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Environmental valuation of hydro-environmental services of the Tropical Montane Cloud Forest: a recreational value of "La Granada" waterfall in the municipality of Coatepec using the travel cost method

Valoración ambiental de los servicios hidroambientales del Bosque Nuboso Tropical Montano: un valor recreativo de la cascada "La Granada" en el municipio de Coatepec utilizando el método de costo de viaje

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Abstract: Environmental externalities are just one class of externalities (or external effects). They are not more important than any other type of economic externalities, but it would not be possible to find rational arguments to justify that they are less so. If more complex and therefore better decisions are to be taken, these externalities should be duly quantified and incorporated in the framework of an economic analysis of public or private decisions of society. In that case, they can be accounted for as costs of our decisions. Environmental economics has different environmental valuation methods to include ecosystems and its dynamics into an economic system. The most applied methods are contingent valuation, hedonic prices, and travel cost. These methods may be used as a guide to formulate public policies to protect the environment and have an efficient management. The present research is an analysis for hydro-environmental services (recreational services) of the tropical montane cloud forest (La Granada waterfall) of Coatepec due to the increasing risks caused by human activity. Therefore, the travel cost method will be applied to estimate the economic value associated with the ecosystem. This method applies conventional empirical techniques used by economists to estimate economic values based on market prices. The findings showed different travel costs for every chosen zone and a consumer surplus of $47.10 MXN and an estimated yearly value of $70,645 MXN.

Keywords: Economic Valuation, Recreational Value, Ecosystem Services, Hydrological Services, Travel Cost, Tropical Montane Cloud Forest.

Resumen: Un tipo de externalidades (o impactos externos) son las externalidades medioambientales. No son más significativas que cualquier otro tipo de externalidad económica, pero no hay justificaciones lógicas para decir que son menos significativas. Estas externalidades deben evaluarse adecuadamente e incluirse en el marco de un estudio económico de las decisiones públicas o privadas tomadas por la sociedad si se quieren hacer juicios más complicados y, en consecuencia, mejores. Así pues, pueden considerarse costes asociados a nuestras decisiones en esa circunstancia. En economía ambiental se utilizan distintas técnicas de valoración ambiental para incluir los ecosistemas y su dinámica en un sistema económico. Las técnicas más utilizadas son los costes de viaje, los precios hedónicos y el valor contingente. Estas técnicas pueden servir de guía a la hora de crear políticas públicas para preservar el medio ambiente y garantizar una administración eficaz. Debido a los crecientes peligros ocasionados por la actividad humana, el presente estudio analiza los servicios hidroambientales (servicios recreativos) del bosque tropical montano de niebla (cascada La Granada) en Coatepec. Por lo tanto, se utilizará el enfoque de costos de viaje para calcular el valor económico del ecosistema. Utilizando enfoques empíricos tradicionales, este enfoque estima los valores económicos basándose en los precios de mercado. Los resultados revelaron varios gastos de viaje para cada zona seleccionada, un excedente del consumidor de $47.10 MXN y un valor anual estimado de $70,645 MXN.

Palabras clave: Valoración económica; valor recreativo; Servicios de ecosistema; Servicios Hidrológicos; costos de viaje; bosque nuboso tropical

Introduction

Humans have a wide range of needs to be met. After fulfilling basic needs come a second level of things to be satisfied. On this second level humans need to accomplish different requirements to increase their welfare. For example, watching a football game to satisfy their need for entertainment or travel somewhere nearby just to enjoy nature for culture or recreation. And, under this context of satisfying secondary needs, we need to understand the costs and value of goods to hierarchize our choices (Ledesma, 2010). When planning a trip to a natural area, it is important to consider several factors, not only the environment to which a person is going. It is imperative to emphasize the costs involved in reaching a specific location. In this way, it is possible to know the willingness to pay and the acceptance from potential users. This leads to an objective valuation of nature that lacks private property (Shogren, 1994).

The propose of this paper is to apply a tool for environmental valuation focused on knowing the consumer's surplus where the cost of travel plays the main role. It is known that most, but not all, of natural areas do not have a specific price or entrance fee. However, the use and enjoyment of these spaces by their visitors implies economically measurable elements. For example: the time spent in the environment, as well as the cost of reaching and accessing the area.

Natural areas, such as Natural Protected Areas (NPA's), ecological reserves or tourist sites represent great fascination and enjoyment for the extraordinary landscapes that societies take advantage of to recreate themselves. However, over the course of time, these spaces have had a recreational use in decline compared to the uses of exploitation. And consequently, they have suffered a greater impact from human beings and their activities (Azqueta, *et al*., 2007).

That is why it is essential to manage these natural areas in a sustainable and efficient way in the long term, since they bring economic and social benefits that depend on environmental conservation and care. Over the last decades, economists such as Professor Diego Azqueta from the Alcala university in Spain, have stated preferences valuation methods to properly manage these environmental goods. And whit this, the academic community have experienced a generalized growing interest on these methods, including an increasing number of applications in developing economies.

For example, in 2017 Koshy *et al*. Applied this method to calculate the economic value of the Kilim Karst Geoforest Park in Malaysia, a conservation area consisting of limestone landscape, an extensive mangrove forest system, beaches, coastal wetlands and islands. Their research gave a large economical value due to the touristic activities of the natural area and the time that international tourists spent there (Koshy et al., 2019). This information gave an efficient price for the natural area and a guide point for private and public sector to maintain and create conservation policies to protect the area.

