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Social Perception and Willingness to Pay in Peruvian High Andean Lakes: A Study of Lake Patarcocha with Anthropogenic Contamination and Lake Parón Impacted by Glacial Retreat

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The lakes of the high Andean zones of Peru are ecosystems of great strategic importance, and they are being affected by climate change or anthropogenic impacts. The aim of this research was to estimate the willingness to pay (WTP) for the restoration of Lake Patarcocha, which was conducted by activities of the population Chaupimarca, Pasco, and Lake Parón. In both cases, the contingent valuation method was applied to find the WTP. For Lake Patarcocha, a survey was conducted among 370 households near Lake Patarcocha, asking residents about the environmental impacts on water quality, flora, fauna, landscape, the importance of the lake in their daily lives, as well as the WTP for the recovery of the lake. For Lake Parón, a survey was conducted among 297 residents, who were asked about the services and environmental value provided by the lake. The data collected was then analyzed with the LOGIT model using STATA 16 statistical software. The results showed that households directly or indirectly affected by pollution in Lake Patarcocha had the WTP of $3.7 per inhabitant/month, estimating 1 136 773.1 million/year. While for Lake Parón, respondents revealed an average WTP of $23.9 per inhabitant/month, estimated at $1.4 million/year. The difference in the WTP between the two high Andean lakes is influenced by social belief and the local context, showing that the percept of Lake Parón, affected by glacial retreat in the basin, has a higher economic value than Lake Patarcocha, which has been affected by anthropogenic activities.

Keywords: willingness to pay, Lake Patarcocha, contingent valuation, Lake Parón, social belief.

Introduction

Freshwater as a water resource is not well distributed among the world's population and many countries suffer from shortages of this resource (Martins et al., 2020). FAO (2002) already warned about the scarcity of freshwater and the competition between users that was increasing in different areas of the world. This situation appears because of a high aggregate demand by all water-consuming sectors with respect to the available supply (FAO, 2013). Thus also, the availability of freshwater and its associated ecosystem services is impacted by factors such as glacial retreat (Bolch, 2017) or by anthropogenic activities that are increasing in quantity and intensity and its scarcity can be the source of social and political tensions that can turn into instability or even serious conflicts (Hijioka et al., 2014); consequently, there is a loss of services such as its use for human consumption, irrigation, recreational use, and alteration of the regulation process (Zambrano, 2018).

Peru is the eighth country in the world with the highest availability of water resources, and the third in Latin America (Schneir, 2016). Peru has a strategic location for water resources with a large water supply that stands for 4.6% of the global runoff volume (Eda and Chen, 2010), and lakes are the main water resource of natural origin fulfilling different ecosystem services of significant importance in water management in Peru. These lakes have ecosystem services, such as climatic thermoregulators of the ecosystem, keeping a balance between flora and fauna, absorbing, degrading or diluting foreign substances or compounds, stabilization of water supply and ecological integrity and tourism (Grêt-Regamey et al., 2008).

Lake Patarcocha is of the foremost importance in the region and its water was used for human consumption and livestock beverages in 1946 (ECP, 2017). Currently, the lake is affected by wastewater from the surrounding districts varying its level depending on the season (DA, 2017), being an imminent danger of overflow and flooding with a direct effect on the houses of the settlers settled on the banks (INDECI, 2017). Due to its history, social identity and ecosystem services, Lake Patarcocha is impacted by wastewater dumping and inadequate solid waste disposal, a situation aggravated by the lake's water conditions, which are subject to an aggressive eutrophication process (García, 2020). As a result, this water resource and its ecosystem services are being progressively lost.

Lake Parón has a glacial origin and is in the Huascarán National Park and in the Santa River basin (Untiveros, 2011). This lake is directly affected by glacial retreat in the area, affecting its cryogenic ecosystem services. These changes are significantly altering the availability of water in the watershed lake, and it poses critical risks to local populations that are highly dependent on these resources for livelihoods (Bury et al., 2011). Besides, high Andean wetlands that are not supplied by a continuous flow of water are at risk of fragmentation with a consequent loss of biodiversity (Cuadros, 2018) and loss of the glacial landscape. There is a growing concern about the climate impact on Lake Parón coupled with the need for its conservation due to the enormous benefits it brings in terms of use and non-use values, making this natural space stand out as an eco-social asset with direct and indirect benefits for the populations.

Historically, pond restoration or conservation efforts are often limited by budgetary constraints, disagreement about the severity of the problems, and inappropriate policies (Makwinja et al., 2019). In recent years in Peru, research has been conducted using the contingent valuation method (CVM) to assess the enhancement or conservation of ecosystem services in lakes (Ramos Pacheco, 2018; Verona and Rodríguez, 2013). Moreover, there is hardly any of this information to be integrated into the decision support system to address changes in high Andean areas.

Taking into account the different anthropogenic impacts on Lake Patarcocha and the effect of climate change on the glacial retreat affecting Lake Parón, a proposal arises to collect the social perception of the inhabitants who benefit from these ecosystem services, their uses and importance, as well as to estimate the economic value they assign to these services.

This research aims to analyze social perception and estimate the willingness to pay (WTP) for the recovery of Lake Patarcocha, affected by anthropogenic pollution, and the conservation of Lake Parón, impacted by glacial retreat. To do this, the contingent valuation method (CVM) will be used through surveys directed at the inhabitants of the Chaupimarka district, Pasco, who reside near Lake Patarcocha, and the Caraz district, Áncash, in areas near Lake Parón. The results obtained will serve as a key source of information for decision-making in the management and protection of these ecosystems.

Methods

Study area

Lake Patarcocha is the only source of water resources currently available in the city of Cerro de Pasco. It is found at UTM coordinates 363135 E and 8818462 N, in the Chaupimarca district at 4360 m.a.s.l., and it has a perimeter of 1400 meters (*Fig. 1a*). Temperature in the city of Cerro de Pasco can reach below 0°C, so the presence of this lake benefits the city by regulating its temperature, as it absorbs heat during the day and releases it during the evening, night and early morning, reducing the risk of frost or drastic temperature decrease in its environment (Rosas et al., 2016). Currently, Lake Patarcocha is surrounded by houses built inappropriately and without planning due to the lack of attention from the competent authorities. This has caused sewage and solid waste from nearby communities to discharge into the lake, which has had a significant negative impact on aquatic life (flora and fauna) altering its ecosystem services (García, 2020).

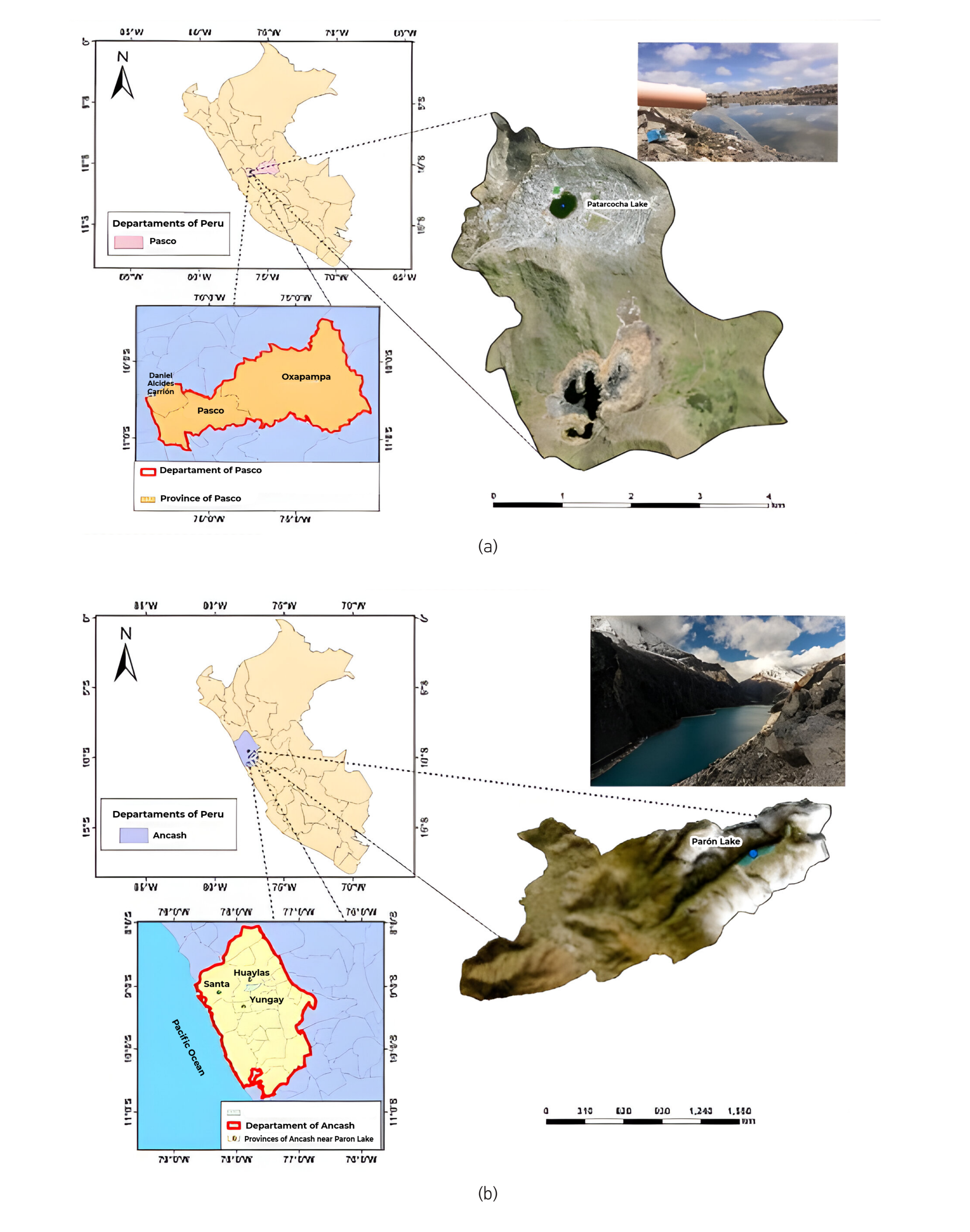
Parón glacial lake is found at UTM coordinates 204817 E and 9004082 N, in the Santa River basin and in the upper part of the Parón River sub-basin, in the district of Caraz, province of Huaylas, department of Ancash (*Fig. 1b*). Surrounded by the snow-capped mountains of the Cordillera Parón, this lake is one of the largest and most voluminous in Peru, with an approximate surface area of 1 480 488.70 m^2 and a volume of 39 888 952.6 m^3 according to the latest National Inventory of Glaciers and Lakes conducted in 2014 (ANA, 2014). Lake Parón is being directly affected by the glacial retreat present in the glacial environment of the area and, with this, its ecosystem services such as regulation, water availability in the future, alteration of the glacial landscape that the lake is part of, among others. Water availability altered by glacial retreat poses critical future risks to local populations that are highly dependent on these resources (Bury et al., 2011).

