Determination Of Consumer Surplus Using Poisson Models Through The Travel Cost Method. Case: Lizas-Ilo Well Beaches

[1]Eduardo Flores-Condori, [2]Eduardo Luis Flores-Quispe, [3]Jose Quiñonez-Choquecota, [4]Mayda Yanira Flores-Quispe

[1]Orcid Https://Orcid.Org/0000-0003-0983-5250
Universidad Nacional Del Altiplano
Puno, Perú, Corresponding Author: Eflores@Unap.Edu.Pe
[2]Orcid Https://Orcid.Org/0000-0001-5106-9583
Universidad Nacional De Moquegua
Ilo, Perú, Efloresq@Unam.Edu.Pe
[3]Orcid Https://Orcid.Org/0000-0003-1966-2146
Universidad Nacional Del Altiplano
Puno, Perú, Josequch@Unap.Edu.Pe
[4]Orcid Https://Orcid.Org/0000-0002-8803-9772
Universidad Nacional De Juliaca
Juliaca, Perú, Mflores@Unaj.Edu.Pe

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Abstract: Natural resources and environmental services are public goods characterized by being generators of direct utility without the existence of a market in which the respective prices are formed. The research was conducted on the beaches of Pozo de Lizas de Ilo, where the individual travel cost method was applied, using the Poisson model and the Limdep 8.0 software. The surveys reveal that the number of visits is once (88%); the average monthly income was S/. 2581.84; in terms of environmental perception, 79% stated that there is no contamination; the family size is 3.38 individuals; in terms of educational level, 67% stated that they had higher education, and 66.7% were male; and the average cost of a visit was S/.1532.06 soles. The variables of cost of visit, age and family size have negative signs, which indicates an inverse relationship. However, the variables educational level, gender, monthly income and environmental perception, with positive signs, indicate a direct relationship with respect to the number of visits. Monthly income with probability P = 0.0006, which with respect to P ≤ 0.01 indicates that there is high statistical significance (z = 3.42), indicating that the higher the family income, the higher the probability of visiting the beach. The goodness-of-fit was r^2 = 64.44%, with a good degree of association between variables. The minimum consumer surplus was S/.55.83 soles and the average surplus was S/. 91.32 soles and the aggregate surpluses were S/913200.00 and S/.558300.00 soles ($.164205.88 and $.268588.24). The values obtained would be voluntary contributions from visitors, so that the local authorities responsible could use the estimated amount for the conservation of environmental goods and services of the Pozo de Lizas beach.

Keywords: consumer surplus, travel cost method, Poisson model, environmental economic valuation, environmental economic valuation.

Introduction

The importance of conservation and sustainable use of ecosystem goods and services is an integral part of the development strategy of the country, which requires studies on the allocation of scarce resources that provide technical arguments for the quantification of the benefits derived from the environment. The idea of the travel cost method comes from Hotelling (Hotelling, 1947), who suggested it as a valuation measure for national parks in the United States. The first application was by Trice and Wood (Trice & Wood, 1958), who estimated the recreational value of a U.S. river. However, it was Clawson (1959) and Clawson and Knetsch (1966) who most influenced the beginnings of this line of valuation after applying the method to Yosemite National Park in California.

The travel cost method is applied to the economic valuation of natural areas that fulfill a recreational function. It is arguably the oldest technique of all those that attempt to obtain the value of environmental goods and services that have no market. As the author (McConnel, 1985) points out, the first valuation was carried out in the USA with Yosemite National Park, at the end of the 50's. It was through the zonal travel cost method, which dominated mainly in the 60's and 70's. With statistical evolution came the individual travel cost method, which was dominant in the 1990s (Riera & Ferras, 2004).

The purpose of this method is to use demand functions to obtain the surplus of the consumer visiting a given natural park. Since the measurement of consumer surplus is closely related to utility

maximization, it seems appropriate to specify, firstly, a simple model of consumer behavior, based on a household utility production function, and, secondly, it will be seen how this maximization model is very clarifying both in terms of the measurement of the flows of services provided by the environmental good and in terms of the costs per unit of service (McConnel, 1985).

Regarding the work applied in this line of valuation of strategic ecosystems, Bullon (Bullon, 1996) employs the travel cost and contingent valuation methods to economically value the environmental recreation services associated with the La Florida wetland, in Bogotá. Velásquez (Velasquez, 1996) values the recreational benefits of El Cocuy National Natural Park, in Colombia. Del Saz y Suarez (Del Saz & Suarez, 1998) value the recreational use of protected natural areas, applying the contingent valuation method to the natural park of L'Albufera, in Spain. Kunze (Kunze, 2001) estimated demand for natural resources in Lake Llanquihue, in Chile, using the trip cost method, and Riera and Ferras (Riera & Ferras, 2004) used contingent valuation and travel cost models, applied to the protected natural areas in Mallorca, in Spain.

