

Willingness to pay for water ecosystem services in a river basin of the in South America largest semi-arid region

Disposição a pagar pelos serviços ecossistêmicos da água em uma bacia hidrográfica da maior região semiárida da América do Sul

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Abstract

This study presents the result on the Willingness To Pay (WTP) of Ecosystem Services (ES) regulating water a Brazilian watershed. The Brazilian semi-arid region is the largest semi-arid region in South America, this area is ranked as the most populated semi-arid region in the world. 393 questionnaires were applied using the Contingent Valuation Method (CVM). Of the respondents in the basin territory, over (77.9%) expressed a positive WTP for maintaining the (SE) of Water. The payment for the conservation of the (ES) water regulators was R\$10.00/month, the quality of water purification seemed to be an important aspect in terms of the value assigned in the payment. On the other hand, the protest votes for non-payment, which were (22.1%), pointed to the payment of too many taxes. The (WTP) for water conservation was defined by environmental interest and the loss of the (SES) provided Caatinga.

Keywords

Caatinga, Environmental Valuation, Management of river basins.

JEL Codes Q25, Q57, Q56.

Resumo

Este estudo apresenta o resultado sobre a Disposição A Pagar (DAP) de Serviços Ecossistêmicos (SE) reguladores da água em uma bacia hidrográfica. O semiárido brasileiro é a maior região semiárida da América do Sul, esta área é classificada como o semiárido mais povoado do mundo. 393 questionários foram aplicados utilizando o Método de Avaliação Contingente (MVC). Dos inquiridos no território da bacia, mais de (77,9%) expressaram uma DAP positiva para manter os (SE) da Água. O pagamento pela conservação dos (SE) reguladores da água foi de R\$ 10,00/mês, a qualidade da purificação da água pareceu ser um aspecto importante em termos do valor atribuído no pagamento. Por outro lado, os votos de protesto por não pagamento, que foram (22,1%), apontavam para o pagamento de muitos impostos. A (DAP) para a conservação da água foi definida pelo interesse ambiental e pela perda dos (SE) prestados da Caatinga.

Palavras-chave

Caatinga, Avaliação Ambiental, Gestão de bacias hidrográficas.

Códigos JEL Q25, Q57, Q56.

1 Introduction

There is a growing concern in the science of ecosystem services regarding water management in river basins, especially in semi-arid environments, as pointed out by some studies (Boafo *et al.*, 2016; Ferreira *et al.*, 2019; Gunkel *et al.*, 2015; Mueller; Soder; Springer, 2019; Rajasekhar *et al.*, 2018; Rao *et al.*, 2018; Schild; Vermaat; van Bodegom, 2018). and important reports, such as (Millennium Ecosystem Assessment., 2005).

Historically, populations in semi-arid regions have adapted to chronic environmental pressures, such as drought, and human-induced deforestation actions, and have raised ecosystem services to a subsistence level and to practical adaptations for conservation and survival (Boafo *et al.*, 2016). These conditions are even more serious when it comes to semi-arid regions in Brazil. The semi-arid region of Northeast Brazil corresponds to 982,563.3 km², occupying around 11% of the national territory. This region has as particularities the low annual rainfall and a high spatial-temporal variability, in addition to high evapotranspiration (Inácio Silva *et al.*, 2017). These factors combined with the strong variability of rain, produce very wet years and extreme droughts (Montenegro; Ragab, 2012).

Even under adverse weather conditions, the northeast region, where the Brazilian semi-arid is located, has important river basins that offer many ecosystem services. Therefore, they are relevant in terms of maintaining life, improving social quality, and boosting and encouraging the economy, thus being essential for the people who live in this territory. However, there is little knowledge about the ecosystem services provided in the semi-arid region by Caatinga, and this knowledge would be vital for the valorization of the water resources in that region, especially for the planning of the basin's territory (Oliveira, 2016).

In this sense, the quantification of this territory may bring important information for the basin's management. The quantification of ecosystem services involves understanding the relationship of ecosystem services among themselves, with ecosystem properties and with other ecological processes, identifying and valuing their quantitative and qualitative importance in this process (Costanza, 2000; Costanza *et al.*, 2017; De Groot *et al.*, 2010; Van Oudenhoven *et al.*, 2012). Understanding patterns of use of ecosystem services and understanding Willingness to Pay (WTP) by the population, are fundamental to support environmental and economic

policies in the semi-arid area of Brazil (Willams; Aleixo, 2014). The importance of a study about the WTP in a river basin, which documents expert opinions and local community perceptions and preferences, using the ecosystem services framework, brings important information to decision makers about basin management (Bhandari *et al.*, 2016). It is necessary to understand the dynamics of society's preferences so that a new conservation paradigm can be devised for human welfare (Millennium Ecosystem Assessment., 2005).