This tool is used to estimate the value of a wide range of non-market goods in terms of maximum Willingness-To-Pay (WTP). The method can be used to estimate economic benefits or costs arising from: Changes in the cost of entering the recreation area, demolition of existing recreation area, adding of a new leisure facility and changes in the quality of the environment (Parsons, 2003).

The environmental services have been compromised by the increases in agriculture and urban growth. Especially those that are related with hydrological resources. This means a considerable impact on ecosystems and human activity (CONABIO, 2017). Environmental economics makes possible to relate ecosystem services with economic aspects from a scientific orientation. It seeks to integrate the current state of environmental quality with the economy of a region. Currently 60%

of the planet's ecosystem services show signs of degradation or overexploitation. These contemplate the delicate ecological and economic systemic balance (Azqueta *et al*., 2007). Therefore, damages on one system led to serious effects on others. It is necessary to guide studies that relate various ecosystem services to each other and human well-being. The present research is an analysis applied to hydro-environmental services of the tropical montane cloud forest due to the increasing risk caused by human activities and how the travel cost analysis may help to formulate public policies for its conservation and efficient management.

The main objective of this research is to find the *recreational value* (economical value) of the *hydro-environmental services* (ecosystem services related to water resources) that are provided by the cloud forest of the municipality of Coatepec. As it was mentioned before and to be more specific, the hydro-environmental services of the ecological reserve of the "La Granada" waterfall. To achieve this goal, the Zonal Travel Cost Method will be applied. For this, it is necessary to analyze the visitor's profile through socioeconomic variables, as well as the reasons for their visit and the distances from where they visit the site. With this information, the corresponding public authorities will have a more comprehensive knowledge of the characteristics of the visitors, as well as the needs of the area to carry out an improvement public management of environmental goods.

1. Description of the study área

1.1. Tropical Montane Cloud Forest characteristics

The Tropical montane cloud forest (commonly known as cloud forest) is one of the most important ecosystems in our country. It is home of a great biological diversity in proportion to the area it covers. Although it represents less than 1% of the national territory (18,534 km2) (CONABIO, 2017). It contains more than 10% of plant species, as well as many endemic species. However, it is also one of the most threatened ecosystems in our country. More than 50% of this forest has already been transformed into crops or urban settlements, so more than 60% of the tree species in Mexico (about 450 species) are already in some category of risk (Williams-Linera, *et al.*, 2011).

Currently, the cloud forest in Veracruz covers 2.07% of the state's surface (1,480.2 km2) (CONAFOR, 2009). The state is in third place nationally in terms of biodiversity. However, more than 90% of the area covered by natural vegetation has been modified by human activities.

The cloud forest is one of the largest and most valuable collections in terms of biodiversity in Mexico. With a wide variety of plants, animals and fungus that are vital for the functioning of the ecosystem and to provide ecosystem goods and services, including ecotourism (Bruijnzeel, 2004).

The environmental services provided by this type of ecosystem are diverse. Among these, the provision of water, food, medicine, and fuel has been recognized, as well as climate regulation, recreation, and scenic beauty (SEMARNAT, 2004).

It is characterized by presenting a composition of species where deciduous trees of temperate climate, for example liquidambar (Liquidambar), oaks (Quercus), beeches (Fagus) and pines (Pinus) while the understory is conformed mainly by tropical evergreen species, such as shrubs of the families Acanthaceae, Rubiaceae and Myrsinaceae, and in the treetop's epiphytes of the families Orchidaceae, Bromeliaceae, Piperaceae and Araceae abound (Rzedowski, 2006).

The most emblematic fauna species include the endangered quetzal (Pharomachrus mocinno) and peacock (Oreophasis derbianus), the endangered hocofaisan (Crax rubra), and several species of hummingbirds of the Eupherusa gender (Pérez, *et al*., 2019).

The cloud forest is mainly characterized by the frequent or persistent presence of clouds at the vegetation level (Hamilton, 1995). This climate-based definition reflects the importance of clouds or fog to the ecology of this ecosystem.

Tropical montane cloud forest is recognized as a priority ecosystem for conservation and restoration for its vital role they play in the maintenance of hydrological and nutrient cycles (Bruijnzeel, 2004). Within the framework of the "Global Forest Resources Assessment" (MacDicken, 2015) cloud forest has been recognized worldwide as an ecosystem that requires special attention due to its hydrological relevance.

1.2. Municipality of Coatepec, Ver.

The municipality of Coatepec, is in the central zone of the state of Veracruz, on the eastern foothills of the Cofre de Perote and due to its location contains great natural wealth. Its territory is made up of conifer and tropical montane cloud forests and has four hydrological streams, Pixquiac, Pintores, Sordo and the Huehueyapan. Its current population is around 93,911 inhabitants of which 52% are women and 48% are men (SEFIPLAN, 2020).

Coatepec, throughout its history has gone through major changes, and one of them has been its transition from being a primary economy to one of services, added to this, there has been a problem with water scarcity during low stream season, because the water level is too low for the population supply. Which is directly related to the rate of deforestation of the micro hydrological basin of the Huehueyapan River (Perez *et al*., 2019).

