OWA AGGREGATION TO DETERMINE THE WATER EQUILIBRIUM PRICE IN THE TANCÍTARO AREA

José M. Brotons, Ruben Chávez, Gerardo **Ruiz** Sevilla

Abstract **- The growth of the population in the world requires a greater demand for all resources to satisfy food needs. As expected, water is the main element for developing production processes. This situation is dire in The Tancítaro peak, located in Michoacán (Mexico). This region is one of the highest producers of avocado, a plant whose water requirements are very high. The natural resources are the same, year after year, and the water requirements are becoming higher and higher. It is not only a question of availabilities; it is also a question of quality. The main problem is that the native people who inhabit the high basin are the actual water owner and are getting without this essential element. This paper aims to solve this problem by proposing the payment for the use of the water to reduce its consumption and provide funds to improve the quality of the water. As no market exists in the area, we want to create an artificial market using the willing to pay methodology combined with the Ordered Weighting Average (OWA) and with the level of confidence assigned to each expert. Due to the level of uncertainty inherent in the experts' answers, fuzzy logic will be beneficial to deal with this uncertainty. The results obtained show an equilibrium price of $ 0.5650 $ m-3. We want to point out that these are preliminary results, and the main objective of the work is to present a methodological proposal.**

Keywords **- OWA, Water demand function, Water supply function, Willingness to accept, Willingness to pay.**

I. INTRODUCTION

The growth of the population in the world requires a greater demand for all resources to satisfy food needs. Studies estimate that the population will increase from 7.9 billion to 10.9 billion inhabitants by 2050, with their highest growth in developing countries. It is to suppose that the associated effect is the intense exploitation of natural resources in agricultural production (UN, 2019). As expected, water is the main element for developing production processes, which is contaminated with agrochemical agents. The growth of fertilizers went from 14 million tons in 1950 to 177 million in 2010 [1]. The previous leads to creating management mechanisms for Ecosystem Water Services focused on establishing strategic planning in economic and environmental matters, within a context to generate the necessary conditions, based on organizational policy, to achieve comprehensive and sustainable development [2, 3]. The Tancítaro Peak is located in the west-central region of Michoacán, Mexico. Due to the economic growth and the development, effective management of the environmental services is required as well as rational use of them. It is predicted that by 2030 several large hydrological regions will be found in a critical condition [4]. In Mexico, there is a severe crisis caused by deficient water management, aggravated by both high rates of deforestation and the loss of the Ecosystem Water Services (representing a country's forests and jungles) [5,6,7].

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The economic valuation of water resources plays an essential role in demand and distribution management. Optimized management of water resources requires decisions based on economic efficiency, social equality, and, above all, ecological sustainability. In addition, the values of water resources depend on the quality, location, reliability of access, and availability, among others [7].

The state of Michoacán stands out for its fruit production, mainly Hass Avocado (Persea Americana). Back in the eighties, the total percentage occupied by fruit trees was only 42%, representing 21,241 ha, and by 2009 the percentage increased to 55% (103,602 ha). Followed by the production of blackberry (Rubusfructicosus), more than 12,390 hectares are cultivated. The state contributes 10% to the national agricultural Gross Domestic Product (GDP). Agriculture represents 7% of the total state's GDP, establishing itself as the main economic activity in some regions and municipalities [8]. In Michoacán, there is a planted area of 169,939 ha, from which 64,808 hectares are irrigated, and 105.13 hectares are rainfed. The total production is 548,150 tons per season [9], and since 2018, the great economic growth has generated a positive impact on the regional economy, increasing the producers' income, as well as direct and indirect employment [10]. According to De la Tejera et al. [11],