With regard to the econometric problems presented by the travel cost method, Bockstael (Bockstael, 1995) points out that the most novel modification in demand function estimation is the non-negative discrete dependent variable models (Count Data Models). In this case, to avoid an overestimation of consumer surplus, the coefficients of the maximum likelihood regression are estimated assuming that travel demand follows a Poisson or Negative Binomial distribution (McKean, Johnson, & Walsh, 1995). Specifically, if it is assumed that Y is a random variable with a discrete distribution and that, in addition, the value of Y must be a nonnegative integer, then Y is said to have a Poisson distribution with mean λ (being λ > 0) if the probability function of Y is as follows:

$$Prob(Y = yi) = \frac{e^{-\lambda_i}\lambda^{yi}}{y_{i!}}$$

for y = 0,1, 2, …; where:

$$\ln(\lambda_i) = \beta' Xi$$

In this distribution it is assumed that λ_i is both the mean and variance of y_i. On the other hand, the negative binomial distribution is an extension of the Poisson function where the variance is allowed to differ from the mean (Cameron & Trivedi, 1986). A final difficulty of this method is the following: suppose that the Administration wishes to know the impact on the economy of a region of improving the quality of the recreational services offered by a given natural area (for example, an improvement in the water quality of a lake that allows, in addition to water skiing, bathing and sport fishing). In order to accurately calculate this impact, the four phases that make up the potential visitor's choice process must be taken into account (Loomis, 1995).

Firstly, the tourist has to decide whether or not to participate in a given recreational activity (swimming, fishing, skiing, etc.); secondly, he has to select, from among the different places available, the one where he wishes to carry out the recreational activity; thirdly, he has to decide how often he will visit the chosen place; and finally, he has to decide how long he will spend in that place (a few hours, a few days, a few weeks, etc.). Therefore, if these four phases are not taken into account, the potential impact on the local economy of such an environmental improvement may be underestimated. The objectives of the research are: To evaluate the parameters of the relationship between consumer surplus (CE) and the socioeconomic characteristics of the users, using Poisson models in the case of the Pozo de Lizas beach in Ilo; and To determine the aggregate values in order to formulate the integrated recreational management plan for the Pozo de Lizas beach in Ilo.

Materials and Methods

Study area

The study was carried out at Pozo de Lizas Beach in the city of Ilo; it is located on the southern coast of the Peruvian coast, between 17º14'48" and 17º49'16" South latitude and 71º29'15" and 70º54'50" West longitude. The temperate season lasts 3 months, from December 25 to April 2, and the average daily maximum temperature is over 24°C (75°F).

The warmest day of the year is February 7, with an average maximum temperature of 26°C and an average minimum temperature of 20°C. The coldest day of the year is August 14, with an average minimum temperature of 11°C and an average maximum of 16°C. Based on the tourism score, the best times of the year to visit Ilo for hot weather activities are from early March to late May and from early November to mid-January (Quispe & Flores, 2015).

The study is correlational and analytical, the estimated population was 15,000 visitors and the sampling formula was applied:

$$n = \frac{Z^2 * N * P * Q}{e^2 * (N - 1) + (Z^2 * P * Q)}$$

Where: Z = 1.65 of 90%, P = Q = 50%; N = 15000 visitors; e = 5%; n = 267 heads of households.

Let Y be a random variable with a discrete distribution and suppose that the value of Y must be a non-negative integer. Where Y has a Poisson distribution with mean λ (where $\lambda > 0$) if the probability function of Y is as follows: $\boldsymbol{Prob}\ (Y = Yi) = \frac{e^{-\lambda_i} y_i}{Y_i!}$

For $Y = 0,1,2,\ldots$ where: $ln\lambda_i = \beta Xi$. In this distribution it is assumed that λ_i is both the mean and the variance of Y_i. on the other hand, the Negative Binomial distribution is an extension of the Poisson's function (Cameron & Trivedi, 1986).