This problem has been caused by immoderate logging, which is carried out by the poor and marginalized population of this zone, as well as the overexploitation of forest areas, accelerated urban growth, and the deterioration of natural resources, which generates problems in the social, environmental, and economic spheres.

Land use comprises 49% forests and jungles, including coniferous forests, cloud forest, medium and low forest. These forests present evidence of disturbance both in ecological richness and in wooded area. This scenario is a product of changes in land use, grazing and illegal logging. Deforestation in Coatepec, in the upper part of the micro-basin, has had a strong impact on water collection, since it prevents the recharging of aquifers, causing water to run off and escape from the micro-basin (CONAFOR, 2009).

1.3. The ecological reserve of “La Granada”

"La Granada” waterfall is an ecological reserve that depends on the public management with more than twenty hectares of cloud forest, which has 1000 steps for hiking (about 2 km), photography and bird watching. This reserve is dedicated to the preservation of the flora and fauna of the region. It is located 5 km from the center of Coatepec, making it a tourist attraction for those who visit the city.

The mountainous region of central Veracruz is among the most botanically diverse in Mexico (Rzedowski, 1996). Rare and endemic species abound in the cloud forest communities. The short distance to the administrative area of the state of Veracruz and the attractiveness of natural and

traditional values have contributed to the demographic and economic growth of the region, which is negatively affecting the natural values of the area. Perhaps the main conservation problem in the region is urban growth along the Banderilla-Xalapa-Tlalnelhuayocan and Xalapa-Coatepec-Xico axis, which has been surrounding the eastern side of the Cofre de Perote (SEFIPLAN, 2020).

The delicate structure of the cloud forest and its distribution in the upper parts of river basins, make this forest a provider of essential environmental services, such as climate regulation, carbon fixation, water capture and purification, soil erosion control and silting of rivers and reservoirs, regulation of river flow to prevent floods and droughts, and soil fixation on steep slopes, preventing landslides (Challenger, 2001).

Hydrological services maintain the water flows that sustain fish and crustacean fisheries, or river fish farming (Manson, 2004). Also, the forest mass of the cloud forest maintain valuable ecological services such as pollination or the reserve of insect populations, which allow for greater production or better quality in agricultural products of great economic importance, such as coffee and avocado.

1.4. Environmental valuation

Over the past 2-3 decades, the most dynamic and fastest growing field of economics has been environmental assessment. The progress made in the field in such a brief period of time has been so remarkable that some prefer to refer to this change as a paradigm shift in economics (Eckstein, 1958). Nowadays, the impacts that human activities have on the environment must be quantified, assessed, and incorporated in the economic analysis. Environmental economics uses methods that are based on the preferences of the consumers. Methods such as travel cost and hedonic pricing have become standard methods for environmental assessment.

Environmental disasters and environmental damage draw policy makers attention to the value of the environment. Environmental disasters began to occur more in developed countries and valuation techniques evolved over time to cope with these changes. The need to address environmental issues related to disasters has been a major driving force behind the development and progress of assessment technologies (Brown, 2000). Therefore, environmental policy has become an integral part of the policy process in developing countries.

To make this policy making process the most accurate possible it is necessary to understand the costs and benefits of individual choices. The identified benefits and costs are assigned monetary values through evaluation. Benefits and costs are often viewed from an anthropocentric perspective. Meaning that every choice is linked to an outcome and this action is expected to increase or decrease human welfare.

Public goods characteristics makes their externalities complex to analyze. Because of a lack of well-defined property rights, market forces cannot be relied upon in valuing environmental and natural resource related costs and benefits. When environmental goods become scarce, they gain economic value. This scarcity uses the valuation of natural resources and environmental services because they lack efficient market prices. Therefore, environmental economics uses market and non-market valuation techniques to value these resources.

2. Methodology and data collection

2.1. Travel cost method

Environmental goods lack a market for their commercialization and therefore there is no price that can guide us on their value. That is why different methods of valuing environmental goods arise (Azqueta, 1998). The cost of travel method refers to the amount in monetary units that people are willing to pay to visit a place.

The Travel Cost Method (TCM), developed by the statistician Harold Hotellin in 1947, is the most used within the indirect methods or of revealed preferences methods. The TCM assumes that the goods to be valued must require travel for the consumer to reach. From the information of the cost of the displacement necessary to be able to enjoy the good, it will be possible to obtain a valuation of this good. There are different concepts to include in the travel cost among which we find such as: fuel, the time of the displacement, the cost of camping, the cost of the food or the time used in the visit (Cristeche, 2008).

Different individuals face different travel costs, and their response (their greater or lesser number of visits) to these variations in implicit prices is the basis for estimating the demand curve. The value of the recreational services provided by the site is the area below the aggregate demand curve by the number of individuals accessing it (Llanes, 2012).

This methodology focuses on calculating the recreational value of a place that does not have a market scheme per se. Based on specific assumptions such as that there is no substitute for the study case, visitors are also sensitive to changes in the costs of getting to the site. Even if the entrance fee to a natural area of interest is zero, the cost of access is higher than that amount, since the visitor incurs expenses caused by the travel (Azqueta *et al.*, 2007).