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more than 47 thousand direct and 187 thousand indirect jobs have been created since then. To sum up, this activity generates annually around $ 30,265,787.40 [12]. These orchards consume about 1,800 l/plant/month. Consequently, a hectare of avocado containing 156 trees can consume up to 5.2 times more water than the same area of a natural forest with a density of 677 species per ha. The growth of orchards and their economic benefits forces the change from forest to agricultural land and the intensive use of agrochemicals [13]. In Mexico, the lack of updating in the pesticide catalogues allows the existence of a registry of 111 pesticides, prohibited in other countries, used for the cultivation of potatoes, corn, lemon, chia, and mandarin, bringing with it, environmental damage and of health for farmers and consumers [14]. Without neglecting the effects of the environment associated with climate change caused by increased temperatures on the planet, with records in the period 1983-2012 as the warmest years in the last 1,400 years, which represents a global linear trend between terrestrial temperatures and Oceania of 0.85 ° C [15].
The region of the Tancítaro peak, with an elevation of 3,800 m., is one of the most important hydrological regions in the state due to the production of avocado, whose main destination is exportation. The municipality of Tancítaro is part of this avocado strip [16]. The avocado is the source of the development for approximately 39,783 inhabitants, distributed in 81 towns and communities. This region is one of the most important producers in the country [17]. Here, about 30 million m3 of water are reported annually, thus benefiting the inhabitants' agricultural activities and domestic use [16]. The overexploitation and devastation of the forests have provoked the reduction of water availability for agricultural uses. It is expected that the water valuation improves the use efficiency of the water [16, 17, 18].

From an economic logic, the resources' exploitation implies the scarcer the resources, the higher the price would have to be paid for their use. Then, the objective will consist of assessing the economic contribution to irrigation in agricultural systems through the payable provision for the obtained benefits [19, 20]. Several methodologies have been used to valuation environmental goods, such as the willingness to pay (WTP) or to accept (WTA), contingent valuation, travel costs methodology, or hedonic prices, among others. In general, these methodologies are based on the user's opinions, in which it is not possible to introduce subjectivity. Several studies have addressed the willingness to pay for water, such as [21] concerning the Savegre River in Costa Rica, where the cost per opportunity methodology was applied [22], focusing on the Yamuna River, New Delhi. In Mexico, Soto [23] used the contingent valuation method to estimate the benefits of the comprehensive project for the sanitation of Alto Atoyac in Puebla [24], in the Apatlaco River, calculated the WTP to improve the water quality of the Apatlaco river basin, or Rodríguez and García [25] studied in the Guayalejo Basin in the south of the state of Tamaulipas.

We are aware of the difficulty that entails making this type of assessment. On many occasions, the responses portray a wish rather than an opinion. In other words, a water buyer tends to indicate a low price when interviewed to avoid paying a higher actual price in the future. For these reasons, we believe that the introduction of subjectivity will make it possible to express opinions in a better way. As a result, the use of Fuzzy Logic is proposed for better treatment of subjectivity. Furthermore, the paper will introduce a methodological proposal for quantifying the equilibrium price of the water, employing Fuzzy Logic, particularly in aggregating subjective information. The use of fuzzy logic introduces a better treatment of the expert's opinions allowing them to graduate. However, it has not permitted the graduation of the respondent's optimism or pessimism degree so far. A widespread aggregation method is the ordered weighted averaging (OWA) operator introduced by Yager [26]. The OWA operator and its extensions have been used in various applications [27-32]. In this work, given the increasingly pressing water shortage in the Tancítaro area, we propose to approximate the price that could apply if the public administration makes the necessary improvements to ensure availability for farmers in the future. For this purpose, experts representing the stakeholders have expressed their opinions through linguistic labels in an artificial market created to determine the equilibrium price. Furthermore, the use of fuzzy logic allows better treatment of the information provided by the experts. Finally, the use of OWAs and the confidence assigned to each expert allows graduation of the results according to different degrees of optimism or pessimism.

II. MATERIAL AND METHODS

Next, we will proceed to estimate the water demand and supply curves, whose intersection will allow obtaining the equilibrium point.

A. Water Demand Function

In order to estimate the supply curve, a group of J experts has been selected and asked about their willingness to pay a series of prices for water to ensure water availability in the future. The experts are administrators of hydraulic

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resources (CONAGUA) and Organismo Operador de Aguas (OOAPAS) municipal of Tancítaro, Michoacán. In the same way, we have tested the willingness to accept for the people who had the water availability in the reservation area. Prices have been presented in ascending way, so that . If experts agree to pay for the water use, they will be asked if they are willing to pay $ m-3. If they are not, the final price would be 0 $ m-3, and if they are willing to pay , they would be asked for his willingness to pay for a price . If the answer is negative, the maximum price would be and if it is positive, they would be asked for the next price and so on. Given the subjectivity in each answer, it is accepted that the respondent does not respond with a dichotomous answer (yes / no), but rather that they do so according to linguistic labels such as totally disagree, strongly disagree, disagree, etc. (Table I). Each of the table elements will be assigned a membership function (from zero to one, according to it).