Therefore, the function that has been proposed based on the variables: NVI = number of visits; CVI = cost of visit; EDA = age of the respondent; EDU = educational level; Gen = gender; ing = monthly income; PAM = environmental perception; TAH = family size; and ε = error (Flores, 2006).

$$\text{NVI} = \text{f}(\text{CVI}, \text{EDA}, \text{EDU}, \text{GEN}, \text{ING}, \text{PAM}, \text{TAH}, \varepsilon)$$

According to (Mendieta, 2005) the Poisson model is of the form:

$$\overline{NVI} = exp(\beta_0 + \beta_1 * CVI + \beta_2 * ING + \cdots + \beta_n * N)$$

with β<0

Where: $\overline{NVI} =$ number of expected visits and EC the consumer surplus which is estimated from the following formula:

EC=-$\overline{NVI}/\beta_1$

Results

The socioeconomic characteristics of the people visiting the Pozo de Lizas beach in the port of Ilo, according to the questionnaires of 267 surveys; people who have visited once (01) were 88.8%, 02 times 10.1% and 03 times 1. 1%, the average number of visits (NVI) was 1.12 times; the average monthly income (ING) was S/. 2581.84, the maximum income was S/.7000.00 and a minimum of S/.1200.00 soles; regarding environmental perception (PAM), 21.0% stated that the beach was polluted and 79. 00% stated that it was not polluted; the average family size (TAH) was 3.38; the average educational level (EDU) was 2.71, that is 4.9% with complete primary education, 23.2% with complete secondary education. 67.00% stated that they had university studies, and 4. 90% had postgraduate studies. Regarding gender (GEN), 33.3% were female and 66.7% were male; and the average cost of visit (CVI) was S/.1532.06 soles, with a maximum cost of S/.3190.00 and a minimum cost of S/.180.00 soles.

Table 1. Descriptive statistics of socioeconomic and environmental variables for 2018

Descriptive	CVI	EDA	EDU	GEN	ING	NVI	PAM	TAH
Mean	1.53	36.71	2.71	1.66	2.58	1.12	1.79	3.38
Median	1.55	35.00	3.00	2.00	2.50	1.00	2.00	4.00
Maximum	3.19	63.00	4.00	2.00	7.00	3.00	2.00	4.00
Minimum	0.18	21.00	1.00	1.00	1.20	1.00	1.00	2.00
Std. Dev.	0.71	9.37	0.63	0.47	0.99	0.36	0.40	0.73

The Poisson distribution is a distribution that models well counting situations, in this case, the number of visits (NVI) to the beach, always evaluated in a given unit of time. Table 2 shows the results of the Poisson function, the coefficients with negative sign, indicating an inverse relationship between the variables of CVI, EDA and TAH and the variable number of trips (NVI); and for the variables EDU, GEN, ING and PAM, whose coefficients have positive sign which indicate the direct relationship with respect to the variable of number of visits. It is necessary to indicate that the monthly income variable (ING) with probability P = 0.0006, which in comparison with P ≤ 0.01, has a high statistical significance, as shown by the z-statistic whose value 3.42 indicates that the higher the family income, the greater the probability of visiting the beach. As for the goodness of fit of the values, the coefficient of determination is r2 = 64.44%, which indicates that the degree of association between variables is good; and the travel cost variable with negative sign, which complies with the econometric theory, indicating that the higher the cost of travel to access the beach, the lower the number of trips made.

Table 2. Results of Poisson's function

Variable	Coefficient	Standard error	z-Statistics	Probability
C (Coefficient)	-0.491143	0.510535	-0.962015	0.3360
CVI (Cost of visit)	-0.012304	0.083286	-0.147731	0.8826
EDA (Respondent's age)	-0.003600	0.006437	-0.559175	0.5760
EDU (Educational level)	0.107290	0.098228	1.092248	0.2747
GEN (Gender of respondent)	0.024413	0.126545	0.192919	0.8470
ING (Monthly income)	0.183381	0.053655	3.417769	0.0006

PAM (Environmental perception)	0.031075	0.144474	0.215090	0.8297
TAH (Family size)	-0.037274	0.081125	-0.459464	0.6459
r^2	0.644389	Dependent variable mean		1.123596
r^2 adjusted	0.634778	S.D. dependent variable		0.362330
Log likelihood	-281.2872	Hannan-Quinn criter.		2.210121
Restr. log likelihood	-289.1301	Statistical LR		15.685760
Avg. log likelihood	-1.053500	Probability (statistical LR)		0.028148

To check if the model is good, the likelihood ratio test is used. The likelihood ratio statistic is equal to: LR = -2 * (ln Lr - ln Ln r) = -2*(-289.1301+281.2872) = 15.6858. The critical value for a chi-square distribution (7 degrees of freedom = to the number of restrictions) is 14.0671. Here the likelihood ratio statistic is LR = 15.6858 > $\chi 2$ and falls in the rejection region. The null hypothesis would be rejected at a 95% confidence level and this indicates that, taken together, the variables explain the model correctly.