The growing concern about the climatic impact on the glacial environment of the Parón basin combined with the need to conserve water resources over time can be measured in terms of ecosystem values. This natural space becomes an economic-social asset with direct and indirect benefits for current and future populations.

Data collection

The research began with exploratory surveys to contextualize the two study areas. The main beneficiaries of the ecosystem services for Lake Patarcocha and Lake Parón were carefully selected. In addition, the direct and indirect use values of all ecosystem services were considered. For Lake Patarcocha, the exploratory survey was conducted in the Chaupimarca district, Pasco. The following eligibility criteria were figured out for the selection of participants. These criteria included the population over 18 years of age, living in the vicinity of the lake, who were heads of a household with a decision-making capacity. The specific locations where the survey was conducted included PP. JJ Túpac Amaru, AA. HH Víctor Arias Vicuña, AA. HH Tahuantinsuyo and that of Jirones Moquegua, Bolognesi, Alfonso Ugarte, El Prado, Yauli and the Túpac Amaru ring road.

Fig. 1. *Location of (a) Lake Patarcocha and (b) Lake Parón in Peru*



On the other hand, Lake Parón, found within Huascaran National Park, plays a particularly important tourism role for the Caraz city. For this reason, exploratory surveys were carried out on residents who frequent the surroundings of La Merced Square, especially those who carry out activities linked to nearby markets and shopping centers. The results of this survey helped to design quantitative questionnaires. For the quantitative technique, a structured contingent valuation questionnaire survey was conducted.

Quantitative data valuation approach

Highly skilled research assistants employed the interview method. The Faculty of Environmental Engineering and Natural Resources at the National University of Callao arranged for direct interviews to be conducted in the houses of participants. A comprehensive questionnaire was designed and administered to a randomly chosen group of individuals in both locations. The sample size was found using Equation 1 (Bernal, 2010).

$$n = \frac{NxZ_{\alpha}^{2}xPxQ}{d^{2}x(N-1)+Z_{\alpha}^{2}xPxQ} \quad (1)$$

where n – sample size; Z – value calculated from the standard normal distribution (Z = 1.96 for 95% confidence); P – the proportion of the population (*P* = 0.5); N – the total population; d – the allowable error of the sample; Q – the probability of not hitting.

According to the central limit theory, the distribution followed the approximately normal distribution under the assumption that the Poisson error was bound by the specific confidence level (Cameron, 2011). The 0.5 in this study represents the probability function of the selected true value based on the probability theory of the normal distribution curve of the underlying population proportion, given a specific confidence interval (Grover and Kaur, 2020).

The estimated sample size for the number of respondents for the inhabitants of the Chaupimarca district in Pasco was 370 households, and for the city of Caraz, it was 300 people. The sample object is different for both localities due to the nature of the service provided by the lake, the houses near Lake Patarcocha suffer the effects of the lake's impact, while for the valuation of Lake Parón, the inhabitants of the city of Caraz are those who are related to the ecosystem services of Parón. The sample size was large enough to achieve a high degree of precision and representativeness. The probability sampling technique was applied, where each member of the population had an equal chance of being included in the study (Polit and Beck, 2010).

The contingent valuation (CV) survey adhered to the guidelines provided by the National Oceanic and Atmospheric Administration (NOAA) (Arrow et al., 1993). According to this author, the survey should be sectioned for a better application of the consultation topics. The questionnaire developed for the homes of Chaupimarca was divided into seven sections while the questionnaire developed for the town of Caraz was divided into five sections. The description of each section is shown in *Table 1*.

The questionnaires were evaluated in different geographic areas before being applied. Pre-tests were conducted to standardize the structure, the number of questions, and the length of the interviews, to verify readability and clarity, and to reduce the rejection rate of respondents. The questionnaire was designed in English and then translated into Spanish, which is the official language in the localities. The questionnaire was administered to respondents after requesting consent. The surveys were conducted between October and December 2021.

Table 1 shows the sections of the two types of questionnaires applied for each sample space for each study area. The structure of the questionnaire is based on the nature of the ecosystem services affected in each study area. The main difference between the two study scenarios is the origin of the impact; that is to say, Lake Parón is being affected by climate change, leading to a retreat of its glacier cover (Izaguirre, 2021). This retreat has a progressive impact on the lake, influencing ecosystem services such as increased water flow, tourism, and recreation. In contrast, Lake Patarcocha in the Pasco region faces a different set of challenges, primarily the discharge of municipal wastewater and solid waste (López and Beatriz, 2020). Additionally, political conflicts related to mining activities pose a threat to the lake's existence (García, 2020). The problematic reality and the difference in ecosystem services affected in both high Andean lagoons are different, which leads to differences in the perception of the scenarios for each population. The sections of each questionnaire include dimensions referring to the services involved in the impact of each scenario, developing different questionnaires for each problematic reality.

Table 1. *Description of sections of the questionnaire developed for the locality of Chaupimarca and Caraz*

Lake Patarcocha		Lake Parón	
Section 1	It focused on socioeconomic characteristics (place of residence, age, main occupation, monthly family income, etc.).	Section 1	It focused on socioeconomic characteristics (place of residence, age, main occupation, monthly family income, etc.).
Section 2	Find the ecosystem services provided by Lake Patarcocha.	Section 2	Find if the interviewee belongs to the target group (place of residence, frequency of visit and use of lake resources).
Section 3	Establish the interviewee's attitude towards the quality of the ecosystem service provided by the flora resource of Lake Patarcocha.	Section 3	Establish the interviewee's attitude towards the protection of Lake Parón, based on the information he/she owns.
Section 4	Prove the interviewee's attitude towards the quality of the ecosystem service provided by the Fauna resource of Lake Patarcocha.	Section 4	Informative questions were asked to see the novelty and opinion of the information: Lake Parón provides us with benefits to humanity as the water resource that favors the consumption of drinking water, electricity generation; scenic beauty and tourism; regulation against the effects of climate change and habitat for the biodiversity of mountain ecosystems. Due to the impacts of climate change and the lack of incentives for its conservation and sustainable use, action is needed to address these challenges.
Section 5	Find if the interviewee knows the impact of indirect use goods and services and find the interviewee's attitude about the conservation projects of the use offered by Lake Patarcocha.	Section 5	Verify that the interviewee understood the situation and responded about his disposition to pay (WTP) for the generation of a project for the prevention and conservation of climate change impacts in Lake Parón.
Section 6	Find if the interviewee is aware of the impact of the non-use value goods and services offered by Lake Patarcocha.		
Section 7	Verify that the interviewee understood the situation and responded about his or her disposition to pay (WTP) for the recovery of Lake Patarcocha.		

Economic valuation technique

The valuation economics methods of ecosystemic goods and services that do not have an established market (e.g., externalities), based on consumer surplus, are the following: travel cost method (TCM), the contingent valuation method (CVM), the hedonic price method (HPM) (Marella and Raga, 2014) and the multicriteria method (AHP) (Barrial-Lujan et al., 2022), the latter being a novel method used for the economic valuation of gaps, as well as, the contingent valuation method (CVM).

CVM is one of the most widely used stated preference methods. This method estimates the value of the behavior through hypothetical questions that can reveal the probability of the behavior (Jin et al., 2018). This type of approach uses the WTP of a population, as reflected in hypothetical scenarios, to estimate the value of the environmental good (Perni et al., 2021). CVM has a fast and effective value assessment function to address particularly complex changes in environmental goods or services and can directly estimate the economic value in a specific situation (Jin et al., 2006). As a typical stated preference assessment method, CVM employs the principle of utility maximization to directly investigate respondents' willingness to pay (WTP), using a questionnaire in a hypothetical market environment, from the subjective intentions of respondents (Ke et al., 2022).

The CVM was studied in the estimation of WTP to recover lakes such as Simpson Bay, Saint Martin, the Caribbean (Duijndam et al., 2020) and wetlands in Lake Vellayani, India (Vijayan, 2015). There is scarce research on the economic valuation of glacial lakes. The few research studies carried out apply different methods for their valuation, for example, in China they used the unit service function price method (Yuan and Wang, 2018; Zhang et al., 2019), while in Chile the hedonic method (Segovia, 2014) was used, and finally in Peru, the research by Boyano (2015) used different valuation methods according to the types of cryogenic services.

Contingent valuation model

The utilization of logistic regression analysis is a significant approach for investigating the relationship between values of willingness to pay and a range of influential factors. The method used to estimate WTP was the Spike model, designed by Kriström (1997), which has clear benefits when the WTP distribution is not symmetric and when there is a significant proportion of respondents indicating a WTP > 0. While an individual has to reject or accept a certain value that implies a change (improvement) in environmental quality from z^0 to z^1, he/she is proposed to be willing to pay an amount of money A. The change in WTP is shown in Equation 2:

$$V(Y-DAP,z^1)=V(Y,z^0) \quad (2)$$

where V (y, z) is the individual's indirect utility function. And "Y" is income.