This method of estimating the economic value of recreational services on a natural reserve is based on distance traveled to the site and the time spent there. It cannot easily be used to value a change in quality of recreation for a site and may not consider some of the factors that may be important determinants of value. The zonal travel cost method is applied by collecting information on the number of visits to the site from different distances and locations. Travel and time costs will increase with distance and this information allows researchers to calculate visitor numbers at different prices. This information is used to construct demand functions for each zone and estimate consumer surplus, or economic values, for recreational services of the ecological reserve (Cristeche, 2008).

Up next are the steps to take to apply this method (Azqueta *et al.*, 2007):

1. The first step is to determine the geographic areas surrounding the site. These zones may be defined by concentric circles around the area, or by geographic divisions that make sense, such as metropolitan areas or municipalities surrounding the site at different distances.
2. Step two is to gather information on the number of visitors from each zone, and the number of visits made in the last year.
3. The next step is to calculate the average round-trip travel distance and travel cost to the site for each zone.
4. The fourth step is to estimate, using regression analysis. This is useful to estimate the correlation that relates visits per capita to travel costs and other important variables.

5. The final step is to calculate the total economic benefit of the site by estimating the consumer surplus (the area under the demand curve). This results in a total estimate of economic benefits from recreational uses of the site.

The key variable is the number of trips made in a specific period by a visitor. It is necessary to know the number of visits made by the person in a unit of time (usually a year). Also, to have a better understanding of the results, a multiple regression analysis is to be performed. A function is specified where the number of trips per year is explained by the cost of travel and other explanatory variables. It would be expected that the higher the cost, the fewer the number of trips.

Therefore, its needed to estimate, in a simplest case, a linear function. Where the variables represent the number of visits to the area the individuals during a specific period, the travel cost and, other socioeconomic variables and the coefficients to be estimated. The equation for the model will be used as it follows:

$$\mathbf{Tn = \beta 0 + \beta 1\ Costo1 + \beta 2\ Ingreso2 + \beta 3\ Edad3 + \beta 4\ Sexo4 + \beta 5\ Estudios5 + \mu}$$

Where **Tn** is the number of travels.

2.2. Consumer surplus

The consumer surplus measures the utility that the consumers of a good get from participating in the market. It is closely related to the demand curve of a product. The demand curve shows the willingness to pay of the buyers and also allows the measurement of the consumer surplus (Golsbee, *et al*., 2013) .

The consumer surplus is related to the law of diminishing returns. Meaning that the first unit the consumer acquires has a higher value. When the consumer acquires more units of the good the valuation comes down. That way, the consumer always pays for each unit of the good the market price. In other words, the consumer acquires a positive surplus since the first unit of the good it acquires until the last one in which the surplus is equal to zero. (Mankiw, 2015).

The consumer surplus is located between the market demand curve (below) and the price line (above). The demand curve measures the amount consumers are willing to pay for each unit consumed. Then, the total area under the demand curve reflects the total utility of the consumption of the product. Subtracting the price consumers pay for each unit from this area the consumer surplus is obtained. (Parkin & Loría, 2010).

2.3. Sample description and survey

To obtain the information that the travel cost method needs, a survey was applied to calculate the variables that may influence on the visitors. This focuses on the socio-economic issues of the individuals as well as the number of visits to the natural reserve of "La Granada". The survey was applied to people from the cities of Coatepec, Xico, Xalapa, and Las Vigas de Ramirez.

A confidence level "α" at 95% and a margin of error of 0.5 was taken. To select the sample and ensure that the information from the community is dependable, the number of people included in the research is determined according to the following statistical procedure:

$$n = P(1 - P)[z/E]\text{^}2$$

Where:
n = Sample size
E = Margin of error determined by the investigator, in this case 0.5.
z = The z-value for a 95 percent confidence level.
P = The estimated value of the proportion of the population.

The survey consisted of three parts. In the first one the visitors are asked to answer some socioeconomical questions such as educational level, sex, and income. This was used to know the profile of every visitor to the ecological reserve. The second part asks the visitors how many times and how do they reach the natural reserve and the expenses of their trip. Finally, in the last section the visitors where asked their origin and the activities they were going to do in the reserve.

The number of surveys conducted on visitors to the reserve has been a total of 105. A sample size "n" greater than or equal to 105 has been considered adequate according to the amount of people that visits the reserve in a year (1500 visitors according to information provided by employees of the Municipal Tourism Office). However, due to the conditions of the current research, it has not been possible to conduct a more in-depth and concise investigation because there is no former data collected by the public agency of tourism. The amount of 1500 visitor per year were obtained by contacting the Municipal Tourism Office and asking for an estimated because there is no formal registration of visitors. This is clearly an obstacle for the method applied because it depends on the quality of data and the municipal tourism office seems to not calculate the real data for any year for the “La Granada” reserve. In addition to this, online surveys were applied for collecting data from people from Las Vigas municipality due to the limitations of the pandemic of SARS-COV-2 to try to capture the characteristics of different users and try to avoid bias. However, contacting people who have visited the reserve means a complicated task so most of the surveys were conducted in person in the municipalities of Xalapa, Coatepec and Xico.

