Drinking water attribute preferences for sustainable management in Andahuaylas, Peru

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Abstract. The management of sustainable drinking water is oriented under the framework of the alignments of economic development. The objective was to determine the preferences of the attributes of drinking water for an improvement in the management of the service, in the province of Andahuaylas, Peru. A quantitative research was carried out through the method of experiments of choice of the mixed logit type. The experimental design was descriptive and cross-sectional with a sample of 375 randomly selected households. The technique applied was the survey with cards of choice included socioeconomic characteristics, attributes of drinking water and availability to pay. The results show attribute preferences; have water 24 hours a day, recover lagoon or spring water sources and water pressure, with a positive impact on the user. Likewise, users have a positive impact of willingness to pay with an additional increase in their monthly billing with a preference in improving the continuity of drinking water 24 hours a day and the recovery of lagoons or manantes. Households are willing to pay an additional amount in their rates for the management of safe and sustainable water.

Key words: drinking water; preferences; attributes; sustainability.

1. Introduction

Ensuring access to clean and safe water is one of the biggest challenges to achieving Sustainable Development Goal number six in developing countries. For Wu et al, (1), water is necessary for all usual purposes and is very essential for domestic, economic and agricultural activities, an inadequate water supply impedes good sanitation and hygiene practices (2).

According to the World Bank (3), globally, nine out of ten people do not have treated water to any degree; five out of ten have inadequate sanitation, and two out of ten have difficulty having a drinking water supply.

Particularly in Peru, there is low public investment in relation to water access and the rates established for this type of service are insufficient in urban water supply systems, leading to low levels of service, rationing and unscheduled interruptions (3).

In the province of Andahuaylas, the companies that provide the drinking water service, present different problems in terms of their service; however, these are insufficient to maintain the operation of the company, and therefore to project investments and improvement projects that enhance the quality of the service provided.

However, it is necessary to know the attributes of water that affect the preferences of domestic users and of great importance in decision-making for the government and water service providers.

For this reason, research is undertaken that seeks to estimate the attributes that customers prefer, within the framework of Goal six (6) of the Sustainable Development Goals (SDGs), where ensuring...
the availability and sustainable management of affordable, reliable and safe water, is fundamental to make the human right to water a reality with a focus on prices and affordability. From the methodological perspective, the study was developed with the participation of domestic users, through surveys. The purpose was to detect the preferences of the service attributes. In the study, socioeconomic characteristics were considered through choice experiments with the purpose of knowing the preferences of the drinking water user in the province of Andahuaylas. The study was carried out in the months of January and February 2021, with a sample population of 375 households using drinking water in the province of Andahuaylas, Apurimac region, Peru. To this end, a survey with election experiments (EE) and an in-depth interview were applied. The research is of an analytical descriptive type with a quali-quantitative approach with data collected in the field that provides reliable primary information regarding the subject of study.

*Sustainability of drinking water*

The ecosystem offers a diversity of environmental goods and services such as wetlands, water sources, which are used by humanity for its social well-being (4). However, water fulfills a vital function, not marketable, however, they are rarely considered in the decision making of improvement and sustainable management. Inadequate management and administration could cause their depletion of water resources (5). Currently in the economy has incorporated techniques to estimate the economic value and importance of water fundamental to humanity. There are different study techniques that show the willingness to pay for an improvement of the water resource

Based on the Dublin Principles, the management of water as a resource in the economy, allows equitable and efficient development through comprehensive management for its conservation (6). Consequently, assigning a value to water is of vital importance to keep for the future, affordable and continuous. According to Thamapapillai (7), water is not marketable and cannot be valued in common market systems. Non-marketable goods and services do not fluctuate openly in markets, however, they can have a positive impact on the consumer (8).