Since it is assumed that each individual has a different valuation, the probability of WTP for an individual not exceeding quantity A is shown in Equation 3:

$$prob(DAPxA)=F_{DAP}(A) \quad (3)$$

where F_{DAP} (A) is a continuous non-decreasing function. As it is a continuous function, WTP will be expressed as shown in Equation 4:

$$E(DAP)=\int_0^\infty 1-F_{DAP}(A)dA-\int_{-\infty}^0 F_{DAP}(A)dA \quad (4)$$

The Spike basically uses two valuation questions: the first asks the individual whether or not he/she wants to contribute financially for a given public or environmental good. That is, it tries to find out whether or not the individual is in the market for this good or service, and the second one offers him a certain price A. If the individual answers *No* to the first one, this second question is unnecessary. Therefore, for each individual i, we define an indicator (E_i) that tells us whether or not the individual is in the market or (D_i) that tells us whether or not the individual is willing to pay the suggested price. These indicators are shown in Equations 5 and 6, respectively.

$$E_i=1 \text{ if WTP > 0 (0 in all other situations)} \quad (5)$$

$$D_i=1 \text{ if WTP > 0 (0 in all other situations)} \quad (6)$$

At this point, three possible situations arise. First, an individual can reject the proposed payment A because it seems too high but accept to pay some amount. Second, he/she can refuse to pay A or any other amount and, finally, he/she can accept to pay A since his/her true WTP is above this proposed value. Once the maximum-likelihood function (Equation 7) has been estimated, to obtain the mean WTP one has to solve the integral of Equation 8.

$$l=\sum_1^N E_iD_i\ln\left[1-F_{DAP}(A)\right]+ \\ +E_i(1-D_i)\ln\left[F_{DAP}(A)-F_{DAP}(0)\right]+(1-E_i)\ln\left[F_{DAP}(0)\right] \quad (7)$$

$$\int_0^\infty \frac{\exp(\alpha-\beta A)}{1+\exp(\alpha-\beta A)} \quad (8)$$

Logistic regression model (LOGIT)

Individual attitudes and perceptions regarding ecosystem degradation are often linked to the spatial distribution of beneficiaries and the degree to which an individual has been exposed to vulnerability due to ecosystem service dynamics. According to economic theory, individuals are expected to balance the marginal utility of anticipated avoided negative experiences with the associated costs, taking into account budget limitations. Additionally, they consider dynamic ecological indicators, as well as various factors such as socioeconomic status, demographic characteristics, institutional factors, and personal attitudes. Hence, given that the suggested indicators for both gaps in the questionnaire sections and the factors influencing responses of WTP were binary variables ranging from 0 to 1, the logistic regression model presented in Equation 11 was employed (Gujurati, 1999).

$$WTPi=ln(\frac{P}{1-P})= \\ =\beta_0+\beta_1X_1+\beta_2X_2+\beta_3X_3+\ldots+\beta_nX_n+\xi \quad (9)$$

where WTP represents a dummy variable (where 0 = positive WTP and 1 = negative WTP); P – as a dependent variable of probability 1; β_0 – a constant parameter; β_1 – the regression coefficient; X – both endogenous and exogenous factors.

Ethical approval

All participants were fully informed about the purpose of the study. Before the interview, consent was requested from each participant and no personal identification was recorded. Consent was proposed verbally as the cross-sectional nature of the study required descriptive data and the response had no personal, social, political, or significant risks. The confidentiality of the raw data was guaranteed and was accepted by mutual agreement between the investigators involved in the design, conduct and financing of the study.

Variable coding and data analysis

The questionnaires used for data collection contain sections of questions focused on the contingent valuation method as shown in *Table 1*. Each section contains a series of questions, so in order to simplify the introduction of the data into the STATA software and to perform the LOGIT model, coding was made for each question, which is an abbreviation of the question. *Table 2* shows the questions of the questionnaires and their respective coding.

The results of the surveys were analyzed descriptively using Microsoft Excel (2016), while for the estimation of Data Base, it was performed by the LOGIT model using Stata 16.0 software.

Table 2. *Coding of the questions of the questionnaire for the analysis of Lake Patarcocha and Lake Parón*

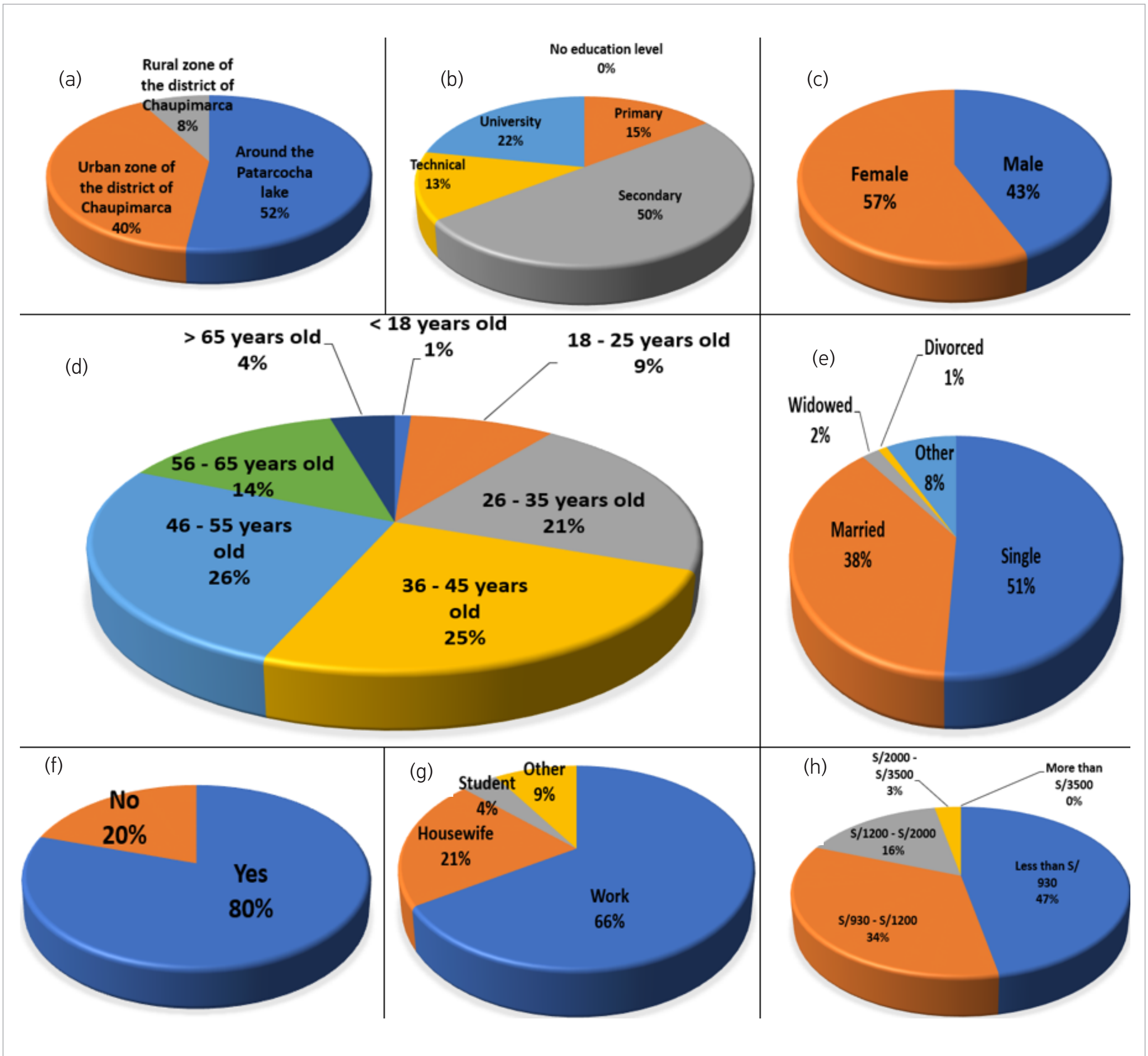
Lake Patarcocha		Lake Parón	
Codification	Description	Codification	Description
Place	Place where you live	Visit	Have you visited Lake Parón? Yes = 1
Sex	Gender (Male = 1)	use_resource	Do you use any resources from Lake Parón? Yes = 1
Age	Age	Sex	sex of respondent, Male = 1
Education	Educational level	Age	Respondent’s age
Civil status	Marital status	Civil status	Respondent’s marital status
Occupation	Occupation	Education	Respondent’s educational level
Eco_cont	Economic contribution (Yes = 1)	Occupation	Occupation
Ingm	Monthly income	Eco_cont	Economic contribution (Yes=1)
ss_ambiental	Environmental service	Ingm	Monthly income range
Flora	Decrease in flora	Transport	Type of transportation you use to get to Lake Parón
dis_flora	Decrease in wildlife	t_transport	Travel time from Caraz to Parón
Fauna	Water quality	Expenditure	Level of expenses incurred in Lake Parón
dis_fauna	Decrease in water	r_water	Did you know that Lake Parón is used as a water reservoir? Yes = 1
cal_water	Flora is linked to L.P. (Yes = 1)	t_recorrido	Travel time at Lake Parón
causas_water	Wildlife is linked to the P.L. (Yes = 1)	p_volver	Do you plan to visit Laguna Parón again? Yes = 1
Visit	Visit to Lake Patarcocha (Yes=1)	Reason	Reason why you would visit Lake Parón again
no_visita	No visit to Lake Patarcocha	impor_person	Do you consider Lake Parón important in your daily life? Yes = 1
soluc_paisaje	Solutions to improve the landscape	Contamination	Do you consider Lake Parón to be contaminated? Yes = 1
utilidad_lp	Utility for Lake Patarcocha	n_water	Did you notice the high-water level in Lake Parón in February 2021? Yes = 1
ss_desaparecer	Services to disappear from Lake Patarcocha	Impact	Did you notice that the lake is impacted by glacial retreat and climate change? Yes = 1
mtv_dap	Why are you disposed to pay for?	Protection	Do you think it is necessary to protect the Parón Lake? Yes = 1
Adm	Why are you not disposed to pay?	Knowledge	Do you know the benefits of Lake Parón? Yes = 1
mtv_nopago	Institution administering the funds	Problem	Main problems of Lake Parón

Results and Discussion

Social perception and WTP in Lake Patarcocha

Fifty-two percent of the surveyed population lives around Lake Patarcocha (*Fig. 2a*). Fifty percent of the population completed secondary school, 22% have university education, and 15% have only primary school education (*Fig. 2b*). 76% are women and 43.24% are men (*Fig. 2c*). Twenty-five percent of the total population were in the age range 36–45 years, 26% between 46–55 years, 21% between 26–55 years, 14% between 56–65 years, 9% between 18–25, 4% over 65 years, and 1% under 18 years (*Fig. 2d*). In terms of marital status, the population is distributed between 51% being single and 38% being married (*Fig. 2e*). Eighty percent contribute economically to the household and 20% do not (*Fig. 2f*). Besides, 66% work in what they studied, 21% are housewives, 9% have no choice for their current occupation, and 4% are students (*Fig. 2g*). Of the monthly family income, 47% indicated that it was less than $251.4, 34% indicated it to be between $251.4 and $324.3, 16% between $325 and $540.5, and 3% between $541 and $946 (*Fig. 2h*).

Fig. 2. *Socio-economic profile of respondents*



Regarding the impact on the lake, 70% of the population considers that the lake does not provide any ecosystem services, which may be due to a lack of knowledge of the lake's potential and the discomfort generated by lake contamination, especially among the population living near the lake. The remaining 30% consider that it does provide environmental services (*Fig. 3a*). 58% of the population is extremely affected by pollution of the lake, 36% quite affected, 5% affected regularly (*Fig. 3b*). 84% of the population believes that the main cause of pollution is sewage discharge, 8% think it is due to poor solid waste disposal management, and another 8% attribute it to the lack of environmental education (*Fig. 3c*). Sixty-four percent of the population indicated that they would not visit the lake and 36% indicated that they would. This perception is associated with the anthropogenic contamination of the lake (*Fig. 3d*); 85% of those surveyed would not visit Lake Patarcocha because of the presence of bad odors, 9% because of the accumulation of solid waste, and 5% because of the houses that are very close to the lake and affect the landscape (*Fig. 3e*). When asked about the best solution to improve the landscape, 42% indicated that the drainage system should be improved, 41% indicated that reclamation projects should be promoted, 14% indicated that the lake should be emptied and used as an urban center, and 3% indicated that the houses around the lake should be relocated (*Fig. 3f*).