Ecosystem services can be evaluated across different disciplines and can consider different types of value (De Groot, 2006). Methods based on socio-economic information preferences have been proposed as useful tools to support environmental policies (Favretto *et al.*, 2017; Majdalawi *et al.*, 2016; Rao *et al.*, 2018; Rincón-Ruiz *et al.*, 2019). The Contingent Valuation Method (CVM) has been one of the most widely used in research on about environmental resources and, within the framework of environmental public policy management, the CVM is one of the most suitable for valuing environmental resources involving ecosystem services (Arabomen; Chirwa; Babalola, 2019; Livingstone; Cadotte; Isaac, 2018; Mattos *et al.*, 2015; Sylla; Lasota; Szewrański, 2019; Tammi; Mustajärvi; Rasinmäki, 2017). Thus, the CVM was used in this study to investigate the revealed preferences of the residents of the river basin territory. The stakeholders' willingness to pay reflect their global feelings for local ecosystem services (Li *et al.*, 2019).

Therefore, the aim of this study was to identify the value of the (WTP) for ecosystem services of water regulation in the territory of the Riacho do Pontal basin in the State of Pernambuco – Brazil. Based on the study of (Lalika *et al.*, 2017), this article also incorporated the perception of the river basin residents to understand their WTP on water ecosystem services.

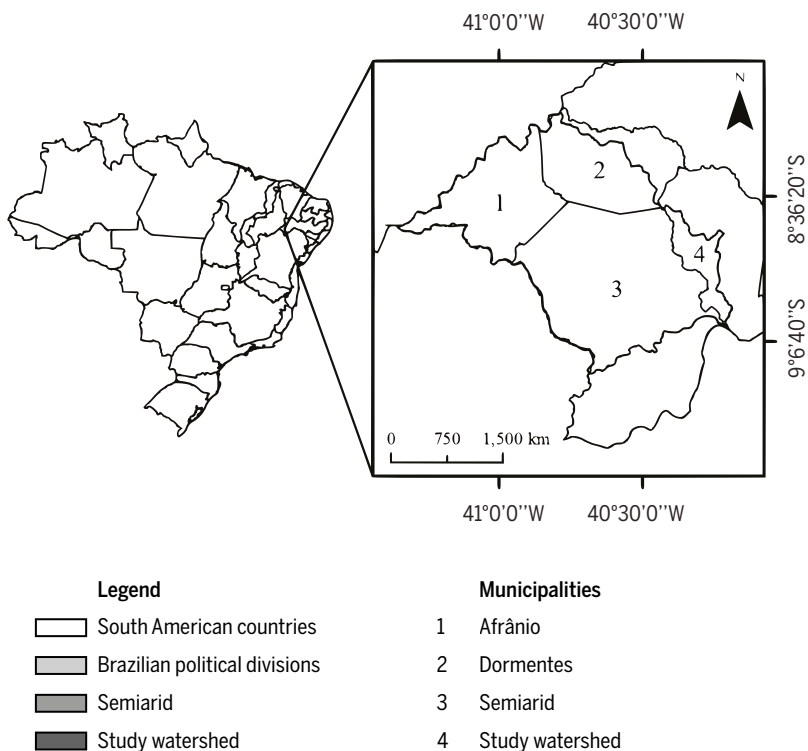
The effective contribution of this work is to identify the willingness to pay by the population residing in the Pontal basin, which allowed the creation of scenarios, illustrating how much would be collected if the contribution of economically active people were made. This evidenced that the population is interested in conserving the ecosystem services of the Pontal stream basin. In the next sections, the research methodology and results will be described. Followed by the discussion and finally the conclusion, with some implications for public policy making.

2 Methodology

2.1 Study Area

This study was conducted in the Brazilian Caatinga region, an area of approximately 982,563.3 km². This area corresponds to the largest semi-arid region on the planet and includes the Brazilian states of Alagoas, northern and central Bahia, Ceará, Pernambuco, Paraíba, Rio de Janeiro, Rio Grande do Norte, southeast Piauí, Sergipe and northern Minas Gerais. (IBGE). (Fig. 1).