3. Survey outcomes

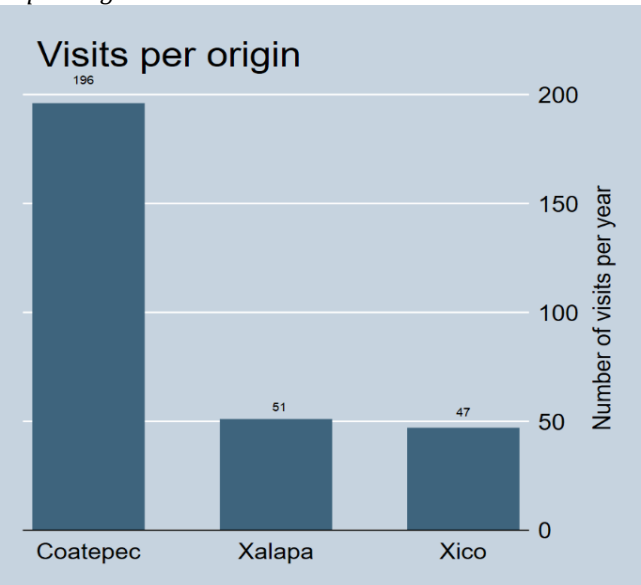
It is important to know the profile of the people that visits the ecological reserve since this way we can have a real understanding of their characteristics, preferences and hypothetical choices to travel.

Table 1
Origin

Origin	Respondents	% Of the sample
Coatepec	66	62.85%
Xalapa	27	25.58%
Xico	9	8.57%
Las Vigas	3	3%

Source: own elaboration with data from the survey.

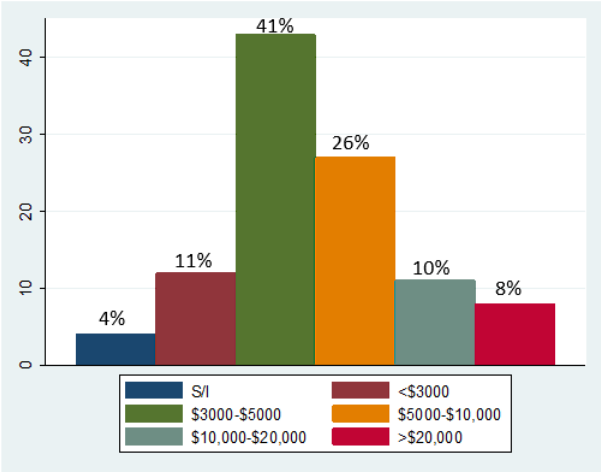
Figure 1
Visits per origin



Source: own elaboration with data from the survey.

On **Table 1**, *Origin*, people who visit the ecological reserve tends to be uneven according to the sample. Therefore, the zonal travel cost method could be better adapted to the conditions of the data. Since 66% come from the municipality of Coatepec this means lower transportation costs than the other two municipalities. People from Las Vigas municipality are less likely to be willing to spend on the trip and visit at the waterfall or other close touristic attractions. On figure 1: *Visits per origin* is notable the great difference on the total amount of visits per year of the people who answered the survey from Coatepec, Xalapa, Xico. Las Vigas was excluded from the graph because there were no visits from there to the ecological reserve.

Figure 2
Income



Source: own elaboration with data from the survey.

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Figure two shows the monthly income of the people who visited the "La Granada" waterfall, the results showed that 41% of the people who visit the cloud forest earn between $3000 and $5000 pesos a month. This suggests that people with low incomes who belong to low class are more likely to visit the "La Granada" reserve. Only 18% of those surveyed had incomes of more than $10,000 pesos a month which paradoxically means that low-income or middle and high-class people look for enjoinment and recreation in natural areas of free access more than people with higher income. Only four percent of the people who answered the survey have no income and analyzing the data they correspond to the student class.

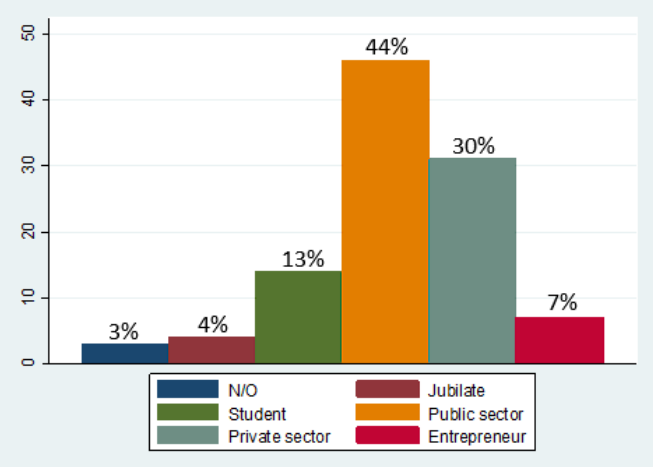
Table 2
Educational level

Education level	Percentage	Results
No Studies	0%	0
Primary school	0%	0
Secondary	0%	1
High school	51%	53
College	31%	32
Master or PhD	17%	20

Source: own elaboration with data from the survey.

In terms of educational level, table 2 shows that people with a high school education contribute 51% of the total number of the survey respondents. This data goes coordinated with the previous data on income and gives the idea that people with less economic opportunities prefer to visit natural reservoirs. The other side of the survey shows that 48% of those visitors have a higher level of education of college and postgraduate education. Although there is no substantial difference on the educational level of the people who visited the waterfall it is important to clarify that people with less opportunities to assist to college are more likely to travel. Perhaps due to the proximity of their point of origin and the lower cost of the trip.