Fig. 3. *Social perception of the ecosystem services of the lake*

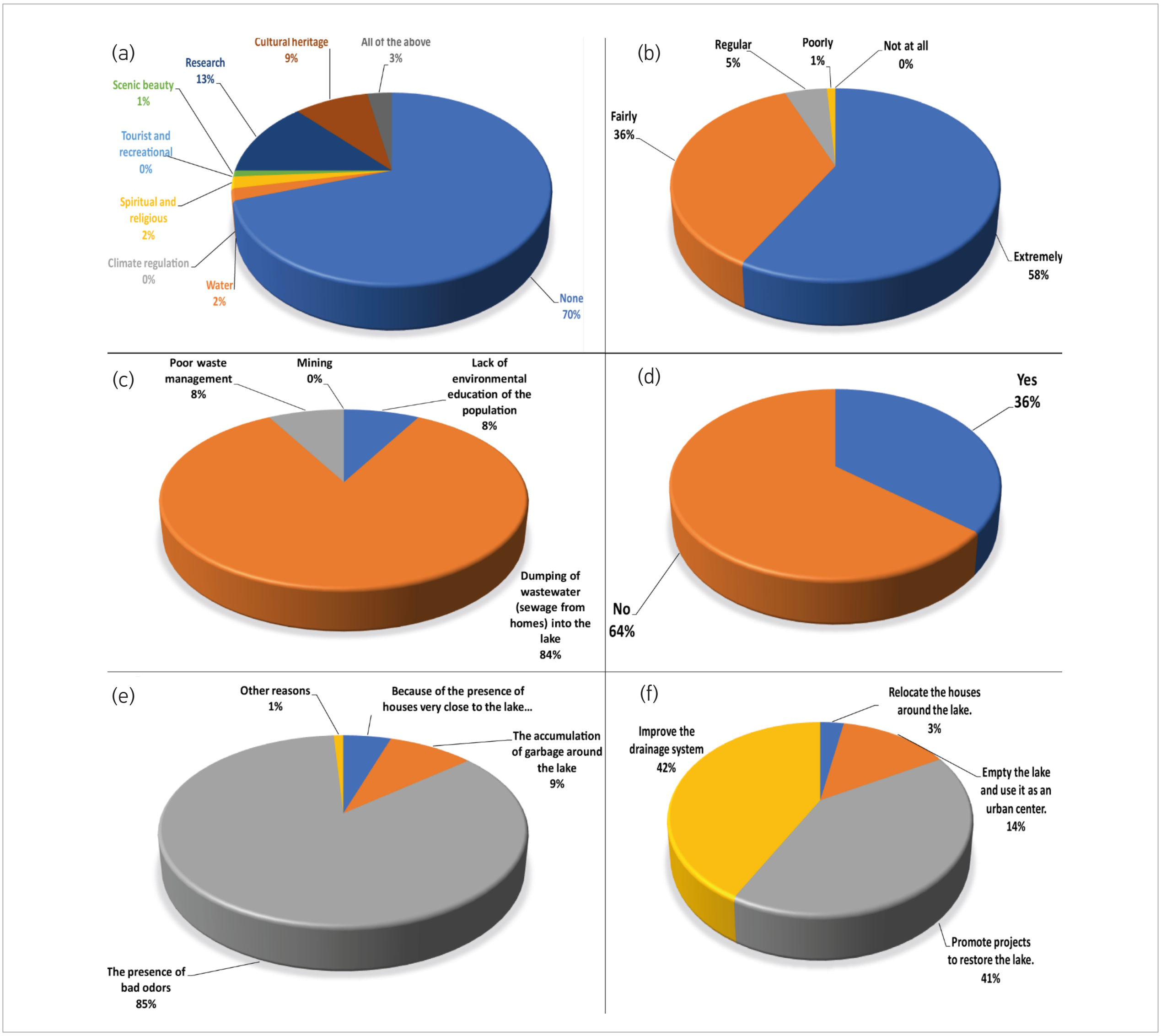
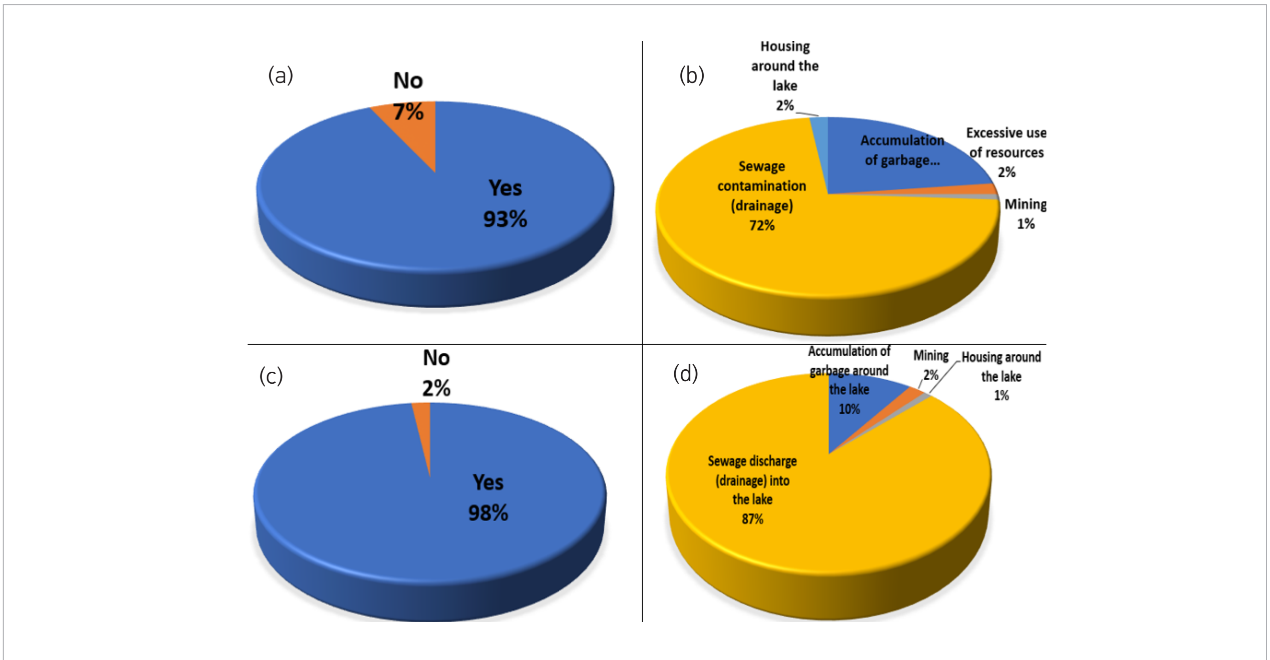


Fig. 4. *Social perceptions of the flora and fauna in the lake*



Ninety-three percent of the population indicated that they believed that the flora of Laguna Patarcocha decreased over the last 20 years, while 7% indicated that it did not (*Fig. 4a*). According to their perception, 72% of this is associated with wastewater contamination, 23% with the accumulation of solid waste, 2% with the excessive use of resources, 2% with the surrounding houses, and 1% with mining (*Fig. 4b*).

Regarding fauna, 98% of the population considers that it has been affected in the last 20 years, and 2% indicated that *No* (*Fig. 4c*). According to their perception, 87% is associated with wastewater contamination, 10% with the accumulation of solid waste, 2% with the excessive use of resources, and 1% with mining (*Fig. 4d*).

When asked about the service of the lake as a source of research and/or education for students, 52% of the population considered it for the study of plants and animals, 36% did not consider it to be of value, 10% did not specify which, and 2% considered it as a source of research because it prevents frost (*Fig. 5a*).

Regarding its legacy value, 57% of the population believes that if the lake were to disappear, the lake would lose its historical and cultural value, 23% think that the enjoyment of future generations would be lost, 12% think that the habitat for migratory birds would be lost, and 8% believe that the lake has no value (*Fig. 5b*).