Table I. Values Assigned to the Linguistic Labels

Linguistic labels	μ_j
1: Totally agree	0.00
2: Strongly agree	0.20
3: Agree	0.40
4: Disagree	0.60
5: Strongly disagree	0.80
6: Totally disagree	1.00

From this information, it is possible to obtain the water demand function. For this purpose, three different aggregation methodologies have been used: i) arithmetic means, OWAs, and aggregation according to the confidence degree assigned to each expert.

A.1. Using Arithmetic Means

The first aggregation will suppose that all the experts are equally important. All the experts will have to answer a questionnaire about the price they are willing to pay (WTP). The prices will be ordered from lower to higher, and the interviewee will express the degree of agreement with each price using linguistic labels from table I.

We will use the following algorithm:

Step 1. Willing to pay prices. The price that expert j (WTP_j) would be willing to pay for water can be obtained as:

$$WTP_j^1 = \sum_{i=1}^{P} \Delta P_i \cdot \mu_{ij}$$

Being μ_{ij} the membership function assigned by expert j to price i and $\Delta P_i = P_i - P_{i-1}$, that is, the increase that occurs in each new price provided to the expert to express his willingness to pay, over the previous one. In this way, a series of prices have been obtained representing the price that each expert would be willing to pay

$$WTP^1 = \left\{ WTP_1^1, WTP_2^1, ..., WTP_p^1 \right\}.$$

Step 2. Willing to pay weights. All of the J experts have the same weight ($1/J$).

Step 3. Water demand function. The demand curve is constructed from a series of points whose abscissa $P = \{P_1, P_2, ..., P_P\}$ are the prices initially provided to the experts and the ordinate axis of each P_i, $\mu^1(P_i)$ are the number of experts who did not were willing to pay a price equal to or higher than P_i divided by the total number of experts who have answered the enquiry (J):

$$\mu^1(P_i) = \frac{n_i}{J}$$

B. Assigning Different Degrees of Optimism and Pessimism, based on the Opinions Provided by Experts Through OWAs.

An ordered weighted average (OWA) is defined as a mapping of dimension n, $F : R^n \rightarrow R$ that has an associated weighting vector W of dimension n, $W^T = [w_1, w_2, \dots w_n]$, such that

$$w_j \in [0,1] \text{ and } \sum_{j=1}^{n} w_j = 1, \text{ with}$$

$$f(a_1, a_2, \dots a_n) = \sum_{j=1}^{n} w_j \cdot b_j$$

Where b_j is the jth largest of the a_i.

The essence of OWA [26] is the rearrangement of the elements or arguments, causing aggregation in the a_j not associated with a weighting w_j but with the placement order instead.

For obtaining the water demand function, the following algorithm is proposed:

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Step 1. Willing to pay prices. It is the same as in 2.1.1
Step 2. Weights of each willing to pay. We will assign 1 to the expert who provides the lowest opinion, 2 to the second-lowest, etc. To ensure that the sum of the weights equals to 1, we will have to normalize them by dividing them by the total sum. As a result, the expert's weight who has the jth lowest opinion is $2j/((J+1)J)$. This value can be weighted by an α factor representing the degree of optimism or pessimism. The highest positive α values correspond to a greater optimism degree, and the lower α values (even negatives) represent a higher pessimism degree.

$$\omega_j^p = \left[\frac{2 \cdot j}{(J+1) \cdot J}\right]^{\alpha}$$

Once again, we have to normalize the weights, ω_j^p, and the final weights are

$$\omega_j = \frac{\omega_j^p}{\sum_{j=1}^{J} \omega_j^p}$$

Step 3. Water demand function. The demand curve is obtained combining for each price presented to the experts (P_i), abscissa axis, the sum of the experts' weights for whom we have calculated a WTP equal to or higher than the price, P_i.