In this regard, a growing number of countries are restructuring their water allocation regimes through the use of economic instruments, where monetary values are estimated for environmental goods or services at different prices, and are important for resource management (6). These values can be implemented in many ways, through the use of market price information, which induces consumers to employ preferences from a wide range of valuation methods (8). This represents for the service provider a guide to improve today and in the future (9). The reason behind the importance of implementing sustainable water resources management is that it covers economic, social and environmental aspects (10).

With regard to the sustainability of drinking water and its management, different national and international entities have developed indicator systems in order to evaluate the sustainability of water use, based on quality and quantity. The most representative indicators have been highlighted by the United Nations Commission on Sustainable Development (11) through the UN, the Global Water Resources Assessment Programme (UN/RRAP), the European Organisation for Cooperation and Development (12). The sustainability of an environmental resource is given in function of socio-economic, ecological, social, cultural and lifestyle points.
2. Methodology

2.1. Study area
The study was carried out in the province of Andahuaylas, Peru, with a local altitude of 2935 m.a.s.l. (13°42' S. 73°24' O), being one of the seven provinces of the department of Apurímac. The domestic users of drinking water participated in the study districts were San Jerónimo, Andahuaylas and Talavera.

![Figure 1. Sampling and intervention points](image)

2.2. Study Design
The research was applied, descriptive and cross-sectional with an experimental design. Choice experiments were carried out using econometric analysis with the mixed logit model or random parameters where it is specified that the dependent variable is the choice made by the user based on the preferences of the attributes of drinking water: water continuity, recovery of water sources (lagoons or springs), pressure and its willingness to pay. The survey was of the choice experiments type (EE). The information was collected using survey sheets.

The survey was developed in the months of January and February 2021, with a sample population of 375 households using drinking water, where each user of drinking water was personally interviewed. The survey contained: sociodemographic characteristics, attributes and willingness to pay. The survey contained different options of water attribute alternatives. The alternatives with their options are described in Table 1.
Alternatives or cards of choice in questionnaire

| Card 1 | Option 1 | Option 2 | Status Quo |
|--------|----------|----------|------------|
| Water continuity | Increase to 24 hours a day | Increase to 12 hours of the day | It doesn't change |
| Conservation of water sources | Conserve other water sources (lagoons and springs) | Conserve the churrubamba lagoon. | It doesn't change |
| Water pressure | Improve water pressure to the maximum | Improve medium water pressure | It doesn't change |
| Availability to pay | Addition in your consumption rates S/6.00 | Addition in your consumption rates S/3.00 | The current rate is maintained |
| Choose just one | X | | |

Source: Own elaboration.

Table 2 shows the selected attributes and signs expected in the study. Respondents must select the preference option of water attributes.

Table 2. Attributes and expected sign.

| Attribute | Descriptions | Expected |
|-----------|--------------|----------|
| Water continuity | Have water available 24 hours a day | Positive |
| Recovery of water sources | Recover wool or spring water sources for the future | Positive |
| Water pressure | Improve water pressure from 9.14 to 18.7 m.c.a. | Positive |
| Price of water | The price refers to the water bills. | Positive |

Source: Own elaboration

2.3. Data analysis

Data analyses were performed using an econometric estimation through the use of LIMDEP 8.0 / NLOGIT 3.0 software. Statistical analysis was performed through the SPSS software program (v24, IBM corp).

3. Results

3.1 Socio-economic characteristics

Socioeconomic characteristics are associated with household water treatment (Saket and Rietveld, 2020), according to Dreibelbis and Wich, (13) and Daniel et al., (14), a system-level approach is
required to explain household water use that combines with socioeconomic characteristics. According to the study, the socioeconomic profiles are presented in Table 3.

