

# WILLINGNESS TO PAY FOR WATER RESOURCES FOR HUMAN CONSUMPTION IN THE CITY OF AZÁNGARO

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**ABSTRACT:** **Objective:** Determine the willingness to pay for water resources for human consumption. **Material and method:** The deductive and econometric method was used, with a quantitative, non-experimental, basic type approach, with descriptive and explanatory scope, cross-sectional, the population was delimited based on 5,530 cases of water supply in the city of Azángaro, located at 3,850 masl, and an estimated sample of 365 respondents was estimated, with a Cronbach's Alpha value of 0.908, the binomial logit econometric model was applied. **Results:** The value of the willingness to pay was S/ 2.52 soles per month, estimating a total of S/ 172,217 soles per year, useful for the application of environmental improvement policies for water resources in Azángaro. **Conclusions:** The determining factors of the willingness to pay were: age, education, gender, the importance of the water resource and the perception of improvement in the quality of the water resource in the future.

**KEYWORDS:** human consumption, willingness to pay, logit model, water resource.

## DISPOSICIÓN A PAGAR POR EL RECURSO HÍDRICO PARA CONSUMO HUMANO EN LA CIUDAD DE AZÁNGARO

**RESUMEN:** **Objetivo:** Determinar la disponibilidad a pagar por el recurso hídrico para consumo humano. **Material y método:** Se utilizó el método deductivo y econométrico, con enfoque cuantitativo, no experimental, de tipo básica, con alcance descriptivo y explicativo, de corte transversal, la población se delimitó en base a 5,530 casos de abastecimiento de agua en la ciudad de Azángaro que se encuentra a 3,850 msnm, y se estimó una muestra estimada de 365 encuestados, con un valor Alpha de Cronbach de 0.908, se aplicó el modelo econométrico *logit binomial*. **Resultados:** El valor de la disposición a pagar fue de S/ 2.52 soles por mes, estimándose un total de S/ 172,217 soles anuales, útil para la aplicación de políticas de mejora ambiental del recurso hídrico en Azángaro. **Conclusiones:** Los factores determinantes de la disponibilidad a pagar fueron: la edad, la educación, el género, la importancia del recurso hídrico y la percepción de mejora de la calidad del recurso hídrico en el futuro.

**PALABRAS CLAVE:** Consumo humano, disponibilidad a pagar, modelo *logit*, recurso hídrico.

### 1 | INTRODUCTION

Willingness to pay is the most widely used tool to measure environmental goods (Vásquez, 2017), since it assumes a hypothetical market for the payment of an environmental good. In the hypothetical market, it is assumed that people would be willing to pay under certain conditions such as quantity, quality, location, time, or duration. Among the factors that determine the willingness to pay are demographic aspects, such as age, gender, literacy level, income, family size and price (Makwinja et al., 2019).

Jalilov (2018) estimates the benefits of providing clean water quality in the Philippines, using a sample size of 240 respondents, with random sampling, mean willingness to pay has been US\$2.03 for optimal water quality for bathing and an average willingness to pay for the quality of fishing water of US\$ 2.03. The total economic benefits are US\$ 190 million/year. Despite economic growth, especially in the industrial sector, there have been significant ecological and hydrological changes in urban areas. Affecting the quality of water, having to improve prior intervention of environmental policies in water quality.

In this context, the city of Azángaro has problems of water contamination due to mining, and which are a concern for the population that consumes drinking water, and having protests at a social level, no proposal for improvement has been registered. of environmental policies in the protection and conservation of water resources. Therefore, this research aims to assess the water resource through the question of how much would be willing to pay for the conservation of the water resource.

In studies of willingness to pay related to water resources, logistic regression models have been the most used (Perni et al. 2011; Peixer, 2011; Almendarez et al., 2013; Kebede and Tariku, 2016; Aslam et al. , 2018; Jalilov, 2018; Makwinja et al., 2019).

## 2 | MATERIALS AND METHODS

The type of research is quantitative, non-experimental, descriptive and explanatory, cross-sectional, with a simple random probabilistic sample (Hernández et al., 2010). The population of 5,530 was obtained from the National Institute of Statistics and Informatics, through the database of water supply in the home, with a public network inside and outside the home, which have a pool for public use, use the tanker truck or that they acquire from the neighbor. The sample size estimate was 365. Data was collected through surveys, validated with Cronbach's Alpha coefficient, whose resulting value was 0.908, highly reliable.