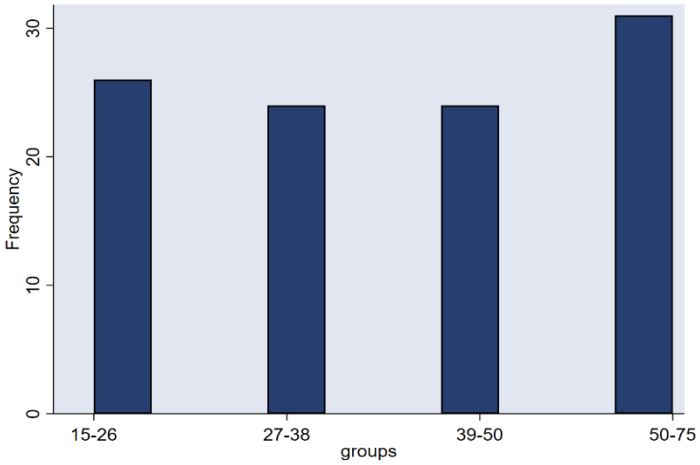
Figure 3
Employment situation



Source: own elaboration with data from the survey.

According to data of the survey the average age is 39.75 years old. Therefore, most of the respondents belong to a working age. Also, figure 3 shows the participation in terms of employment. Most visitors work in the public sector (44%) while the lowest participation is of retired people and entrepreneurs. Thirty percent work in the private sector. Usually, they work on the local businesses of the Coatepec municipality and they seek the time to go to natural areas.

Figure 4
Age range



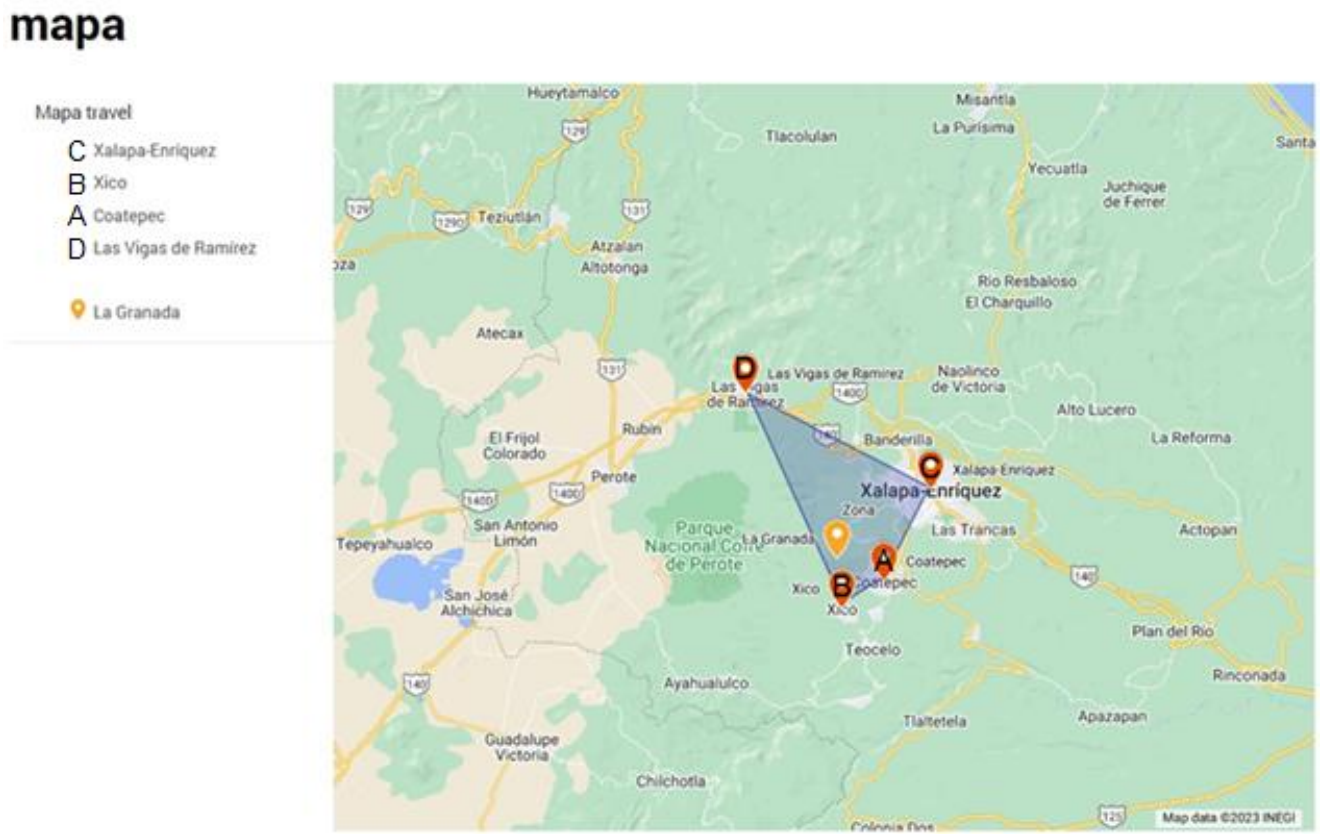
Source: own elaboration with data from the survey.