Fig. 5. *Social perception of environmental impact on use and non-use value*

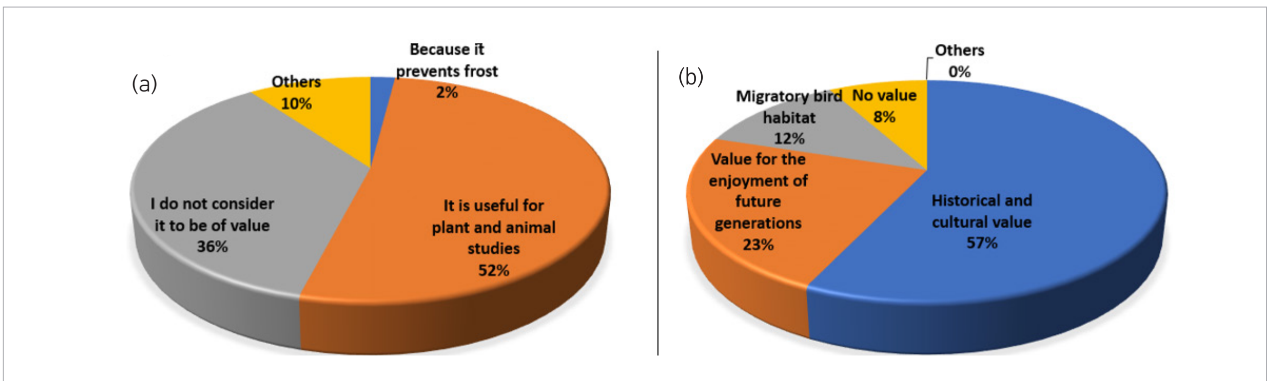
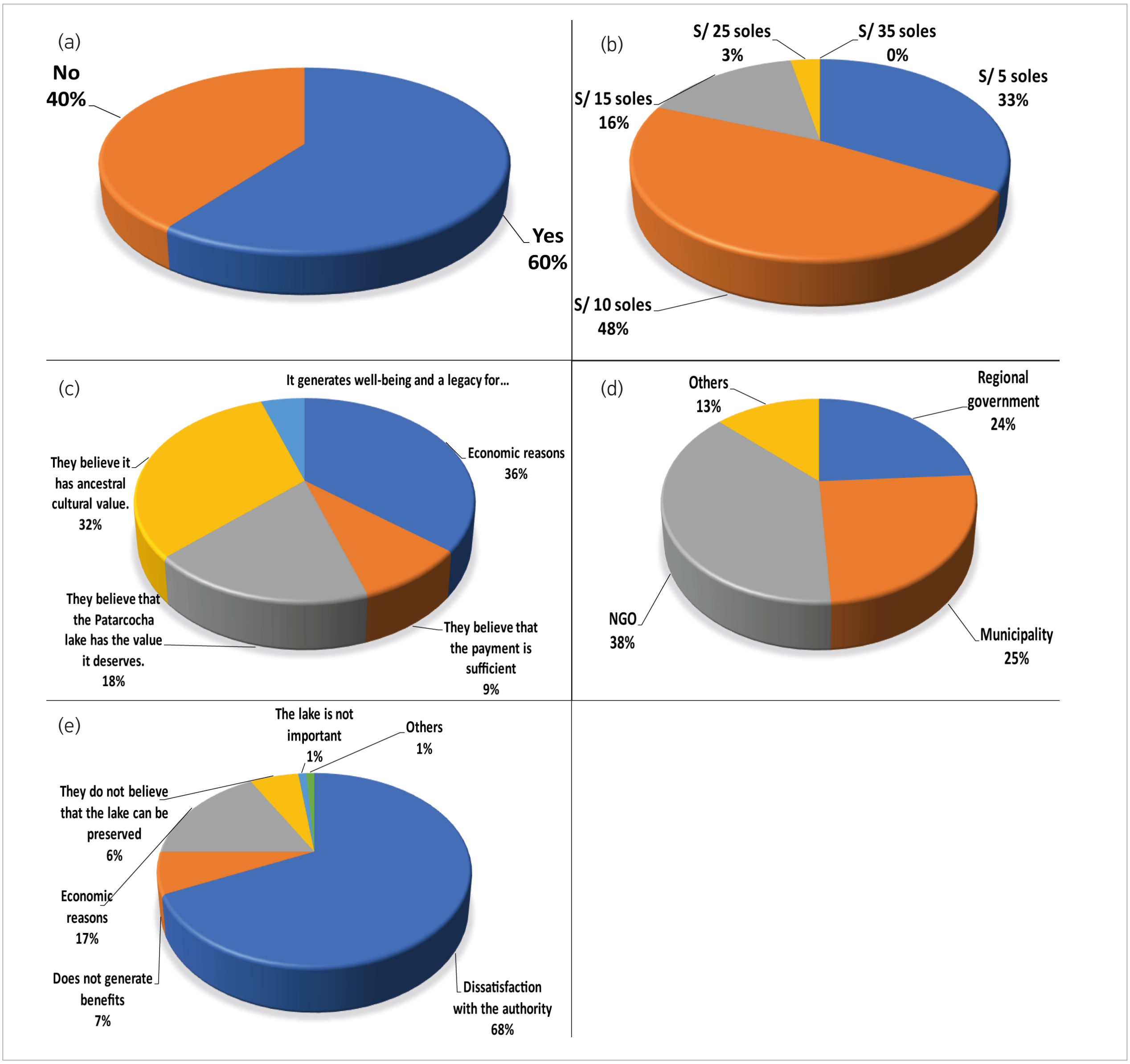


Fig. 6. *Social perception of willingness to pay (WTP)*

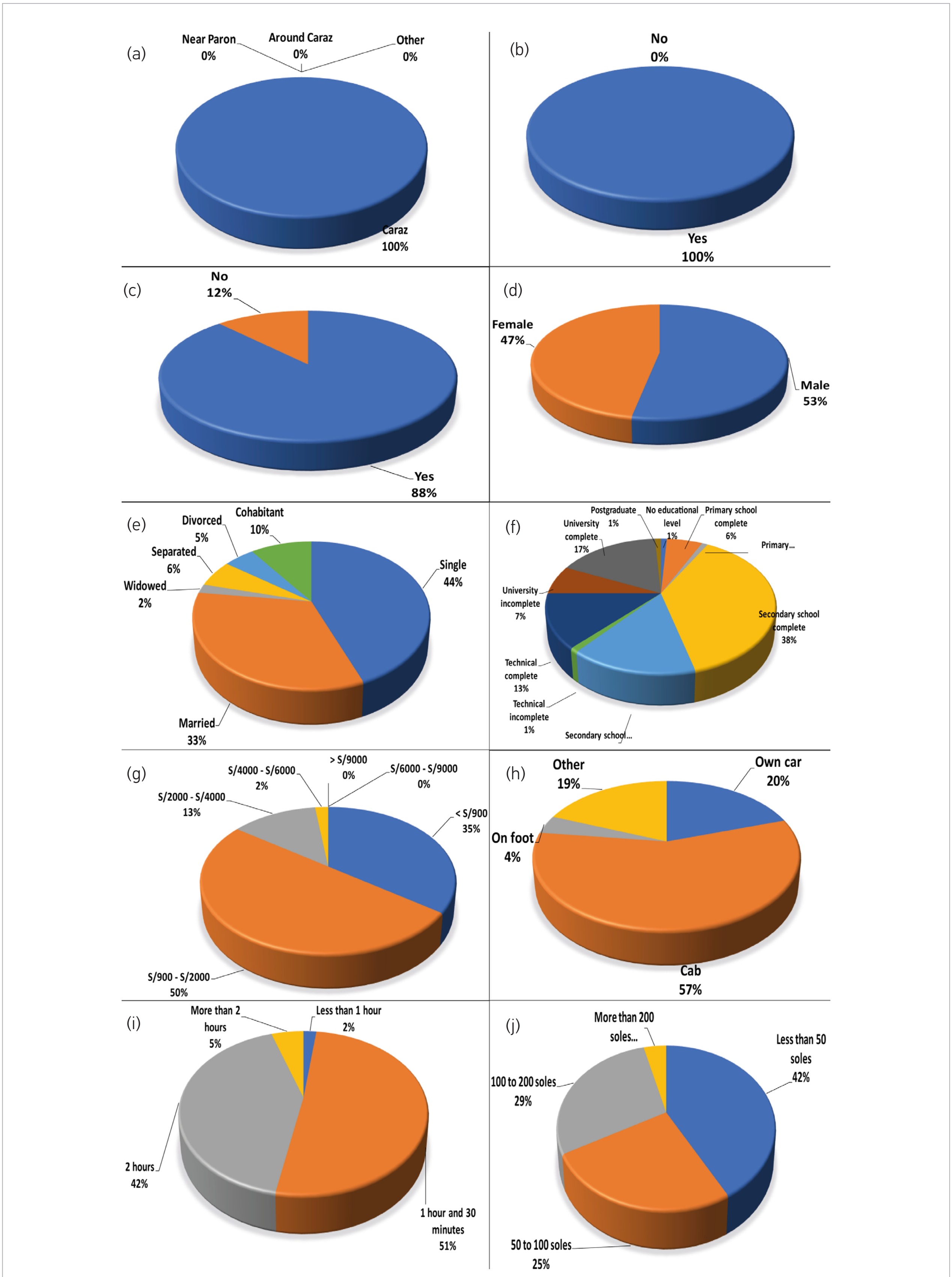


When asked if they would be willing to pay for the recovery and conservation of Lake Patarcocha, 60% said *Yes* and 40% said *No* (*Fig. 6a*). Of those who responded affirmatively to the payment, 48% would be willing to pay $2.7, 33% an amount of $1.35, 16% an amount of $4, and 3% an amount of $6.75 (*Fig. 6b*). Thirty-six percent are motivated to pay these amounts for economic reasons, 23% because they believe the lake has an ancestral value, 18% because of the value the lake deserves, for 9% the payment is sufficient, and 5% because it generates welfare and a legacy for future generations (*Fig. 6c*). Twenty-eight percent considered that the funds should be collected and administered by an NGO, 25% by the municipality, 24% by the regional government and 13% by none of the above (*Fig. 6d*). Of those who responded negatively, 68% said they were unhappy with the authorities, 17% said it was for economic reasons, 7% said it would not generate benefits, 6% did not think the lake could be recovered, 1% said the lake was not important, and the remaining 1% did not specify (*Fig. 6e*).

Lake Parón

In the survey, 100% are from Caraz (*Figs. 7a* and *7b*); 88% of these respondents consider that they use at least one resource or service provided by the lake (*Fig. 7c*), 53% are men and 47% are women (*Fig. 7d*),

Fig. 7. *Socioeconomic profile of the interviewees from the city of Caraz who visit Parón*



44% are single, 33% are married (*Fig. 7e*), 38% have completed secondary school, 17% have completed university, 15% have incomplete secondary school, 13% have completed technical studies, 7% have incomplete university studies (*Fig. 7f*), 50% have incomplete university studies (*Fig. 7f*), and 50% have incomplete secondary school education (*Fig. 7e*), 38% have completed secondary school, 17% have completed university, 15% have incomplete secondary school education, 13% have completed technical studies, 7% have incomplete university studies (*Fig. 7f*), 50% of the respondents have income between $243 and $540, 35% have income below $243, 13% have income between $541 and $1081, and 2% have income between $1082 and $1621 (*Fig. 7g*). 57% of the respondents arrived by cab, 20% by their own car, 19% arrived in another type of vehicle, and 4% arrived walking to Lake Parón (*Fig. 7h*). For more than half (51%) of the respondents, it took 90 minutes to arrive to the lake; 42% spent 2 hours, 5% spent more than 2 hours to arrive, and 2% arrived in less than 1 hour at the lake (*Fig. 7i*). 42% of the respondents spent less than $13.5, 29% spent between $27 and $54, 25% spent between $13.5 and $27, and 4% spent more than $54 to visit the lake (*Fig. 7j*).

When asked about their attitude towards the use of Laguna Parón's resources and services, 73% of those surveyed were aware that Laguna Parón is the largest lake in the Cordillera Blanca (*Fig. 8a*), while 83% were aware that Laguna Parón is a cultural heritage site (*Fig. 8b*). Also, 93% of those surveyed were aware that Laguna Parón is used as a water reservoir to supply the Cañón del Pato Hydroelectric Plant (*Fig. 8c*). Sixty-four percent of those who visited Parón spent 1 to 2 hours visiting the lake, 22% spent more than 5 hours, 8% spent less than 1 hour, and finally 6% spent 3 to 5 hours (*Fig. 8d*). 97% of respondents thought they would visit the lake again (*Fig. 8e*).