Figure 1 Location of the Riacho do Pontal basin – PE in the semi-arid region of Brazilian Northeast



Source: Prepared by the author.

The application of Contingent Valuation Method (CVM) questionnaires was conducted in the Riacho do Pontal basin, which is located in the extreme west of the State of Pernambuco, cutting four municipalities: Af-

rânio, Dormentes, Lagoa Grande and Petrolina, between 08°19'00" and 09°13'24" south latitude, and 40°11'42" and 41°20'39" west longitude. Riacho do Pontal has its water source in the extreme west of the State of Pernambuco, between the limits of the states of Piauí and Bahia, in the municipality of Afrânio (Brito *et al.*, 2011; Silva *et al.*, 2016).

The Riacho do Pontal basin has a drainage area of 6334 km² at its river mouth in the São Francisco River, flowing into the left bank of the São Francisco River, after a distance of approximately 200 km, with the predominant direction being northwest-southwest (Silva, *et al.*, 2015).

2.2 Research methods

The CVM is used in this study to investigate the preferences revealed by stakeholders about the conservation of the ecosystem services of water in the Riacho do Pontal basin in a hypothetical scenario, where the residents of the territory would pay a monthly fee for environmental conservation work of the Caatinga and improvement of the regulatory water ecosystem services. CVM is a type of stated preference method that uses a hypothetical market system to extract the stakeholders' willingness to pay to accept specific assets or services (Ardeshiri *et al.*, 2019; Börger *et al.*, 2018; Schuhmann *et al.*, 2019; Skeie *et al.*, 2019).

In the hypothetical market, the clients are questioned directly through a survey to indicate the amount they are willing to pay for a grant (Garrone; Grilli; Marzano, 2019; Jensen, 2019; Li, 2017; Mazzocchi; Sali, 2016; Pham *et al.*, 2018). It is recognized that this technique is capable of identifying instructional information to policy makers in the management of the river basin's ecosystem services (Fan; Ou; Chen, 2019; Gashaw *et al.*, 2018; Jujnovsky *et al.*, 2017; Lin *et al.*, 2017; Paudyal *et al.*, 2019; Sahle *et al.*, 2019).

2.3 Questionnaire design

Since the CVM uses a survey to obtain the WTP from stakeholders, a questionnaire was created to conduct the CVM survey. The questionnaire consisted in three sections with a total of nine questions. The first section contained five questions regarding the socioeconomic background

information (age, gender, municipality living in the basin, schooling, and monthly personal income). The socioeconomic questions were organized according to the database of the Instituto Brasileiro de Geografia e Estatísticas (IBGE). The total size of the population living in the basin in the four municipalities (Afrânio, Dormentes, Lagoa Grande and Petrolina) totals 351,225 people, as shown in the latest census (IBGE, 2010).

In this study, the group chosen for sampling was the economically active urban and rural population of the four municipalities in the Riacho do Pontal river basin, which corresponds to a total of 72,709 people according to (IBGE, 2010). The profile chosen to participate in the interviews were people between 18 and 65 years old. The choice of the age pyramid is based on the index of the Economically Active Population of Brazil (PEA), which corresponds to employed and unemployed people between 18 and 65 years old (Reis, 2018). The following equation was defined for sampling:

$$n = \frac{N \cdot p \cdot q \cdot z_{\alpha/2}^2}{(N - 1) \cdot e^2 + p \cdot q \cdot z_{\alpha/2}^2} \tag{1}$$

Such that:

- n = Number of individuals in the sample;
- N = Population Size (finite);
- p = Proportion of individuals belonging to the study category;
- q = Proportion of population of individuals not belonging to the study category ($q = 1 - p$);
- $Z_{\alpha/2}$ = Critical value for the desired degree of confidence;
- e = Margin of error.

Random sampling was used according to studies from (Park; Lim; Yoo, 2018). The improvement of random sampling and statistical inference techniques enabled the possibility to represent a large part of a population with great reliability, using a reduced number of sample units. Therefore, any person residing in any municipality of the Riacho do Pontal basin and within the parameters of the economically active population (PEA) was considered for this study. The collection happened on the entire territory of the river basin, following a 95% confidence margin. The second part of the questionnaire contained two questions related to (WTP), the first, whether the interviewee would be willing to pay for the conservation of ecosystem services of water regulation in the Pontal River basin. The question (WTP) asked in the CVM survey was: 'Are you willing to pay for

the conservation of ecosystem services of water regulation in the Pontal River basin?'. The alternatives were YES or NO and DON'T KNOW. If the answer was yes, it followed the question of what monetary value the person was willing to pay, where the source of elicitation was the payment card. The payment card asks stakeholders to report their willingness to pay (WTP) as a point in a list of values and then treat each WTP answer as a range (Svenningsen; Jacobsen, 2018; Voltaire *et al.*, 2019; Vondolia; Navrud, 2019; Vossler; Holladay, 2018; yang *et al.*, 2018). If the respondent was unwilling to pay, then he was asked the reason for his negative answer to the WTP with an open-ended question.