In order to determine the consumer surplus (CE) associated with the visit, S/.91.32 soles were obtained, which is equivalent in U.S. dollars to $.26.00 and the average travel demand is 1.12 times, this value indicates that the Pozo de Lizas beach is visited only once a month in the summer months.

Table 3. Results of consumer surplus and demand calculations.

Variable	Mean	Stand. dev.	Minimum	Maximum	Cases
DEMANDA	1.12	0.277	0.687	2.668	267
EC	91.32	22.573	55.828	216.883	267

In order to calculate the consumer surplus associated with a visit, the EC formula consumer surplus is estimated from the following formula: EC=-$\overline{NVI}/\beta_1$

Thus, a consumer surplus per visit of S/.91.32 soles and the equivalent in U.S. dollars is $.26.86.

Table 4. Results of the aggregate surplus of visitors to the Pozo de Lizas beach.

EC (S/.)	Population	aggregate surplus (S/.)	aggregate surplus ($.)
216.88 (maximum)	10000	2168800.00	637882.35
91.32 (mean)	10000	913200.00	268588.24
55.83 (minimum)	10000	558300.00	164205.88

The value of the consumer surplus expressed in soles, represents the total consumer surplus of the sample being, therefore, the total minimum individual surplus is equal to $164205.88 and an average of $268588.24 US dollars, figures that represent the value of the recreational environmental service provided by the beach; the mentioned amounts can be used for the maintenance and formulation of the sustainable preservation plan of the Pozo de Lizas beach in the city of Ilo.

Sarmiento (Sarmiento, 2004), This research obtained the difference between the methods: Contingent valuation method $ 1,192,800 and travel cost method $ 3,248,000 in its research Environmental economic valuation of recreational services of Lake Termas de Rio Hondo, Santiago del Estero, i.e. compared the Contingent valuation method versus travel cost.

Discussion

Flores (2006) concludes in his thesis that the method applied in his research obtained an average consumer surplus of each national visitor a value of S/.47.99 nuevos soles (US$.14.12), with an average bias of 43.88%, making a total aggregate consumer surplus of use of the island of S/. 4.00 million nuevos soles (US$ 1,177 US dollars). These values are for the cost of travel, and for the cost of the visit, an average consumer surplus of S/.38.34 was obtained, equivalent to US$ 11.30 US dollars, which makes a total of S/.3.2 million nuevos soles (US$ 0.94 US dollars).

In other research, Moreno (Moreno, 2004) concludes that the travel cost variable resulted with the expected sign and statistically significant at 96%. The Z statistic reaches values higher than 2.08, which gives the variable a level of explanatory reliability higher than 90%, while the negative sign ratifies the inversely proportional relationship that exists between consumer behavior, in terms of the number of visits demanded and the amount of trips consumed, as a result of the price. The use value of a natural recreation area is a consistent parameter to measure the adequate compensation for the partial or total elimination of a park of this type, as well as to determine the minimum investment value to maintain the social welfare provided by a natural recreation area.

Conclusions

Of the 267 people surveyed, the number of visits (NVI) was 01 time (88%); the average monthly income (ING) was S/.2581.84; with respect to environmental perception (PAM), 79% stated that it was not

contaminated; the average family size (TAH) was 3.38; fromeducational level (EDU), 67% stated that they had higher education, and 66.7% were male; and the average cost of visit (CVI) was S/.1532.06 soles. In the application of the Poisson models in the determination of the CE, the coefficients of the CVI, EDA and TAH variables were obtained with a negative sign, indicating an inverse relationship between independent variables and the dependent variable number of trips (NVI). However, the EDU, GEN, ING and PAM variables, whose coefficients have a positive sign, indicate a direct relationship with respect to the NVI variable. In is necessary to indicate that the monthly income variable (ING) with probability P = 0.0006, which with respect to P ≤ 0.01 there is high statistical significance, as shown by the z-statistic whose value was 3.42, which indicates that the higher the family income the greater the probability of visiting the beach; as for the goodness of fit of the values, the coefficient of determination is r2 = 64.44%, which indicates that the degree of association between variables is good; and the travel cost variable with negative sign, which complies with the econometric theory, indicating that the higher the cost of travel to access the beach, the lower the number of trips made.

The minimum consumer surplus (CE) was S/.55.83 soles and the average surplus was S/.91.32 soles and the aggregate surpluses were S/913200.00 and S/.558300.00 soles and whose equivalents in U.S. dollars were $.164205.88 and $.268588. 24 respectively, these values obtained are voluntary contributions from visitors to the beach, so the local authorities responsible could use the estimated amount for the formulation of comprehensive plans for sustainable management of environmental goods and services of the beach of Pozo de Lizas.