68% of those surveyed felt very satisfied with their visit to the lake, 17% were moderately satisfied, 12% expressed themselves being extremely satisfied and 3% said they were not very satisfied (*Fig. 8g*).

Fig. 8. *Graphs of the attitude towards the use of Laguna Parón services*

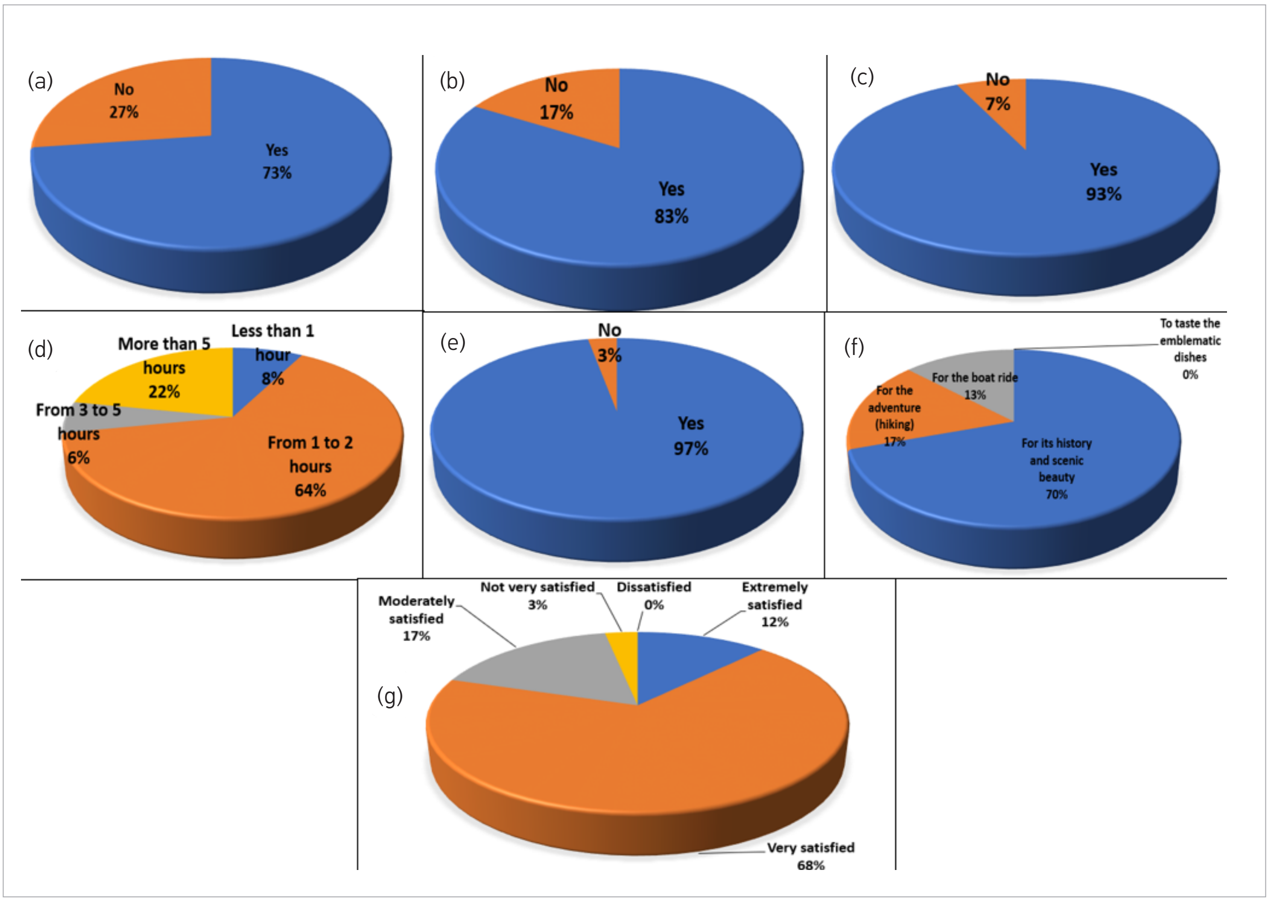
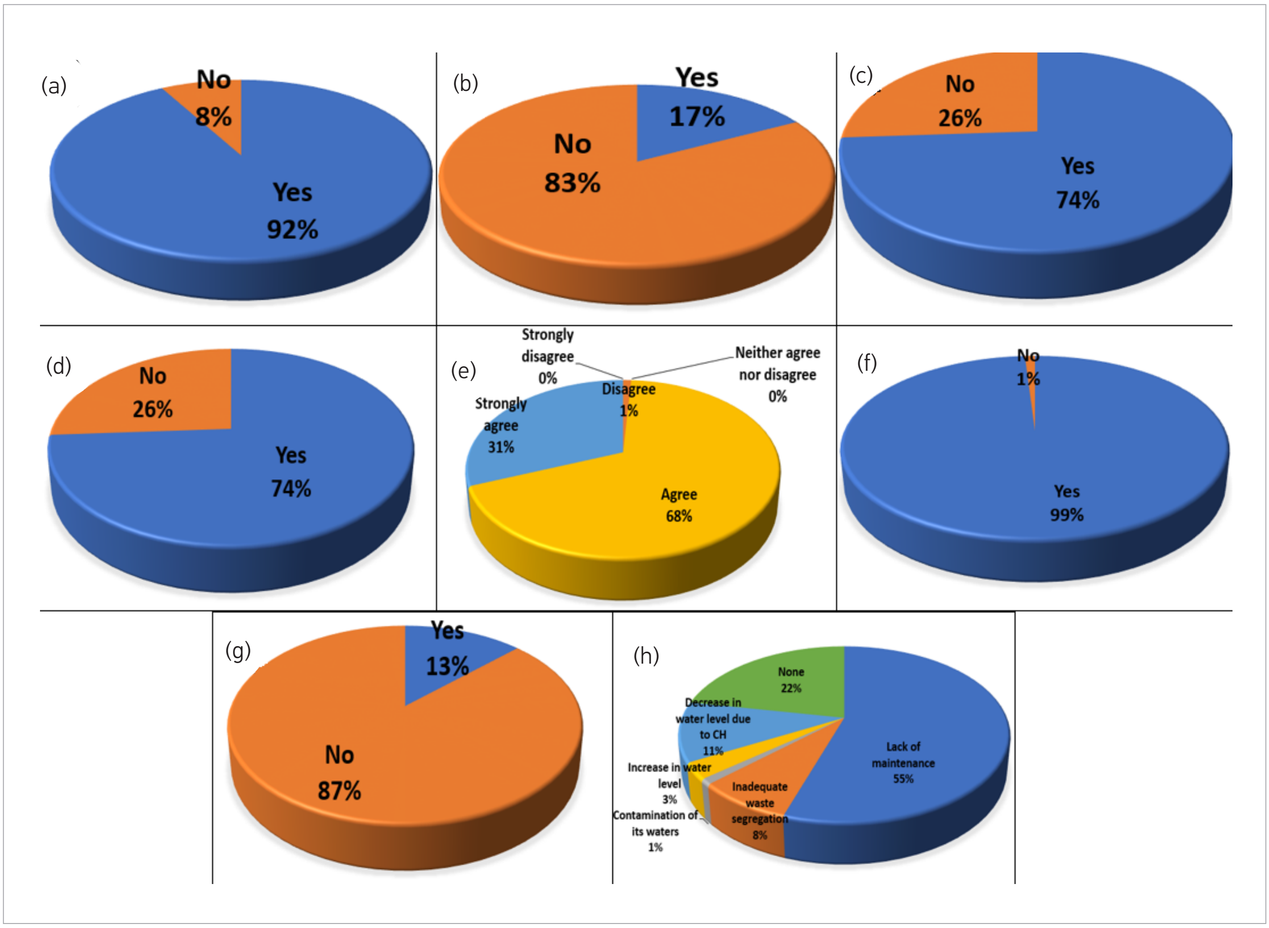


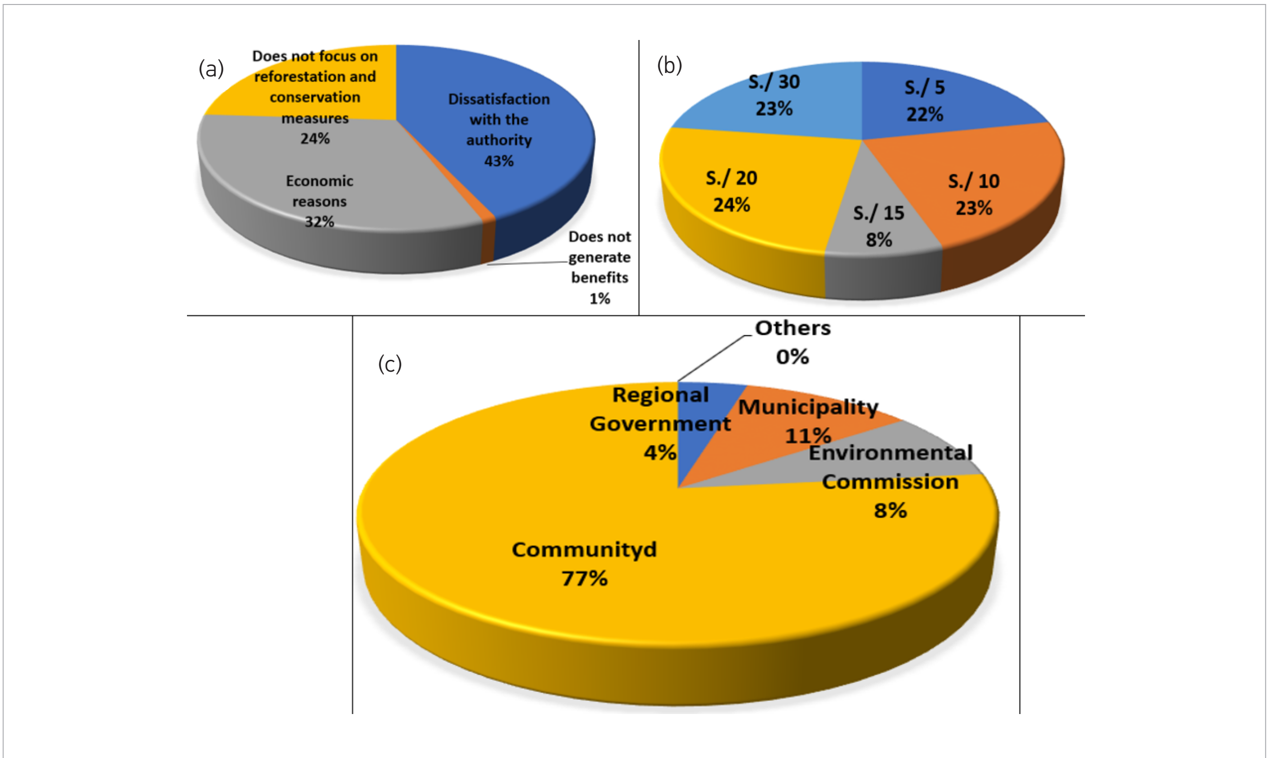
Fig. 9. *Charts on the environmental value of the Parón Lake*