The surveyed population was 375 households. Of the respondents, 62% were women and 38% were men, as specified in Table 3. The results show that it is mostly made up of women who act as heads of household and assume the payments of their bills. In terms of age, 45.3% of respondents are aged 31 to 40 years. While 25.3% were 41 to 50 years old. It was found that 58.9% of respondents had between 4 to 6 people in the household, 26.1% had children under 3 members in the household, while 14.9% corresponded to those with more than 7 people in the household. The level of education of the respondents, where I highlighted technical training with 40.8%, university studies 34.9%, then 17.6 with secondary education and with 6.7% with postgraduate studies. To determine the economic situation of households, it was found that 40.1% of respondents have an income between S / 1,500.00 and S / 2,500.00 per month. Then 32.4% of respondents with S / 2,500.00 and S / 3,500.00 per month, and 20.5% have an income of S / 800.00 and S / 1,000.00 per month. According to some sources, wealthier households with a higher level of education were more likely to treat water (15). As for the main occupation of the head of household, 36.8% is dedicated to trade, 25.1% to the public sector and 17.1% to services. Socioeconomic characteristics influence water use behavior. (16)

Table 3 shows the socioeconomic profile.

| Indicators                      | Percentage (%) | Indicator                      | Percentage (%) |
|---------------------------------|----------------|--------------------------------|----------------|
| Gender                          |                | Economic condition of the      |                |
| Woman                           | 47,5           | Between S/ 800.00 and S/        | 22,5           |
|                                 |                | 1300.00                        |                |
| Man                             | 52,5           | Between S/ 1300.00 and S/       | 40,1           |
|                                 |                | 2300.00                        |                |
| Age                             |                | Between S/ 2300.00 and S/       | 32,4           |
|                                 |                | 3300.00                        |                |
| 20-30                           | 28,3           | Between S/ 3300.00 and S/       | 3,5            |
|                                 |                | 4300.00                        |                |
| 31-40                           | 33,3           | Greater than 4300.00            | 1,5            |
| 41-50                           | 25,7           | Main occupation of the home     |                |
| 51-a more                       | 13,1           | Commerce                       | 36,8           |
| Number of household members     |                | Agriculture                     | 5,6            |
| ≤3 people                       | 26,1           | Services                        | 17,1           |
| 4-6 people                      | 58,9           | Transport                       | 8,3            |
| >7 people                       | 14,9           | Public sector                   | 25,1           |
| Level of education of the head of the household |            |                                |                |
| Primary                         | -              |                                |                |
| High school                     | 17,6           |                                |                |
| Technician                      | **40.8**       |                                |                |
| University                      | **34.9**       |                                |                |
| Postgraduate studies            | **6,7**        |                                |                |
3.2. Drinking water attribute preferences

Table 4 presents the estimate according to the mixed logit model. The parameters of the model usually present the expected signs. The attributes of having water 24 hours a day, recovering sources such as lagoons and springs, improving pressure and willing to pay, had a significance of 1% with the expected positive signs. The significance of the coefficients present interesting data. It can be observed that the attribute of having water 24 hours a day present positive signs, such as user preference as the main attribute, continuity of water. As for the variables between recovery of water sources and improvement of pressure, a positive preference of 5% was found, without embargo the payment attribute, I present a negative sign as a monetary attribute, understanding that the expectations of election preferences will be lower when the cost of election increases. So an increase in the price of water indicates a lower willingness to pay among respondents due to the decrease in the level of public services. An improvement in the attributes of the drinking water service generates a very high level of satisfaction.

Table 4. Estimation of the mixed logit model without interactions

| Variable                                      | Coefficient | Standard error | T-ratio   |
|-----------------------------------------------|-------------|----------------|-----------|
| 24-hour water continuity (ACONT24H)          | 2.1719      | 0.1447         | 15.014*** |
| Water availability 12 hours a day (ACONT12H) | 0.3806      | 1.1161         | 3.279***  |
| Recover from the Churrubamba Lagoon (RLC)     | 2.2923      | 0.0922         | 24.87***  |
| Recover from other lagoons and flows (RLOL)   | 1.0963      | 0.1965         | 5.578***  |
| Water pressure (MP1)                          | 2.1882      | 0.0836         | 26.184*** |
| Water pressure (MP2)                          | 1.2029      | 0.1573         | 7.646***  |
| PAYMENT 1                                     | -0.6807     | -0.3667        | 10.038*** |

