figure 2. Income *vs*. bid.

The bid for entry to the BP registers mainly five options: 20.00, 40.00, 0.00, 10.00 and 30.00 MXN, in order of importance (Figure 3).
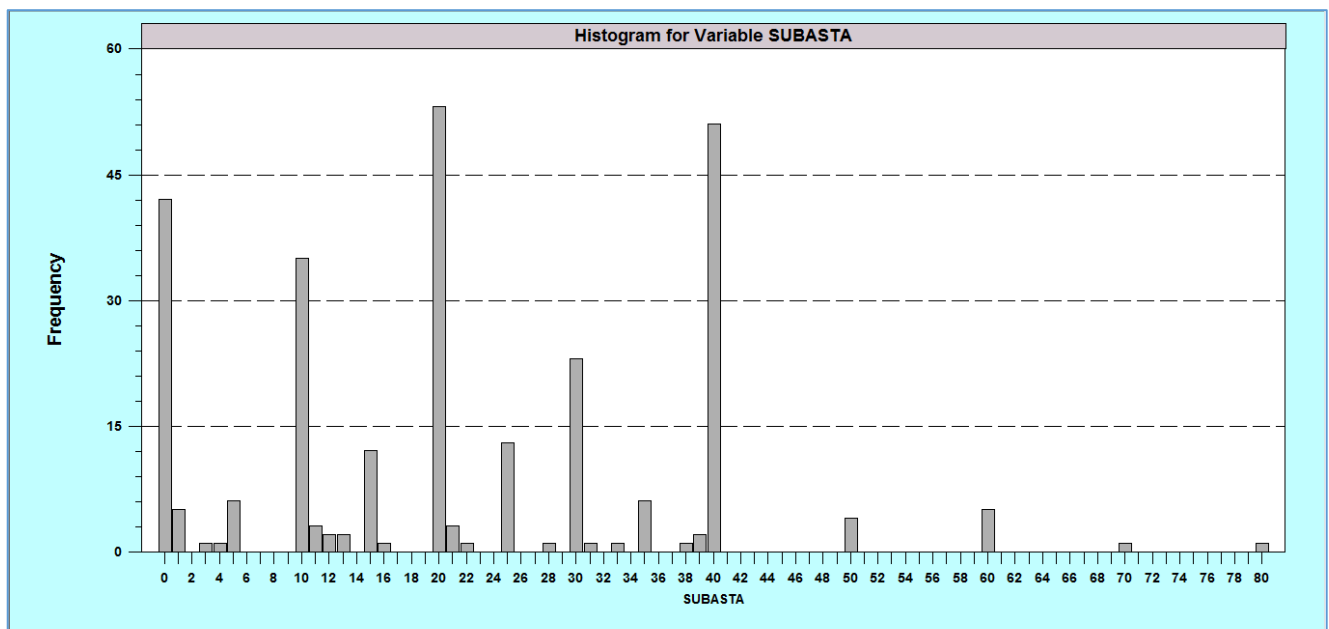

Figure 3. Descriptive statistics of the model variables.

The independent variables presented in Figure 4 are a set of economic and social characteristics that have been considered in various researches related to the economics of natural resources (Tudela *et al.*, 2018).

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+--------+----------------+----------------+--------+--------+----------+
|Variable| Coefficient    | Standard Error |t-ratio |P[|T|>t]| Mean of X|
+--------+----------------+----------------+--------+--------+----------+
 Constant|     13.6571323      8.17697319     1.670    .0960
 INGF    |    .509826D-04      .00013707       .372    .7102   9862.41135
 ESC     |     .20210387       .35871104       .563    .5736   13.6843972
 TF      |    -.06320310       .80976621      -.078    .9378    3.92907801
 EDAD    |     .27191179       .11637016      2.337    .0202   36.6702128
 SEX     |   -1.79908360      2.75875380      -.652    .5149     .54609929
 EC      |   -3.52220504      2.90210316     -1.214    .2259     .60283688
```

$$WTP_{(bid)} = 13.7 + 0.5 * FINC + 0.2 * SCH - 0.06 * FS + 0.3 * AGE - 1.8 * SEX - 3.5 * MS + \mu$$

Figure 4. Descriptive statistics of the model variables.

Most of the variables in the suggested linear model had a low statistical significance (Figure 4); the statistically significant ones were age, with an estimated "t" value of 0.02, and marital status, with an estimated "t" value of 0.23, resulting in the following model:

$$WTP_{(bid)} = 13.66 + 0.27 * AGE - 3.52 * MS + \mu$$

The WTP with bidding format is in terms of the origin, age and marital status, with a positive relationship in the age variable of the people interviewed; that is, the greater the age, the higher the willingness to pay. However, the relationship of the variable marital status is negative, which means that single people have less willingness to pay for environmental improvements. The result is logical, according to the specific characteristics expected from married people, as these have higher income level, schooling and age, compared to single visitors, who showed less willingness to pay,

as their income available for recreation is lower. Borrego (2018) also considers the variable age, although he uses the arithmetical mean for his estimations and does not apply modeling or statistical regressions. Hernández and López (2017) include age, but only for exploratory purposes, as it has no statistical or predictive significance. Cuevas *et al.* (2016), in a two-phase cluster analysis, use categorical variables for the segmentation —marital status (MS), gender (SEX)—, as well as continuous variables: the price that the consumer is willing to pay for improvements in the project (CPR), family income (FAMI), age (AGE), level of schooling (LSCH), and family size (FSI).

In a second programming with the LIMDEP Econometric software, version 9.0, for estimating the bidding price in which the variables age and marital status were considered, a willingness to pay (WTP) value of 13.78 MXN was estimated for improving the environment. Since the natural resources existing in the BP contribute to the welfare of tourists who come to the region, their conservation and maintenance are of economic importance.

In this study, most of the variables of the auction-type model were observed to have a low statistical significance; the most significant variables were age and marital status in relation to the WTP.

It is advisable to reinvest the capital for improvements so that, through the Total Economic Value (TEV), the flow of benefits of the project —which amounts to 137 800 MXN, based on the maximum installed capacity and the WTP— may be entered in the books of the BP. Thus, the Hicksian demand for knowing the ideal fee for the conservation and management of the natural resources was estimated. We also suggest using these rationally, in order to avoid the tragedy of the commons, as exposed by Hardin (1968).

Conclusions

The WTP for entry to the BP takes into account elementary aspects. The implementation of environmental conservation and improvement projects in the future requires a cash flow that will allow funding these actions. In relation to the variable income *versus* bid, the tourists who have a high income do not increase their WTP (bid) for improvements and conservation of the environment; this is "paradoxical".

Most of the variables of the suggested auction-type model have a low statistical significance. The two with the highest values are age and marital status.

The bidding price that considers the variables age and marital status amounts to 13.78 MXN as willingness to pay (WTP) for improvements to the environment. The current entrance fee is 40.00 MXN. If the reinvestments become a reality, the new fee will be a maximum of 53.78 MXN according to the compensatory variation with a TEV of 137 800 MXN per event, based on the maximum installed capacity and the WTP.

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Conflict of interests

The authors declare no conflict of interests.

Contribution by author

The three authors were involved in the planning and the cabinet phase, the design of the scientific observation forms, the academic management, the in-field work and collection of information, and the drafting of the manuscript.

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