When asked about the environmental value of Lake Parón, 92% of the respondents considered Lake Parón to be important in their daily lives, 8% did not (*Fig. 9a*), 83% of the respondents considered the lake to be polluted, 17% did not (*Fig. 9b*), and 74% noticed the high water level in the lake, while 26% did not (*Fig. 9c*). 74% noticed the high water level in the lake, 26% did not think there was a high water level (*Fig. 9d*), and 68% of the villagers interviewed thought the lake was important to them (*Fig. 9e*). Regarding the protection of the lake, 99% of those surveyed thought it was necessary to protect it (*Fig. 9f*). Information was read to the respondents indicating the importance of the lake because it supplies water resources (fresh water) to the population, as well as its importance as a regulator of climate change. 87% of the respondents considered that the information read was not new to them, and they already knew about it, while for 13% it was new information (*Fig. 9g*). Regarding the perception of problems in the lake, 55% of the respondents considered that the most important problem facing Lake Parón was the lack of maintenance, 22% considered that the lake had no problems, 11% considered that the reduction of its waters due to the hydroelectric plant was the main problem facing the lake, 3% considered that the increase in water level was the main problem, and finally 1% considered that the contamination of its waters was the main problem (*Fig. 9h*).

When asked how much they would be willing to pay for the conservation of Laguna Parón, 22% indicated that they would be willing to pay \$1.4, 23% indicated \$2.7, 8% indicated \$4, 24% indicated \$5.4, and 23% indicated \$8.1 (*Fig. 10a*). When asked about the reasons for not paying for conservation, 43% would not be willing to pay because they were unhappy with the authority, 32% would not be willing to pay for economic reasons, 24% would not be willing to pay because they did not believe in the

Fig. 10. *Charts on the environmental value of Laguna Parón*



conservation measures, and 1% would not be willing to pay because it did not generate benefits (*Fig. 10b*). Moreover, 73% of the people surveyed would entrust the funds to the community, 10% to the municipality, 8% to an environmental commission, 5% to another type of organization, and 4% to the regional government (*Fig. 10c*).

Model estimation

Initially, we directly surveyed the inhabitants of the district of Chaupimarca with a sample size of 370 households and the district of Caraz, Ancash, with a sample of 300 inhabitants. However, after processing the information, some data were observed (missing data), so the sample was reduced to 344 households for Chaupimarca and 297 inhabitants for Caraz. *Table 3* shows the variables considered by the LOGIT model for both lakes.

The iterations of the variables coded to evaluate the LOGIT model in STATA resulted in 5 linear models. The models present the most significant variables as independent variables, while the response variable is the amount willing to pay (a WTP). The difference between the different linear models shown in *Table 3* is in the degree of significance (*$P < 0.1$; **$P < 0.05$; ***$P < 0.01$); the higher the significance, the greater the effect of the coded variable on mWTP.

The coded variables that explain the models for Lake Patarcocha are socioeconomic (sex, income and age) and environmental value variables (ss_laguna, water_residual, afec_cal_water, visita, proyec_0, proyec_1, lost_hist, flora, fauna and cal_water). Meanwhile, for Lake Parón, the explanatory variables are socioeconomic (income and sex), cultural knowledge variables (r_water, p_cultural and dimension) and environmental value (resource_use, impor_person, polluted, impact and knowledge).

From *Table 3*, only model 5 has statistically significant coefficients at the 5% significance level except for sex, flora, fauna and cal water for Lake Patarcocha and the amount willing to pay for Lake Parón. To complement the decision to use model 5, the Akaike's information criterion (AIC) indices were used to verify the decision to use model 5. These information criteria are a measure of the goodness of fit of a statistical model. It can be said to describe the relationship between bias and variance in model construction or the accuracy and complexity of the model. This complementary criterion presents a simple formulation and an easy application;

Table 3. *Coefficients and significance of coded variables influencing DBH for both ponds*

Lake Patarcocha						Lake Parón					
Codification	Model_1	Model_2	Model_3	Model_4	Model_5	Codification	Model_1	Model_2	Model_3	Model_4	Model_5
aWTP	−0.223***	−0.222***	−0.223***	−0.223***	−0.195***	aWTP	−0.025	−0.025	−0.023	−0.024	−0.023
Sex	0.337	0.335	0.337	0.34	0.376	ing_alto	1.498*	1.501*	1.446*	1.436*	1.422*
ing_medio	0.975***	0.987***	0.986***	0.978***	0.816***	Sex	−0.643*	−0.754**	−0.730**	−0.831**	−0.845**
ing_alto	1.258	1.269	1.269	1.265		r_water	−0.037	−0.052	−0.299	−0.341	
Age	0.261**	0.260**	0.260**	0.269**	0.225**	p_cultural	−0.717	−0.703			
ss_laguna	−0.610**	−0.600**	−0.602**	−0.613**	−0.828***	Dimension	0.771**	0.852**	0.732*	0.779**	0.756**
water_resid~l	−0.196	−0.202	−0.203	−0.196		use_resource	1.490***	1.558***	1.487***	1.547***	1.506***
afec_cal_a~a	−0.039					impor_person	1.843**	1.946***	1.840***	1.868***	1.886***
Visit	0.166	0.166	0.166	0.196		Contamination	0.558		0.62		
proyec_0	0.278	0.276	0.281	0.145		Impact	0.820**	0.886**	0.736*	0.810**	0.751**
proyec_1	0.183	0.18	0.182			Knowledge	−0.372		−0.218		
lost_hist	0.032	0.029				_cons	−1.404	−1.551*	−1.679*	−1.662*	−1.909***
Flora					−0.091						
fauna					0.924						
cal_water					0.197						
_cons	1.552**	1.530**	1.545**	1.639***	0.626						
N	344	344	344	344	370	N	297	297	297	297	297
Ll	−190.204	−190.213	−190.219	−190.343	−210.126	ll	−112.611	−113.429	−113.516	−114.358	−114.499
Chi^2	82.134	82.116	82.103	81.855	76.954	Chi^2	79.084	77.449	77.276	75.59	75.309
AIC	406.407	404.425	402.438	400.687	438.252	AIC	249.223	246.858	249.031	246.717	244.998
BIC	456.335	450.513	444.686	439.093	473.474	BIC	293.548	283.795	289.662	279.96	274.548

once the AIC criterion is calculated for each model, the model whose value is minimum is chosen, but it is not an excluding indicator (Amaya, 2018). In that sense, the AIC and BIC indicators are shown, where model 5 presents a better overall measure of goodness of fit AIC = 400.687 for Lake Patarcocha and AIC = 244.988 for Lake Parón. Therefore, it is assumed that the model selected and identified from this criterion performs well in terms of prediction. *Table 4* shows the variables that best explain model 5 for both lakes where they were included in the model specification.

Model 5 was replaced in its linear version in the LOGIT model for both gaps. The linear equations show the degree of probability for willingness to pay (aWTP) as a function of the significant coded variables:

$$\text{prob}(Si/x) = \beta\_0 + \beta\_1\ awtp + \beta\_2\ sex + \beta\_3\ ing\_medio + \beta\_4\ age + \beta\_5\ ss\_laguna + \beta\_6\ flora + \beta\_7\ fauna + \beta\_8\ cal\_water + \varepsilon\ \text{(Laguna Patarcocha)} \quad (10)$$

$$\text{prob}(Si/x) = \beta\_0 + \beta\_1\ awtp + \beta\_2\ ing\_high + \beta\_3\ sex + \beta\_4\ dimension + \beta\_5\ resource\_use + \beta\_6\ impor\_person + \beta\_7\ impact + \varepsilon\ \text{(Laguna Parón)} \quad (11)$$

Table 4. *Statistical description of model 5*

Coded variable	Obs.	Average	Typical deviation	Min	Max
		Lake Patarcocha			
aWTP	370	11.27	5.656	5	35
Sex	370	0.43	0.496	0	1
ing_medio	370	0.49	0.501	0	1
Age	370	4.23	1.346	1	7
ss_laguna	370	0.70	0.459	0	1
Flora	370	0.93	0.256	0	1
fauna	370	0.98	0.146	0	1
cal_water	370	1.48	0.638	1	5
		Laguna Parón			
awtp	297	16.26263	9.08881	5	30
ing_alto	297	0.1481481	0.3558464	0	1
Sex	297	0.5286195	0.5000227	0	1
Dimension	297	0.7239057	0.4478185	0	1
use_resource	297	0.8787879	0.3269245	0	1
impor_person	297	0.9225589	0.2677411	0	1
Impact	297	0.7441077	0.437098	0	1

Table 5 shows the results of the estimation of the proposed models for both ponds, showing the significance of the coefficients for a confidence level of 95%; however, there are coefficients that do not show any significance between them (P > 0.05).

On the other hand, the environmental value variables of Lake Patarcocha such as ss_laguna and flora negatively influence the probability of being willing to pay, that is, people who believe that Lake Patarcocha offers some environmental service and people who believe that in the last 20 years the flora has decreased negatively influence the willingness to pay. In terms of significance, for the variable ss_laguna, it is statistically significant at a 5% significance level, and with respect to the odds ratios, it is observed that the probability of people who said that the lake offers some environmental service is 2.29 times less likely to be willing to pay than those who said the opposite. However, the variable 'flora' shows that it is not significant and is (1/0.9127 = 1.095) 1.095 times less likely to be willing to pay for an improvement of Lake Patarcocha.

For the environmental value variables of Laguna Parón, the price or amount willing to pay has a negative sign, although it is not statistically significant. This variable has an inverse relationship with WTP, i.e., the lower the price or amount to pay, the higher the willingness to pay, which explains that the lower the price charged for the improvement and conservation of Lake Parón, the more people will be willing to pay for the ecosystem value it offers. The sex variable has a negative sign and is statistically significant at 5%. When the difference between women and men is reviewed, the willingness to pay decreases by 0.429 (1/0.429 = 2.33) or the probability of each man to be willing to pay is 2.33 times less than that of women. In addition, it is observed that income level has an important relationship with willingness to pay; those with high income levels (2 thousand soles or more) are 4.147 times more likely to pay compared to those with low incomes (less than 900 soles).