Statistical summary

| Number of observations                        | 4500        |
| Logarithmic probability                      | -4203.441   |
| Logarithmic probability without coefficient   | 4268.935    |
| Pseudo R                                     | 0.01534     |
| R adjusted                                   | 0.01462     |

Where: *** significance at 1%, ** significance at 5%, *significant at 10%

According to the results of the water continuity attribute, I present greater preference in the respondents in the study. To denote the improvement in water continuity (current condition) to the frequent continuity of existing water a shortage in the months of dryness reaching a critical average of 8.79 hours per day as qualified by SUNASS (17), this attribute being with a bad performance and consequently affecting the well-being of drinking water users.

Improves water pressure, is another of the attributes of preference by respondents according to the analysis of the models applied in the study. As for their willingness to pay, customers have a payment preference in a case of improvement of this attribute compared to their current condition. However,
the attribute recovery of water sources also presented a greater preference in recovering other lagoons and springs (ROLM) of the water basin, with a statistical significance of 1%. According to Nariman, (18), it indicates that, for the inhabitants of the study area, the conservation of water basins for present and future generations had a statistical significance of 1%. Finding that the changes in the improvements of the attributes of the drinking water service, had a favorable acceptance by 87% of the total respondents, while 13% of users prefer to maintain the current condition (status quo), similar situation found, Martines, (19), that 76% of users had preferences for the quality of water quality, however, 24% prefer their current situation.

3.3. Availability of payment

The payment arrangement was made based on the attributes and parameters of payment. In Table 5. It shows the payment provision for the improvement in the continuity of the water service, recovery of sources (lagoons and springs) and water pressure. Likewise, the estimated average value is shown as an increase in your bills.

Table 5. Willingness to pay according to the attribute.

| Drinking water service improvements | DAP Mg by improvement levels |
|------------------------------------|-----------------------------|
|                                    | Well | Excellent | Total | %  |
| Continuity of drinking water       | 0.65 | 3.79      | 4.44  | 48 |
| Recovery of water sources          | 0.66 | 3.01      | 3.67  | 52 |
| Water pressure                     | 0.49 | 1.23      | 1.72  | 57 |
| GENEROX                            | -1.40| 2.28      | -     | -  |
| AGEX                               | -0.46| 2.023     | -     | -  |
| EDUCX                              | 0.44 | 3.78      | -     | -  |
| TOTAL                              | 1.12 | 8.54      | 10.22 | 100|

Source: Own elaboration, 2021

From table 5, 48% of respondents users of the drinking water service show a payment disposition of an S / 3.79 for the attribute of preference continuity of water for 24 hours of the day, in their consumption rates, then as an attribute of preference is the recovery of water sources and mananté with a payment willing S / 3.01 additional soles in their consumption billing slips. Water conservation is a dominant factor that controls the structure and functions of natural and managed ecosystems (20). The marginal rate for an improvement in drinking water pressure users have an additional S/1.23 payment availability on their consumption bills.

4. Conclusions

It was possible to identify the main attributes of preference by users for a sustainable management of the drinking water service, being the following attributes: continuity 24 hours a day; recovery and conservation of lagoon and mananté water sources; and improve water pressure; finding that the attributes present positive signs with a level of significance of 1%, of greater preference of drinking water users. The results in the estimated willingness to pay showed preferences in the attribute of water continuity, water sources and water pressure and are highly valued by respondents. Socioeconomic factors related to attributes for willingness to pay: Income and education show positive signs with a significance level of 1% to 5% respectively; with a favorable impact on the preferences of each attribute of drinking water. According to the study, the study attributes are expected to be considered in projects or actions related to improving the quality of drinking water service compared to households with low economic incomes.
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