The willingness to pay was represented by the logit model (Gujarati et al., 2010), with the following notation:

$$Prob(S_i) = \beta_0 + \beta_1 PC + \beta_2 IN + \beta_3 EDA + \beta_4 ED + \beta_5 GE + \beta_6 TAH + \beta_7 IRH + \beta_8 VRH + \beta_9 PMRHF + \varepsilon_t$$

Prob(S<sub>i</sub>), is the binary variable, indicates the probability of answering Yes to the question of willingness to pay, which depends on the explanatory variables: price (PC), income (IN), age (EDA), education (ED), gender (GE), household size (TAH), importance of the water resource (IRH), monitoring of the water resource (VRH), and the perception of improvement in the quality of the water resource in the future (PMRHF).

## 3 | RESULTS

Table 1 shows the average of the price and income factor, which the respondents would assume in case of facing the availability of payment for the water resource; the price factor ranges from nil to S/ 6 soles, the average price is around S/ 1 sol, and the income factor ranges from S/ 930 soles to more than S/ 4,001 soles, the average is close to an average income of 930 soles.

Variable	Mean	Standard desviation	Minimum	Maximum
Price 1/.	1.0383	1.0101	0.0000	6.0000
Income 2/.	1.5534	0.7883	1.0000	6.0000

Note: 1/. It ranges from S/ 1 to S/ 6 soles

2/. Income. 1=Less than 930 soles; 2= Between 930 - 1,500 soles; 3= Between 1,501 - 2,000 soles; 4= Entre 2,001 - 3,000 soles; 5= Between 3,001 - 4,000 soles; 6= More than 4,001 soles.

Table 1 - Price and income factor

Fuente: Limdep Econometric Software.

Table 2 records the results of the estimation of the logit model, and illustrates the significance of the explanatory variables, with the expected signs and coefficients according to economic theory. The price, income, age, education, gender, household size, the importance of the water resource, the surveillance of the water resource, and the perception



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| Information Statistics for Discrete Choice Model.
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| M=Model MC=Constants Only M0=No Model
| Criterion F (log L) -214.08683 -247.18006 -252.99872
| LR Statistic vs. MC 66.18646 .00000 .00000
| Degrees of Freedom 9.00000 .00000 .00000
| Prob. Value for LR .00000 .00000 .00000
| Entropy for probs. 214.08684 247.18006 252.99872
| Normalized Entropy .84620 .97700 1.00000
| Entropy Ratio Stat. 77.82377 11.63731 .00000
| Bayes Info Criterion 481.27275 547.45920 559.09652
| BIC - BIC(no model) 77.82377 11.63731 .00000
| Pseudo R-squared .23388 .00000 .00000
| Pct. Correct Prec. 71.50685 .00000 50.00000
| Means: y=0 y=1 y=2 y=3 y=4 y=5 y=6 y>=7
| Outcome .4110 .5890 .0000 .0000 .0000 .0000 .0000 .0000
| Pred.Pr .4110 .5890 .0000 .0000 .0000 .0000 .0000 .0000
| Notes: Entropy computed as Sum(i)Sum(j)Pfit(i,j)*logPfit(i,j).
| Normalized entropy is computed against M0.
| Entropy ratio statistic is computed against M0.
| BIC = 2*criterion - log(N)*degrees of freedom.
| If the model has only constants or if it has no constants,
| the statistics reported here are not useable.
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Tabla 3 - Pseudo R-Square of the logit model

Fuente: Limdep Econometric Software.

In table 4, the estimate of the marginal effects, whose probabilities in the willingness to pay for water resource protection and conservation for human consumption, predict a change impact on the explanatory variables is shown. These results, demonstrate a positive response towards payment provision.

The value of price elasticity indicates that, if increasing by 30%, the probability of payment would be reduced by 8.95%, corroborating a scarce sensitivity in price.