Willingness to pay using STATA

The mean as a measure of welfare in the WTP model is given if the variation in utility is zero; the individual will be indifferent between paying and receiving the improvement in environmental quality, which will lead to a better level of welfare, or not making the payment and receiving the initial utility (Osorio and Correa, 2009). *Table 6* shows the coefficients and averages of

Table 5. *LOGIT model estimates with variables influencing WTP*

Variable	Coefficient	Standard error	z	P > z	Odds ratio	Confidence interval (95%)	
Lake Patarcocha							
aWTP	−0.1954	0.0310	−6.31	0.0000	0.8225	−0.2561	−0.1347
sex	0.3756	0.2493	1.51	0.1320	1.4559	−0.1129	0.8641
ing_medio	0.8157	0.2598	3.14	0.0020	2.2608	0.3065	1.3249
Age	0.2248	0.1029	2.18	0.0290	1.2520	0.0231	0.4264
ss_laguna	−0.8278	0.2784	−2.97	0.0030	0.4370	−1.3735	−0.2822
Flora	−0.0914	0.5319	−0.17	0.8640	0.9127	−1.1338	0.9511
fauna	0.9236	0.9656	0.96	0.3390	2.5183	−0.9690	2.8162
cal_water	0.1974	0.2130	0.93	0.3540	1.2183	−0.2200	0.6148
_cons	0.6260	1.0400	0.60	0.5470	1.8701	−1.4123	2.6643
Lake Parón							
awtp	−0.0228	0.0188	-1.2200	0.2240	0.9774	−0.0596	0.0140
ing_alto	1.4223	0.7664	1.8600	0.0630	4.1466	−0.0798	2.9244
Sex	−0.8451	0.3562	−2.3700	0.0180	0.4295	−1.5433	−0.1470
Dimension	0.7559	0.3624	2.0900	0.0370	2.1296	0.0455	1.4663
use_resource	1.5060	0.4905	3.0700	0.0020	4.5086	0.5446	2.4673
impor_person	1.8860	0.6781	2.7800	0.0050	6.5931	0.5569	3.2151
Impact	0.7513	0.3672	2.0500	0.0410	2.1198	0.0317	1.4709
_cons	−1.9089	0.7262	−2.6300	0.0090	0.1482	−3.3322	−0.4857

the models. With the values in *Table 6*, the WTP was calculated. The results show that the average WTP is 13.68 soles, which represents the willingness to pay for the improvement and conservation of Laguna Patarcocha and the average WTP is $24 per inhabitant, which represents the willingness to pay for the improvement and conservation of Laguna Parón.

It can be seen that the proportion of the amount obtained in this study for Lake Patarcocha and Lake Parón was at a similar level to the studies presented in *Table 7*. The high WTP for lakes as natural resources is based on the villagers' dependence on this resource. *Table 7* also shows that the valuations of high Andean lakes in Peru are much lower than the valuation of lakes in other countries. With the exception of this study, which has a similar WTP than in other countries, this may be due to the fact that Lake Patarcocha is currently in social conflict in the region and, therefore, the local people have a negative perception of the lake, while the WTP for Lake Parón is high and is on par with other studies. Laguna Parón is a tourist attraction; social persecution is positive for this lake.

Table 6. *Coefficients and averages of the coded variables that explain the model*

Coded variable	Coefficient (b)	Average (x)	b * x
Lake Patarcocha			
aWTP	−0.1953948	11.27027	
Sex	0.375597	0.4324324	0.162420312
ing_medio	0.8157166	0.4945946	0.403449025
Age	0.2247519	4.227027	0.95003235
ss_laguna	−0.8278363	0.7	−0.57948541
Flora	−0.0913661	0.9297297	−0.084945777
Fauna	0.9235695	0.9783784	0.90360045
cal_water	0.197423	1.481081	0.292399454
_cons	0.6259957		0.6259957
Lake Parón			
aWTP	−0.0228346	16.26263	
ing_alto	1.422286	0.1481481	0.210708969
Sex	−0.8451397	0.5286195	−0.446757326
Dimension	0.7559234	0.7239057	0.547217258
use_resource	1.505976	0.8787879	1.323433486
impor_person	1.886023	0.9225589	1.739967304
impacto	0.7513309	0.7441077	0.559071108
_cons	−1.90892		−1.90892

Table 7. *Comparisons of the WTP obtained with different research studies*

Country	Location	Year	Description of the ecosystem service	Methodology	Amount of the economic valuation		Reference
					Local currency	Dollar	
El Caribe	Simpson Bay, Lake Saint Martin	2020	Recovery due to waste-water contamination and overexploitation.	Contingent method	-	US $ 26.3 million/ year	Duijndam et al. (2020)
Argentina	Lake in southeast-ern Buenos Aires	2017	Wetland of local importance due to the ecosystem services it provides as a recreational space of symbolic sociocultural value for the population.	VET	138 million pesos/year	US $ 1.38 million/ year	Iwan et al. (2017)
India	Vellayani, lake	2015	Freshwater from lake provides a variety of direct and indirect ecosystem services to populations.	Contingent method	354.25 million rupias/ year	US $ 4.60 million/ year	Banerji et al. (2021)
Greece	Southern Peloponnese, Kotychi Waterfalls National Park - Strophylia	2022	Extremely sensitive and protected ecosystem, comprising one of the largest pine forests in Europe (Strofilia) and several important wetlands and lakes (Kotychi).	Contingent method	14.7 to 25.5 million EUR in 4 years		Dimopoulos et al. (2022)
Spain	Regional Park of the Salt Lakes and Arenales de San Pedro del Pinatar, Murcia	2019	Saline wetland that is part of the Natura 2000 Network, declared a Special Area of Conservation and Special Protection Area for Birds, salt production and tourism.	Contingent method and Choice Experiments	2.33 million EUR/year		Hernández Mármol et al. (2021)
Malawi	Chia lake	2019	Improve water quality in the lake for the communities' water service.	Contingent method	2.33 million dollars/ year		https://www.mdpi.com/2071-1050/11/17/4690
Sri Lanka	Jaffna lake	2020	Improved tourism facilities, availability of land for mangrove planting, improved tourism facilities and increased income for fishermen in rural communities.	Contingent method	30.3 dollars/ year by person		Krishnapillai et al. (2020)
Indonesia	Blue Lagoon Tourism Village Widodomartani Sleman	2020	Tourist site with accessibility to facilities and ecosystem services.	Travel Cost	6019 million IDR/ year		Ernawan and Harini (2020)
Peru	Lake Conache, Laredo (La Libertad)	2013	Recovery due to contamination by solid and organic waste, degradation of carob trees and excessive growth of the surrounding flora and areas.	Contingent method	S/. 28 million soles/year	US $ 674 145.04 thousand/ year	Verona Ezcurra and Rodríguez Castillo (2013)

Country	Location	Year	Description of the ecosystem service	Methodology	Amount of the economic valuation		Reference
					Local currency	Dollar	
Peru	'La Milagrosa' lake, Cañete, Lima	2018	Loss of water volume, decrease of species living in the lake (migratory species), water quality, presence of solid waste and invasion of the area of direct influence.	Contingent method	S/. 0.21 million soles/year	US $ 52 166.4 thousand/ year	Ramos (2018)
Peru	Lake Patarcocha, Pasco	2021	Anthropogenic contamination by the population of the district of Chaupimarca, Pasco.	Contingent method	S/. 4.02 million of soles/year	US $ 1.02 million/ year	This research
Peru	Lake Parón, Ancash	2021	Impact of glacial retreat in the Parón basin.	Contingent method			This research

Model adjustments

Table 8 shows the fit of the estimated models for both lakes. For Lake Patarcocha, of the 370 households surveyed, 68.65% were correctly classified. Of the 255 respondents who said they were willing to pay, 70.98% were correctly classified by the model, and of the 115 respondents who said they were not willing to pay, 63.48% were correctly predicted by the model. It is important to know if the model is correctly specified; for this, the sensitivity of the model must be greater than 70%. For the present model, 81.17% were correctly specified, while for Lake Parón, 96.60% were specified, higher than for Lake Patarcocha.

Table 8. *Descriptive indicators for model validation*

Classified	Laguna Patarcocha			Laguna Parón		
	D	~D	Total	D	~D	Total
+	181	74	255	227	39	266
–	42	73	115	8	23	31
Total	223	147	370	235	62	297
Classified + if predicted Pr(D)	> = 0.5			> = 0.5		
True D defined as DAP != 0						
Sensitivity		Pr(+D)	81.17%		Pr(+D)	96.60%
Specificity		Pr(-~D)	49.66%		Pr(-~D)	37.10%
Positive predictive value		Pr(D +)	70.98%		Pr(D+)	85.34%
Negative predictive value		Pr(~D-)	63.48%		Pr(~D-)	74.19%
False + rate for true ~D		Pr(+~D)	50.34%		Pr(+~D)	62.90%
False - rate for true D		Pr(-D)	18.83%		Pr(- D)	3.40%
False + rate for classified +		Pr(~D+)	29.02%		Pr(~D+)	14.66%
False - rate for classified -		Pr(D-)	36.52%		Pr(D-)	25.81%
Correctly classified			68.65%			84.18%

Conclusions

This study revealed that Lake Patarcocha provides various ecosystem services for the inhabitants of the district of Chaupimarca, but according to the perception of the majority of the population, the environmental impact produced by anthropogenic activities has a low degree of importance; the services impacted are water quality, flora, wildlife, landscape quality and public health. The inhabitants who know that the lake offers some ecosystem service and that these are impacted (significance level of 5%) are 2.29 times less likely to be willing to pay for an impacted ecosystem service with an estimated willingness to pay (WTP) of $3.7 household. While for Lake Parón, respondents considered the use of lagoon resources, landscape value, reservoir service and water supply, and recreational and tourism services as important ecosystem services. The residents are willing to pay (WTP) for improvement and conservation at around $24 per person. It is concluded that the predictions generated for both lakes are significant and have a high representativeness and reflect the social perception of the population in both districts, with a difference between the social perception between Lake Patarcocha and Lake Parón. While Lake Parón has a positive perception, it is worrisome that Lake Patarcocha has a low value with a possibility of disappearing. This research shows that high Andean lagoons have high value ecosystem services, but these depend on the local context and the origin of the impact. Likewise, the local context influences the population's perception of the ecosystem services that the lagoons can provide, showing a difference between Lake Patarcocha perceived as a lake with pollution problems without much value for its recovery and Lake Parón perceived as a lake with a high tourist and recreational value.

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