Table 1 Types of process of water regulation services, benefits, and specific examples of the Brazilian Caatinga's semi-arid ecosystem

	Type of ecosystem services regulation	Sources and/or specific examples
1	Regulation of the Microclimate	Air temperature, reduction on the speed of the wind, soil temperature, increase in precipitation.
2	Water regulation (flow)	Better infiltration and percolation in the soil, run-off to aquifers, more perennial rivers.
3	Flood and erosion regulation	Regulation of the removal of the particle from the rock and the soil by the action of water, less leaching of the surface layer, protection of riverbanks.
4	Water purification	Ecosystem conservation in the seasonally dry forest, protection of sources, protection of aquifers.
5	Retention of sediments	Soil aggregation, higher volume of organic matter, higher soil saturation.

Source: MEA (2005), adapted for characterization of Caatinga by the author (2019).

Investigating unwillingness to pay is important to understand which variables affect stakeholders concerning the negative answer (Aichner; Forza; Trentin, 2017; Hilger *et al.*, 2019; Noel *et al.*, 2019; Shao; Tian; Fan, 2018). the third and final section of the questionnaire was dedicated to the perception of the water regulation ecosystem services of the Riacho do Pontal river basin, through the questioning of which ecosystem services the interviewee recognized in the river basin. Based on (Millennium Ecosystem Assessment., 2005), a description of the categories of water regulation ecosystem services and their examples were presented to respondents (Table 1) and were adapted for Caatinga in the Brazilian semi-arid region. The per-

ception of ecosystem services is important as it highlights for stakeholders a positive look at the ecosystem services being studied (Berg *et al.*, 2017; Canova *et al.*, 2019; Queiroz *et al.*, 2017; Torkar; Krašovec, 2019).

2.4 Questionnaire design

A total of 393 questionnaires were applied, distributed as follows: Afrânio (33 residents), Dormentes (38 residents), Lagoa Grande (91 residents) and Petrolina (231 residents). Between October 1 and 18, 2019. To analyze the data collected in the basin, descriptive and inferential statistics (chi-square test) were applied, to identify factors that influence the WTP of the residents. For the statistical inference of the answers, the R software was used. As in other research, (Enriquez-Acevedo *et al.*, 2018; Lagbas, 2019; Obeng; Aguilar, 2018; Rizzei *et al.*, 2018), a binary regression was used to explain how independent socioeconomic variables predict the interviewees responses to questions related to the perception of ecosystem services of water regulation.

The model applied was this following one:

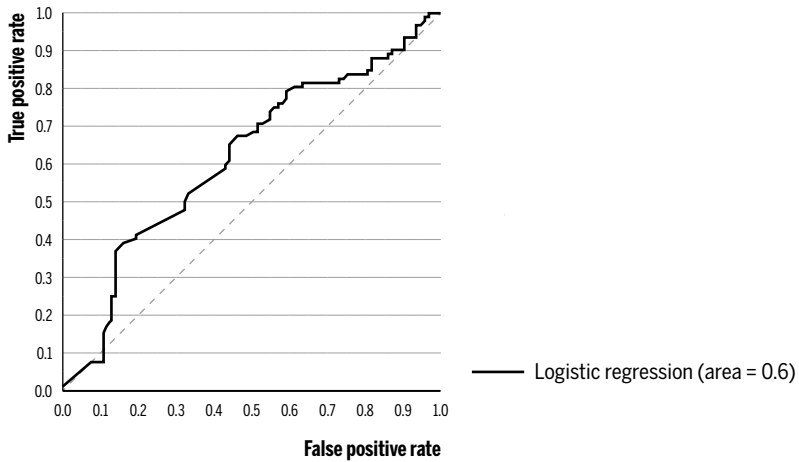
$$P(Y) = \frac{1}{1 + e^{-(0.0003 - 0.0001 \times AG + 0.007 \times SX \times 0.0002 \times RD - 0.0021 \times ED - 0.004 \times MW)}} \quad (2)$$

Based on the following information: age group (AG), gender (SX), residence (RD), schooling (ED) and income range (MW), it is possible to obtain the probability $P(Y)$. Thus, the beta regression model also becomes an alternative in this study. The beta regression model, in concomitance with the CVM, seeks precisely the versatility of the beta distribution in modeling a variety of uncertainties (Bishop; Timmins, 2019; Freeman *et al.*, 2019).