C. According to the confidence degree of each expert.

The following algorithm has been followed:

Step 1. Willing to pay prices. It is the same as in 2.1.1
Step 2. Weights of each willing to pay. The weights are obtained from the confidence degree allocated to the experts ρ_j^* (from 0 to 1). To ensure the sum of weights equals one, we have to normalize them by dividing them by the total sum of confidence degrees.

$$\rho_j = \frac{\rho_j^*}{\sum_{j=1}^{J} \rho_j^*}$$

Step 3. Water demand function. This function will be constructed from the abscissa points $P = \{P_1, P_2, ..., P_P\}$, that is, from the prices provided to the experts, and the ordinate axis will be the sum of the weights of the experts who have obtained a WTP price equal to or higher than the correspondent price:

$$\mu^3(P_i) = \sum_{j=1}^{J} \rho_j \,/\, WTP_j \geq P_i$$

A.4. Aggregated Water Demand Function

The aggregate water demand function will be obtained weighting the three previous water demand functions obtained using arithmetic means, OWA and confidence degree or probabilities.

$$\mu_i^D = \alpha\mu^1(P_i) + \beta\mu^2(P_i) + \gamma\mu^3(P_i),$$

with $\alpha, \beta, \gamma \geq 0$ and $\alpha + \beta + \gamma = 1$

Where α, β and γ are the importance allocated to the arithmetic mean, OWA and probability water demand function, respectively.

B. Water Supply Function

The Pico de Tancítaro is made up of 16 hydrological basins together, representing 678.1 km2(62.998ft2). Although they are not large water bodies, instead, they are low flow runoff between 100-200m3s-1, underground hydrography and permeability are media. So, users take advantage of the water through retention or deep excavation. Thus, due to the great demand for avocado water concerning other fruits such as red fruits (blackberry and blueberries) in the avocado strip, the study focuses on users of the Upper Basin and users of the Lower Middle Basin of the Pico de Tancítaro. As a result, we have proceeded similarly to obtain the supply function. We will use three alternatives considering that all experts have the same importance, using OWAs to assign different degrees of optimism and pessimism, and depending on the degree of confidence generated by each expert.

On this occasion, they would be asked about the price they will be willing to receive for the resource. In this case, the increase indicated in the expression (1) refers to the price reduction provided to the experts in each phase.

C. Equilibrium Price

The intersection of both curves defines the equilibrium point. The equilibrium point will be defined by a price and a membership function. The former price will be the maximum value that a farmer will be willing to pay to obtain water and the minimum that the owner of the resources (inhabitant of the protected areas) will be willing to receive for share water resources.

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III. RESULTS

A. Water Demand Function

A group of 10 experts (farmers, managers of agricultural companies, etc.) were asked about their willingness to pay to ensure a good water quality supply in the future. In particular, a portion of these payments will be assigned to the treatment and protection of the water, especially their quality. Answers are shown in table II, indicating the expert number, their confidence degree and the degree of acceptance of each price. For instance, expert two indicates that he agrees to pay 0.75 $ m-3, he strongly disagrees to pay 0.9 $ m-3, and he totally disagrees to pay 1.05 $ m-3 of water. This linguistic label and their confidence level are similar to the ones used in Brotons & Sansalvador [33]. As an example, the obtention of the willingness to pay of expert two is shown:

$$WTP_2 = 0.15\cdot 1 + 0.15\cdot 1 + 0.15\cdot 1 + 0.15\cdot 1 + 0.15\cdot 0.8 + 0.15\cdot 0.4 + 0.15\cdot 0 = 0.78$$

Here, the value of the linguistic label (0,0.2, 0.4, …) is multiplied by the increase of price for each column (0.15 € m^{-3}).