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| Partial derivatives of probabilities with
| respect to the vector of characteristics.
| They are computed at the means of the Xs.
| Observations used are All Obs.
+-----+-----+-----+-----+
|Variable | Coefficient | Standard Error |b/St.Er.|P[|Z|>z] |Elasticity|
+-----+-----+-----+-----+
          Characteristics in numerator of Prob[Y = 1]
Constant   .29688740   .18960788   1.566   .1174
IN          .00556756   .03644727   .153*   .8786   .01432931
EDA        -.02156332   .01892053  -1.140*  .2544   -.10796145
ED          .01350431   .02889482   .467*   .6402   .05982733

          Marginal effect for dummy variable is PI1 - PI0.
GE          .00604890   .05813015   .104*   .9171   .00612292
TAH        -.03643124   .01535047  -2.373***.0176  -.27781818
IRH        -.01548428   .03248034   -.477*   .6336   -.10845123
VRH        -.01641795   .03167001   -.518*   .6042   -.10858150
PMRHF     -.06328460   .04715108  -1.342**  .1795   -.06032465
PC         -.01116720   .00192686  -5.796***.0000  -.29853005

+-----+
Marginal Effects for
+-----+-----+
Variable | All Obs.
+-----+-----+
ONE      .29689
IN       .00557
EDA     -.02156
ED       .01350
GE      -.00605
TAH     -.03643
IRH     -.01548
VRH     -.01642
PMRHF  -.06328
PC      -.01117
+-----+-----+

```

Note: t-statistic, \* significance at 10% level, \*\* significance at 5% level and \*\*\* significance at 1%.

Table 4 - Marginal effects of the logit model

Source: Limdep Econometric Software.

The econometric estimation, presents a correct prediction of the logit model of 73.28% (table 5).

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Analysis of Binary Choice Model Predictions Based on Threshold = .5000
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Prediction Success
-----
Sensitivity = actual 1s correctly predicted          79.070%
Specificity = actual 0s correctly predicted          58.667%
Positive predictive value = predicted 1s that were actual 1s  73.276%
Negative predictive value = predicted 0s that were actual 0s  66.165%
Correct prediction = actual 1s and 0s correctly predicted  70.685%
-----
Prediction Failure
-----
False pos. for true neg. = actual 0s predicted as 1s        41.333%
False neg. for true pos. = actual 1s predicted as 0s        20.930%
False pos. for predicted pos. = predicted 1s actual 0s      26.724%
False neg. for predicted neg. = predicted 0s actual 1s      33.835%
False predictions = actual 1s and 0s incorrectly predicted    29.315%
=====
Frequencies of actual & predicted outcomes
Predicted outcome has maximum probability.
Threshold value for predicting Y=1 = .5000
      Predicted
----- + -----
Actual  0  1 | Total
----- + -----
      0   88 62 | 150
      1   45 170 | 215
----- + -----
Total 133 232 | 365

```

Table 5 - Projection of the logit model  
Source: Limdep Econometric Software.

Table 6, visualizes the estimated value of readiness to pay with a mean of S/ 2.52 soles, with positive values, in accordance with expectations.

Variable	Mean	Std.Dev.	Minimum	Maximum	Cases
All observations in current sample					
DAPR	2.52272084	.513247624	.998040715	4.05903231	365

Table 6 - Availability to pay model logit

Source: Limdep Econometric Software.

## 4 | DISCUSSION

The willingness to pay is an important decision instrument, which consists in assigning an economic value on the environmental asset and which is not valued in the market (Osorio and Correa, 2009). The research developed in the Rio Grande, Bobo and Chico and Játiva Basins in Ecuador proved, that water resource is the only asset available for water supply for consumption (Paspuel and Tobar, 2017).

Gonzales et al. (2016), estimated that the willingness to pay of households for an improvement in water service, is higher among women than among men. Likewise, they consider that the availability of payment is higher in low-resource residents, as they attach high value to the environmental good. On the other hand, when the degree of schooling is higher, there is a significant degree of awareness, towards the conservation of environmental good.

Jaramillo et al. (2013), maintain that water resource is limited, find that the availability of payment is US\$ 2.20 monthly dollars, markedly low income families, are also willing to pay for environmental resource.

Esquivel (2008) argues that it is important to value environmental goods, because this type of goods do not have a price in the market, and there is an absence of researches of this nature to find such market value. He alludes that communities near a basin in Costa Rica would be willing to make payments towards basin conservation campaigns, merely sacrificing their income.

## 5 | CONCLUSIONS

The willingness to pay, as a study technique allows to find the economic value that an environmental asset has, in this research it has been found that the inhabitants of the city of Azángaro would be willing to pay S/ 2.52 soles for the conservation of the water resource, per medium of the formulation of public investment projects, studies in water management, and promotion of environmental sensitization campaigns. An important role at this stage of intervention would be played by local, regional and national governments for budget allocation.



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