The logistic regression was performed to predict the results of dependent variables (willing to pay or not) based on the predictor variables provided by the questionnaire. The WTP was basically explained by two variables with ($p > 0.07$): first, by the gender of the population surveyed ($p = 0.0330$) and second, by the municipality of the residents in the river basin area ($p = 0.0303$).

The binary logistic regression showed that as the age of the population increases (> 50), the probability of WTP decreases significantly.

Figure 2 Logistic regression



Source: Prepared by the author.

3 Results

3.1 Identification and demographic characterization of the residents of the Riacho do Pontal river basin – PE

The results of the applicability of the CVM regarding the socioeconomic part of the questionnaire demonstrate the homogeneity in the sample size during the collection period, in which the age range was measured. In the age bracket the predominance was from 18 to 24 years old (43.4%), who are young people, followed by the second age bracket from 25 to 34 years old (24.4%). The correlation of gender variables was equal, being male (49.2%) and female (50.8%). The variable that shows the municipality where the interviewees live in the territory of the Pontal river basin shows that the largest collection among the municipalities within the territory was in the city of Petrolina (58.8%), this is the most populous municipality among the municipalities within the river basin.

The schooling of the residents in the river basin pointed out the higher education degree, in which (43.9%) of people concluded a higher education (undergraduate course), showing that the interiorization of education is growing in the Brazilian semi-arid. The monthly income variable shows

that people who inhabit the most populated semi-arid in the world earn up to a minimum wage (45.4%), showing that this value is equal to the average of most of the Brazilian population regardless of region. Table 2 shows the main characteristics of the population studied in the river basin territory. After presenting the social data of the present study, the next section presents the list of preferences revealed by the WTP of the stakeholders about the conservation of ecosystem services of water regulation in the Riacho do Pontal river basin.

Table 2 Distribution of sample frequencies and percentages for the number of interviewees by age group, gender, place of residence, education, and monthly personal income of interviewee

	<i>n</i>	%
Age Group		
18 to 24 years old	171	43.4
25 to 34 years old	96	24.4
35 to 44 years old	48	12.2
45 to 54 years old	66	16.8
55 to 65 years old	13	3.3
Gender		
Male	193	49.1
Female	200	50.8
Municipality where you live in the Pontal basin – PE		
Municipality of Afrânio	33	8.4
Municipality of Dormentes	38	9.7
Municipality of Lagoa Grande	91	23.2
Municipality of Petrolina	231	58.8
Schooling		
Incomplete Elementary School	13	3.3
Complete Elementary School	13	3.3
Incomplete High School	10	2.5
Complete High School	105	26.8
Technical Course	13	3.3
Higher Education (Undergraduate Course)	173	43.9
Postgraduate/Graduate	66	16.8

(continues on the next page)

Table 2 (continuation)

	<i>n</i>	%
How much is your personal monthly income?		
Less than a minimum wage at R\$ 998.00	179	45.4
Between R\$ 998.00 and R\$ 1,996.00	50	12.7
Between R\$ 1,996.00 and R\$ 2,994.00	27	6.9
Between R\$ 2,994.00 and R\$ 3,992.00	113	28.7
More than R\$ 3,992.00	25	6.3

Source: Prepared by the author.

Table 3 Willingness to pay for regulating ecosystem services in the Pontal – PE river basin

	<i>n</i>	%
Would you be willing to pay for the environmental conservation of the ecosystem services of regulation in the Pontal River?		
Yes	307	77.9
No	86	22.1
How much are you willing to pay to promote the environmental conservation of the ecosystem services of regulation in the Pontal River?		
R\$ 2.00	46	11.7
R\$ 5.00	79	20.1
R\$ 10.00	104	26.4
R\$ 15.00	22	5.6
R\$ 20.00	24	6.1
R\$ 25.00	7	1.8
More than R\$ 30.00	4	1.0
I don't know	108	27.4

Source: Prepared by the author.