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References

1. Azqueta, D. A. (1994). *Valoracion Economica de la Calidad Ambiental.* España: McGraw-Hill.
2. BIOFOR/INRENA. (2003). *Valoracion Economica con Fines ecoturisticos de la Reserva Nacional del Lago Titicaca, Apartir del metodo de valoracion Contingente (MVC).* Lima Peru: Proyecto de BIOFOR-INRENA Pp 74.
3. Bockstael, N. (1995). *Travel cost models», en Bromley, D. (ed.).* Oxford: Handbook of Environmental Economics, Blackwell.
4. Bullon, V. (1996). Valoración económica del humedal La Florida por servicios de recreación: Una aplicación de los métodos coste de viaje y valoración contingente. . *Artículo publicable, Facultad de Economía, Universidad de los Andes, Bogotá*.
5. Cameron, C., & Trivedi, P. (1986). Econometric models based on count data: comparisons and applications of some estimators and tests. *Journal of Applied Econometrics*, vol.1, nº1, pp 29-53.
6. Clawson, M. (1959). Methods of Measuring the Demand for and Value of Outdoor Recreation. *Resources for the future*.
7. Clawson, M., & Knetsch, J. L. (1966). Economics of Outdoor Recreation. Resources for the future. *Resources for the future*.
8. Del Saz, S., & Suarez, C. (1998). El valor del uso recreativo de espacios naturales protegidos: Aplicación del método de valoración contingente al parque natural de L'Albufera. *Economia*.
9. Flores, C. E. (2006). *Valorización Económica de las Islas de La Reserva Nacional del Titicaca, Aplicando el Método del Costo De Viaje".* Lima Peru: Universidad Nacional Federico Villarreal.
10. Hotelling, H. (1947). *The Economics of Public Recreation.In The Prewitt Report.* Washington, D. C.: Departament of the Interior.
11. Jimenez, L., Amaya, P., Coayla, E., & Vargas, C. (2001). *Valoracion economica del servicio de Recreacion del Parque de las Leyendas, una aplicacion de los Metodos de Costo de Viaje y Valoracion Contingente.* Lima Peru: CONCYTEC Premio de Investigacion1999 Pp. 171.
12. Kunze, V. (2001). *Estimación de la demanda por recursos naturales, Método del coste de viaje:Lago Llanquihue.* Facultad de ciencias económicas y administrativas, Universidad de Chile.
13. Loomis, J. B. (1995). Four models for determining environmental quality effects on recreational demand and regional economics. *Ecological Economics*, vol. 12, n.º 1: pp. 55-65.
14. McConnel, K. E. (1985). The economics of Outdoor Recreation, en kense Sweeney. Vol II.
15. McKean, J. R., Johnson, D. M., & Walsh, R. G. (1995). Valuing time in travel cost demand analysis: an empirical investigation. *Land Economics*, vol. 71, n.º 1: pp. 96-105.
16. Mendieta, L. J. (2005). *Manual de valoracion economica de bienes no mercadeables.* Bogota Columbia: Documentos CEDE.
17. Moreno, G. J. (2004). Utilización del método del costo de viaje para la valoración económica de los parques recreativos. Caso práctico: Valoración del parque forestal recreativo "Puente Sopó.

Artículos de Reflexión, Diciembre del 2004 vol:8 nro:17 pág:158-179.

18. Quispe, P. M., & Flores, L. P. (2015). *Centro de Eventos de Esparcimiento en el Balneario Pozo de Lizas – Ilo.* Peru: Universidada Nacional Jorge Basadre Grohmann-Tacna Tesis de Arquitectura.
19. Riera, P., & Ferras, V. (2004). El método del coste de viaje en la valoración de daños ambientales. Una aproximación para el País Vasco por el accidente del Prestige. *National Scientific and Technical Research Council Buenos Aires, Buenos Aires, Argentina Join institutionEkonomiaz N.o 57, 3.er Cuatrimestre, 2004*.
20. Sarmiento, M. A. (2004). Valoración económica ambiental de servicios recreativos del lago termas de río hondo, Santiago del Estero. Método de valoración contingente versus costo del viaje . *Asociación Argentino Uruguaya de Economía Ecológica (ASAUEE)* .
21. Trice, A. H., & Wood, S. E. (1958). *Measurement of Recreation Benefits.* Land Economics N° 32 Pp: 195-207.
22. Tudela, W. (2012). *Valoración Económica de los Beneficios Ambientales de la Reserva Nacional del Titicaca.* Puno Peru: Universidad Nacional del Altiplano.
23. Velasquez, D. (1996). Valoración Recreacional del Parque Nacional Natural El Cocuy. . *Artículo*.