Table 2. Willingness to Pay of Each Expert Ranking and Confidence Degree

		Willingness to pay								
Expert	Confidence	0.15	0.3	0.45	0.6	0.75	0.9	1.05	WTP	Order
1	0.60	1.0	1.0	0.8	0.4	0.0	0.0	0.0	0.48	6
2	0.40	1.0	1.0	1.0	1.0	0.8	0.4	0.0	0.78	3
3	0.30	1.0	1.0	1.0	1.0	0.8	0.6	0.2	0.84	2
4	1.00	1.0	0.6	0.2	0.0	0.0	0.0	0.0	0.27	8
5	0.90	0.4	0.2	0.0	0.0	0.0	0.0	0.0	0.09	10
6	0.40	1.0	1.0	1.0	0.4	0.2	0.0	0.0	0.54	5
7	1.00	1.0	1.0	0.8	0.2	0.0	0.0	0.0	0.45	7
8	0.50	1.0	1.0	1.0	0.8	0.6	0.2	0.0	0.69	4
9	0.20	1.0	1.0	1.0	1.0	1.0	1.0	0.7	1.005	1
10	0.70	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.12	9

Weights allocated to each expert are shown in Figure 1. Using arithmetic mean, all the experts present the same weight, 0.10. However, considering the OWA methodology, experts with higher willingness to pay have been overweighed, and those with lower willingness to pay underweighted. As a result, the higher weights are for experts two, three and nine whose willingness to pay are 0.78, 0.84 and 1.005, respectively. These weights have been obtained using expressions (4) and (5), and proceeding similarly to Sansalvador & Brotons [34]. The weights using probabilities are assigned according to the confidence degree. So, experts with higher confidence degrees, four, five and seven, present the highest weights (0.1667, 0.1500 and 0.1667).

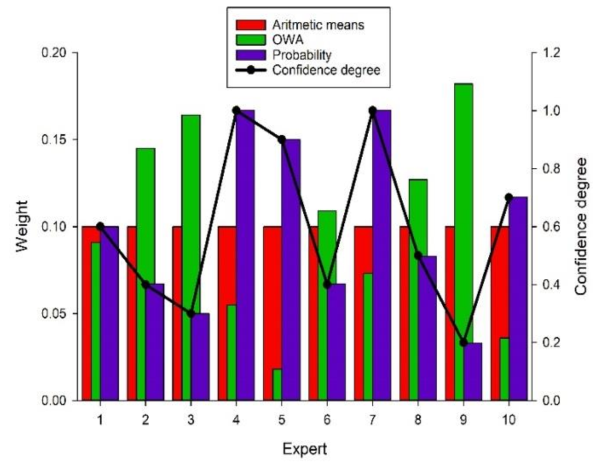

Fig 1. Weights for willingness to pay

Membership functions are shown in Table III for each methodology: arithmetic means, OWA, and probability. The membership of each methodology has been obtained by adding the weights of the experts who have obtained a price equal to or lower than the indicated in the first column. For instance, the membership of the arithmetic means, as all present the same weight (0.10), the membership for the WTP 0.15 € m^{-3} is obtained adding the weight of the eight experts for whom the willingness to pay is lower than 0.15. In this case, eight experts, so $\mu = 0.10\cdot 8 = 0.80$. In the case of the OWA, the membership function for the second WTP (0.15) is obtained as:

$$\mu_{OWA} = 0,0909 + 0,1455 + 0,1636 + 0,0545 + 0,1091 + 0,0727 + 0,1273 + 0,1818 = 0,9455$$

For the probability, the membership of the WTP 0.15 is obtained similarly:

$$\mu_{Probability} = 0,1000 + 0,0667 + 0,0500 + 0,1667 + 0,0667 + 0,1667 + 0,0833 + 0,0333 = 0,7333$$

And the aggregated value (average) is obtained allocating a weight of 0.2 to the arithmetic mean, 0.3 to the OWA and 0.5 to the probability, obtaining a value of 0.8103. Similar aggregation methodology has been used in works such as Sansalvador & Brotons [35] where a new method for the economic evaluation of the ISO 9001 certification was developed. Figure 2 shows the aggregated water demand function using the arithmetic mean, OWA, probability and the aggregated. This figure gives the inherent subjectivity present in the information provided by the experts. For instance, the price of 0.6 € m^{-3} has a membership function for the OWA curve of 0.62, whereas the probability is only 0.23 € m^{-3}.