3.2 Willingness to pay for the conservation of ecosystem services of water regulation in the semi-arid

In total, the WTP among the residents of the Riacho do Pontal basin (Table 3), was (77.9%) showing a willingness to pay for the conservation of ecosystem services for water regulation in the semi-arid. The negative for the WTP was (22.1%). The monthly value presented in the preference of the population to promote the environmental conservation of

the ecosystem services of water regulation in the Pontal River basin, was R\$ 10.00 (26.4%). Another factor that caught the attention in this study was the result of the alternative DON'T KNOW on the monthly amount to be paid chosen by (27.4%) of those interviewed in the basin territory. They did not want to reveal the value at that time but showed WTP for the conservation of ecosystem services of water in the semi-arid.

3.3 Perceptions about aspects of ecosystem services of water regulation in the semi-arid

In the moment of application of the questionnaire, it was explained what ecosystem services were and particularly about the services of regulation in a river basin related to water. After receiving the information, the interviewees were invited to evaluate their perception about the environment where they live, then the following question was asked: "Do you think that the Riacho do Pontal river basin provides ecosystem services of water regulation in the semi-arid through the Pontal River?" Of those interviewed (10.7%) said NO, that the river basin does not provide even one type of ecosystem service of water regulation. Others (45.4%) opted the option DON'T KNOW. And (43.9%) said YES, that the river basin provides ecosystem services of water regulation through Caatinga in the semi-arid. Those who said yes were asked if: "According to your understanding, do you think that ecosystem services of water regulation, being conserved through the Caatinga, can contribute to which natural processes in the Riacho do Pontal-PE river basin". (35.6%) of those interviewed indicated that if the Caatinga is conserved it will result in contributions such as water purification in the Riacho do Pontal river basin. Others (7.7%) noted that if the Caatinga is conserved it will contribute to the improvement of the microclimate in the basin. And (15.5%) stated that if the Caatinga is conserved in the basin, it can contribute to all the ecosystem services of water regulation in the area. As shown in Table 4.

4 Discussion

Other contingent assessment studies about the willingness to pay in semi-arid environments (Guerrero-Baena *et al.*, 2019; Petousi *et al.*, 2015) also

analyzed different locations in a river basin, several factors that may affect the economic valuation placed. In this sense, the analysis of the different environmental characteristics that exist in a river basin is enormous, and they address several issues to the area, such as land use and occupation, access to water, pollution, deforestation and diversified services. When applied in the Brazilian Caatinga is a perceptive exercise to understand the determining factors in the use and assessment of a river basin in such a unique semi-arid region, which depends on water to maintain life, culture, and the economy.

Table 4 Perception of ecosystem services in the Riacho do Pontal Basin – PE

	<i>n</i>	%
Do you think that the Riacho do Pontal-PE river basin provides regulatory ecosystem services through the Pontal River?		
Yes	173	43.9
No	42	10.7
Don't know	179	45.4
According to your understanding, the ecosystem services, if conserved, can contribute to which natural processes in the Riacho do Pontal-PE river basin?		
Regulation of the Microclimate	54	7.7
Water regulation (flow)	47	6.7
Flood and erosion regulation	17	2.4
Water purification	251	35.6
Retention of sediments	13	1.8
All quoted	109	15.5

Source: Prepared by the author.

As represented in (Table 2), the uniqueness of the environment presents changes and brings a diverse population with different views of the environment in which they live. This population is complex and has similar characteristics when it comes to the basin and different opinions between them when the variables that differentiate the municipalities contained in this territory are compared. Therefore, in the general demographic data it was found that women are more likely to pay for the ecosystem services of water regulation in the basin, when compared to men. Similarly, the study of (Aguilar; Obeng; Cai, 2018), presents the same relationship between gender. Regarding schooling characteristics, the highest percent-

age was the ones with higher education (undergraduate course) (Table 2), showing an important indicator for the Brazilian semi-arid region. This region is known as a place with few job and education opportunities, since the long periods of drought typical of this region cause the youngest to seek better survival conditions in large urban centers, therefore, abandoning the region and abandoning local customs and traditions related to the land. The results of this variable are also similar to some findings in the United States (Roesch-Mcnally; Rabotyagov, 2016).