On figure 4 data shows that 29% of visitors have between 50-75 years old. People over 50 years old are the most likely to visit the reserve. Thus, there is no significant difference on the amount of people that visit the ecological reserve and the age gap to say that this variable may influence the model.

Travel cost

As it was mentioned before, the first step of the travel cost is to define a set of zones surrounding the environmental zone to analyze. For this research it was set to consider the cities of (A, Coatepec), (B, Xico), (C, Xalapa), and (D, Las Vigas de Ramirez). These cities were chosen because of the distances from the natural reserve of La Granada. Even though there are other close municipalities it was decided to focus on the main four cities that are near the reserve. Also, it is important to know the costs to visit from the people of the Las Vigas de Ramirez municipality to know the willingness to pay and visit of those who live further away from the waterfall.

Figure 5
Areas surrounding the ecological reserve "La Granada"



Source: Image taken from Google maps.

After defining the locations of the near cities from "La Granada" reserve it was set to calculate the number of travels per person in a year. This data was obtained from the survey. After knowing the number of travels to the ecological reserve of every visitor in one year we need to estimate the visitation rate by dividing the number of visits per year of every zone by its population. As table 4 shows the rate decreases as distance increases.

Table 3
Visitation rate

Zone	Round trip (km)	Visits	Population*	Visitation rate	Estimated visits
A (Coatepec)	17	196	93911	0.002087082	294
B (Xico)	35.4	47	39623	0.00118618	111.395
C (Xalapa)	43.8	51	488531	0.000104395	9.8038016
D (Las Vigas)	112.8	0	20300	0	0

Note: **** The population is estimated according to INEGI's 2020 population census. Source: own elaboration with data from the survey.***

Whit this data it is possible to calculate the travel cost per zone by multiplying the trip distance by the average value of expenses of every zone. **Table 3** shows the increase in the cost of travel

depending on the distance needed to get to and from the ecological reserve. Also, this makes sense on the number of trips from every zone. As shown in table 4, an average value of 4.09 the travel cost for zone A is $69.59 The greater the travel cost the less willingness to visit and pay for the reserve.

Table 4
Travel cost per zone

Zone	Round trip (km)	Average value	Travel cost
A (Coatepec)	17	6	69.5990991
B (Xico)	35.4	2.82485876	144.929889
C (Xalapa)	43.8	4.56621005	179.320032
D (Las Vigas)	112.8	3.10283688	461.810493
		4.09406466	

Source: own elaboration with data from the survey

Regression Model

Table 5
Regression Model outcome

Viajes	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
logCosto	-.4400739	.1196092	-3.68	0.000	-.6745036	-.2056442
logIngreso	.1537628	.1621235	0.95	0.343	-.1639935	.4715191
logEdad	-.2637044	.1667762	-1.58	0.114	-.5905797	.0631709
logSexo	.2487715	.1769242	1.41	0.160	-.0979935	.5955365
logEstudios	-.0489246	.184626	-0.26	0.791	-.4107849	.3129356
_cons	3.669784	.7762461	4.73	0.000	2.148369	5.191198

Source: own elaboration with data from the survey.

Initially we can observe in **Table 5** that the only variable that is statistically significant is the Cost. The regression model estimates the parameters through maximum likelihood. If we use least-squares analysis the direction of the effects serves us to interpret the changes between the variables. In the case of Cost, there is a negative relationship, so we can interpret that the higher the cost, the lower the probability of visiting "La Granada".

Nevertheless, the coefficients of the variables Income, Age, Sex and Studies do not present significance. When interpreting the variable *Income* and having a positive relationship it is understood that the higher the income the greater the probability of visiting the park.

Age shows a negative relationship, so the older the person, the less likely they are to visit the recreational area. The variable *sex* it is interpreted that female visitors are more likely to attending the reserve. Thus, it would be interesting to do profound research on this subject to know why this happens and to know if there are some gender preferences on visiting environmental goods for recreation. And as for the *educational level*, the higher the level of education, the more likely it is to attend the place.

However, the valuable information regarding maximum likelihood is the marginal effects. The mean log value of the variable Costs is 4.448862, Income = 1.190723, Age = 3.617417, Sex = .2574547 and Education = .3432729.