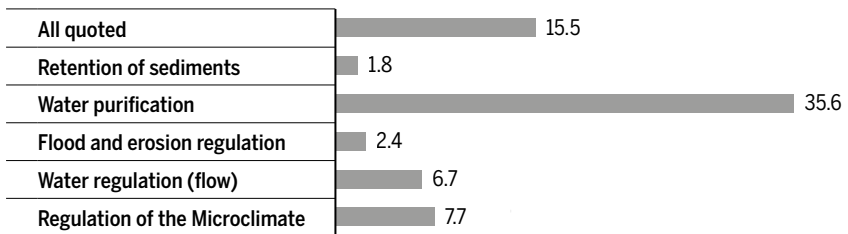
Concerning the age group, the study pointed out that younger people have more WTP for the ecosystem services of water regulation in the basin than older people (Table 2), showing that new generations in the region are more concerned with the issue of water ecosystem services. The WTP of younger people always considers environmental concerns and thinking about the future generations who may need such resources, as indicated in other studies (Forleo; Romagnoli; Palmieri, 2019; Sánchez *et al.*, 2018; Schäufele; Hamm, 2017). The value of the monthly income presented the largest WTP for conservation of ecosystem services of water regulation, which was the range between zero and a minimum wage (Table 2).

This variable was the largest because most of the participants in the interview were young people, who according to the Instituto de Pesquisa Econômica Aplicada do Brasil (IPEA, 2018) are the age group that earns the least and is most vulnerable under social conditions in Brazil. Other studies (Barbier; Czajkowski; Hanley, 2017; Nurmi; Ahtiainen, 2018; Sardana, 2019), pointed out equal conditions in relation to the salary range, showing that people who earn less have greater WTP for conservation of ecosystem services than people who have higher purchasing power. Following, we will present the WTP results that indicated clear preferences for possibilities that produce improvements in water quality in the Riacho do Pontal river basin and in the conservation of Caatinga in the Brazilian semi-arid region. The WTP sample for the conservation of ecosystem services of water regulation in the Riacho do Pontal river basin was positive, as shown in (Table 3), indicating the value of R\$ 10.00 per month. Significantly, the effect associated with the water quality attribute in the WTP was homogeneous in our sample for the basin, as indicated by fixed coefficients.

It suggests that the improvement in water quality had significant and consistent effects on the declared preferences of people living in the basin

territory. Moreover, it suggests, that Caatinga conservation programs can be subsidized by the residents of this territory and can bring benefits to the water ecosystem services in the basin, as shown in (Table 4), according to the declared preferences within the basin. The coefficient estimates are consistent with studies previously conducted (Chaikaew; Hodges; Grunwald, 2017; Chang *et al.*, 2017; Dauda; Yacob; Radam, 2015; Obeng; Aguilar, 2018; Roesch-Mcnally; Rabotyagov, 2016).

Figure 3 According to your understanding, which ecosystem services do you think, if conserved, can contribute to which natural processes in the Riacho do Pontal-PE river basin?



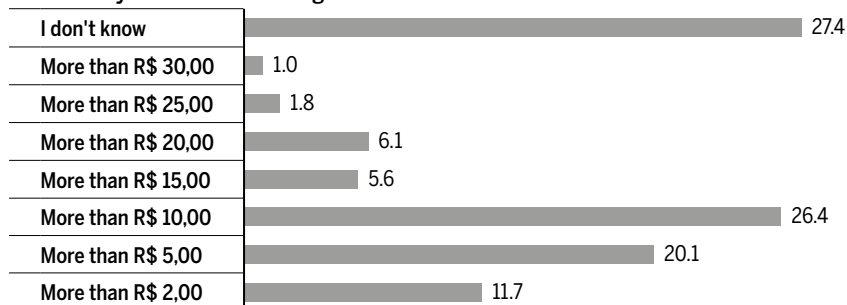
Source: Prepared by the author.

An important piece of information generated in this study was the high number of responses to the WTP's value related to DON'T KNOW alternative, in which many interviewees were willing to pay but did not know what value to assign for conservation of ecosystem services of water regulation in the Riacho do Pontal river basin, choosing the option DON'T KNOW at that time. As shown in (Table 3). Similar findings were observed by (Frey; Pirscher, 2018; Knapp *et al.*, 2018; Portnov *et al.*, 2018; Zawojaska; Bartczak; Czajkowski, 2019). The advantage of providing this option would be to gain information, since its absence would eventually lead people to vote against. In this sense, we have raised some possibilities due to the high number of answers DON'T KNOW. Brazil is going through a very troubled year in its environmental public policy in 2019, especially regarding the preservation of the environment, with scandalous guidelines proposed by the new President of the Republic of Brazil, Jair Bolsonaro. The effect related to the discredit about environmental issues in Brazil, raised by the government, has led people to a condition of non-acceptance of important data and information about the environment. Therefore, people who chose the option DON'T KNOW could be influenced by such statements

of the current Brazilian president. Some studies already point out this trend (Abessa; Famá; Buruaem, 2019; de Area Leão Pereira *et al.*, 2019; Escobar, 2019; Morello *et al.*, 2020). The responses of non-WTP respondents (Table 3) followed a reported negative pattern, which points the payment of many taxes to the government and the unreliability of financial resources in the hands of public agents, as motives for the answer. Interviewees also did not feel obliged to the WTP for signaling that the obligation with the environment, in general, is a responsibility of the State and not of them.