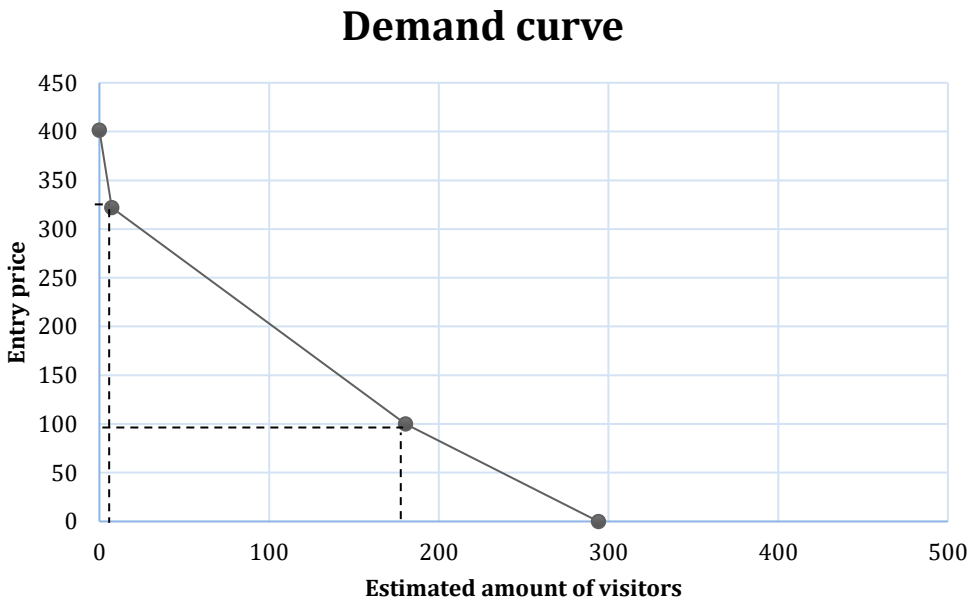
Table 6
Marginal effects

	Dy/Dx.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
logCosto	-.782412	.3131932	-3.78	0.000	-1.796259	-.5685647
logIngreso	.4131374	.4350251	0.95	0.342	-.439496	1.265771
logEdad	-.7085339	.4463959	-1.59	0.112	-1.583454	.1663861
logSexo	.6684113	.4739264	1.41	0.158	-.2604674	1.59729
logEstudios	-.1314531	.4960198	-0.27	0.791	-1.103634	.8407278

Source: own elaboration with data from the survey.

Therefore, in the mean of the variables the probability of attending the reserve as a function of cost is that found in table 6. In other words, the probability of visiting a place as a function of increased travel costs is -78%. For each increase in cost the probability of attending decreases by that percentage.

Figure 6
Consumer surplus



Source: own elaboration with data from the survey.

To calculate the consumer surplus, the area under the demand curve corresponding to each triangle must be calculated. In figure 6 the curve allows us to appreciate that the good to be valued complies with the law of demand since, in the face of an increase in prices, visitors to the reserve are less likely to go. When the area under the curve is calculated geometrically, the result is a surplus of **$47.10** MXN. This means that people are willing to pay that amount to visit the reserve.

By multiplying the surplus by the number of visitors per year (around 1500 visitors according to information provided by employees of the Municipal Tourism Office) we get the recreation value of **$70,645** MXN. This means that the income for the maintenance of the ecological reserve "La

Granada" in one year corresponds to that value. However, the problem of obtaining a low value could be due to the number of visitors who attend the reserve each year. Since there is no real data on the approximate number of visitors per year, it is proposed that the sample might be needed to be increased.

5. Conclusions

Even though the tropical montane cloud forest of the municipality of Coatepec includes a considerable proportion of vegetation, endemic fauna and flora and ecosystem services (recreational services, regulation services, etc.), the population's valuation of the ecological reserve of "La Granada" is extremely sensitive to changes in the costs to reach there.

Nowadays there is no fee to access the “La Granada” waterfall. This means that is a public good for the enjoyment of all those who wish to visit it. This research focused on obtaining the recreational value of visits to the ecological reserve through a particular method of environmental economics. However, the recreational value of the method may not be enough to propose incentives to efficiently manage the site. Since this methodology does not calculate the value of non-use.

However, the estimates serve to understand the population's value of the surrounding municipalities regarding the site as a recreational area. It is important to mention that the estimates of annual visitors come from the data provided by the local tourism agency, since there is no data collection on the number of annual visitors to the waterfall. In addition, due to the SARS-COV-2 pandemic, collecting the data was a complicated task. The population in the areas where the surveys were conducted did not appear to be willing to respond physically for fear of contagion.

Even so, the consumer surplus with the sample obtained is $47.10 MXN per visitor. This incurs a recreational value of $70,645 MXN per year. Although this is a low budget for the maintenance of the natural reserve, it approximates the representative sample's benefits. If conservation policies were planned to apply their cost would have to be less than $70,645 MXN per year. If the costs are greater than this, the staff will have to decide whether other factors make them worthwhile. This might be useful to determine a price for access to the recreational area and acquire resources for the reserve.

The estimate may be limited by the assumptions made regarding the cost of travel. While all respondents marked a minimum cost to get to the site, not all were traveling by car individually, but collectively. Nevertheless, in this way we can understand the characteristics of the reserve and issues to consider for further studies. Therefore, as an extension of this research, there would be other valuation exercises with larger samples and the application of other valuation methodologies that would allow to collect the value of all the attributes of "La Granada", such as the environmental ones, and not only the recreational ones on which this paper has been based.

One of the key limitations for this method is that the simplest models assume that individuals take a trip for a single purpose, to visit a specific recreational site. Thus, if a trip has more than one purpose, the value of the site may be overestimated. It can be difficult to apportion the travel costs among the various purposes. For example, in the research published by Koshy *et al*. In 2019 one of the problems was that, because of all the activities to do in the park, the travel cost could overestimate the consumer surplus or benefits obtained by the tourists.

It is considered that the value revealed by this research may be low for the quality and quantity of ecosystem services that the reserve provides. However, by knowing this data through a

representative sample, decision makers can propose public policies to encourage the conservation of the ecological reserve, improve its current situation and take care of all the species there are and create a promotional campaign as a tourist site. In this way, environmental valuation can be a guide to be accountable for the "La Granada" waterfall with the cooperative participation of state and municipal governments and the citizens who enjoy its ecosystem services.

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