When asked if they were willing to pay for environmental conservation of regulating ecosystem services in the Pontal River, 22% said no. Many of those who said NO were unanimous in reporting that they think the environment and the conservation of ecosystem services of water regulation in the basin are important. Similar responses from non-WTP were also found in the following studies (Chatterjee *et al.*, 2017; Choi; Lee, 2018; Einarsdóttir; Cook; Davíðsdóttir, 2019; Ferreira; Marques; Seixas, 2017). Economic growth generally appears to conflict with ecological protection in Brazil's semi-arid region, which is a region that coexists with water scarcity and urgently needs to seek solutions to its problems of Caatinga conservation and watershed management. In the territory of the Riacho do Pontal river basin there are 72,709 people who fit the profile of economically active people, and who were able to participate in this study. The value of the WTP chosen by the people interviewed indicated the value of R\$ 10.00, which corresponds to 78% of the people who said YES, where it was the preference declared by the study participants.

Figure 4 How much are you willing to pay to promote the environmental conservation of the ecosystem services of regulation in the Pontal River?



Source: Prepared by the author.

Considering a preliminary estimate, if all the people who fit the profile of economically active people within the basin contribute with the value of R\$ 10,00 / month per person, it would gather the value of R\$ 727.090.000 per month. This value could be used for actions of conservation of ecosystem services in the river basin, and to improve considerably the level of ecosystem services in the Brazilian semi-arid.

5 Conclusion

Information was provided on social, environmental, and economic characteristics in a watershed in the largest and most populated semi-arid basin on the planet. The information was regarding the ecosystem services of water regulation in the Caatinga biome, which presents a diversity in its ecosystem with many ecosystem services. In this study, the focus was on the issue of water, since it is the one that presents the biggest concern in this region.

After the analysis of socio-demographic and behavioral variables, it became evident that environmental attitudes significantly influenced the results of WTP and dominated these effects. Constructs that capture values and perceptions of the basin residents about the water ecosystem services, did not affect preferences for WTP. From the present study, it can be concluded that the willingness to pay varies according to the age of the economically active interviewees. Although older people are more attached to the place they live, they have little environmental awareness and are the least willing to pay for the maintenance of ecosystem services in the basin. Younger people, on the other hand, have a greater environmental awareness and are more willing to pay. This work showed that it is possible to maintain ecosystem services through a simple contribution in the amount of 10 reais by the economically active population. However, the interest and effectiveness of management for the conservation of the Pontal basin on the part of government officials is highlighted. Undoubtedly, positive environmental attitudes deserve greater consideration by decision makers, especially if the goal is to make these programs widely acceptable.

The index of people who answered "I don't know" to the question about the willingness to pay for the regulation of ecosystem services was quite considerable, representing 27.4%. From this, we can conclude that an action needs to be carried out with the population, aiming to awaken

in people the environmental value and how important preservation is, not only the maintenance of life in the present, but also aiming at the future.

It should be noted that the information in this study becomes relevant, due to the analyses of searches made in the Scopus and Web of Science journal/article banks. The searches conducted focused on studies of valuation of ecosystem services in hydrographic basins in the semi-arid region of Brazil and no articles have been dated in journals crowded with the above-mentioned bases. Moreover, in more general databases such as Google Scholar – Google Acadêmico, there are 5 (five) papers in conferences focused on bibliographic research on the theme of valuation, relating it to ecosystem services in the semi-arid.

Finally, it is important to state that the method of contingent assessment applied here may have some limitations when identifying more complex aspects in the ES analysis. The method allows only analyzing one scenario in detail, instead of several potential scenarios concerning environmental compensations, particularly in the context of environmental changes. Therefore, it is recommended the development of additional analyses to deepen several aspects related to WTP, environmental changes (how a change in environmental quality affects payments), and social preferences of economic valuation of ES in the semi-arid.

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