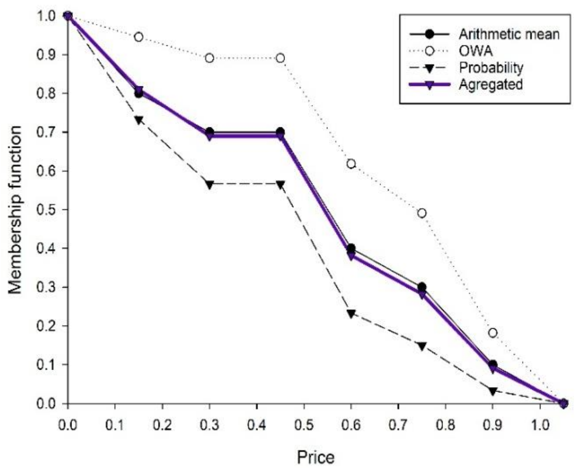

Fig 2. Water demand function.

B. Water Supply Function

In this case, 10 inhabitants of the high basin of the river (the people who have the right to the water) about their willingness to accept a cubic meter of the water belonging to them. A portion of these payments will return to their community in improvements. The answers are shown in Table III.

Table Iii. Willingness to Accept, Ranking and Confidence Degree

		Willingness to accept								
Expert	Confidence	0.15	0.3	0.45	0.6	0.75	0.9	1.05	WTP	order
1	0.8	0.0	0.2	0.4	1.0	1.0	1.0	1.0	0.69	5
2	0.8	0.0	0.0	0.0	0.2	0.4	0.8	1.0	0.36	9
3	0.9	0.0	0.0	0.0	0.0	0.4	0.6	0.8	0.27	10
4	1.0	0.2	0.2	0.8	1.0	1.0	1.0	1.0	0.78	4
5	0.0	0.0	0.2	0.4	0.6	0.8	1.0	1.0	0.60	6
6	0.7	0.0	0.0	0.0	0.0	1.0	1.0	1.0	0.45	7
7	0.6	0.0	0.2	0.2	0.4	0.6	0.6	1.0	0.45	7
8	0.1	0.2	0.6	0.8	1.0	1.0	1.0	1.0	0.84	3
9	0.3	0.8	1.0	1.0	1.0	1.0	1.0	1.0	1.02	1
10	0.2	0.2	0.6	1.0	1.0	1.0	1.0	1.0	0.87	2

According to the answers in Table III, the weights of Figure 2 has been obtained. In the same way, as in the water demand function, the weights for the arithmetic mean methodology is 0.10 for all the experts. In contrast, for the OWA methodology, the highest is for the experts who provide higher values, in this case, the second, the third and the seventh. The weights for the probability methodology are related to the confidence degree allocated to each expert, in this case, the fourth and the third.

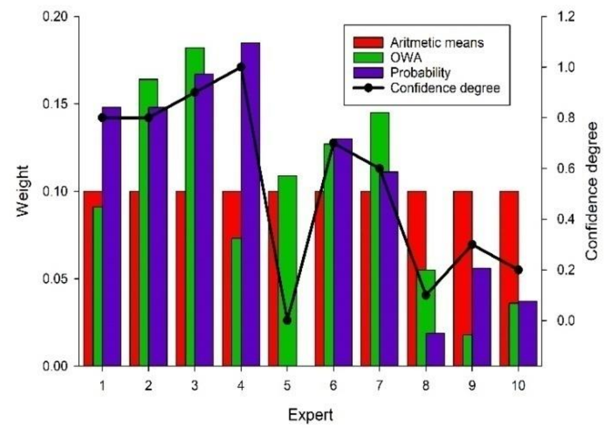

Fig. 3. Expert weights for willingness to accept

Finally, assigning weights (0.2, 0.3, 0.5) to (α,β,δ), that is, to the memberships obtained by each of the three methodologies (arithmetic mean, OWA and probability), it is possible to obtain the membership function of a weighted average). The four supply functions are represented in Figure 4. As in the water demand function, the membership of each function provides a wide range. For instance, for 0.45 € m^{-3}(0.013ft^{-3}) the probability function presents a membership of 0.56, whereas the OWA curve 0.20.

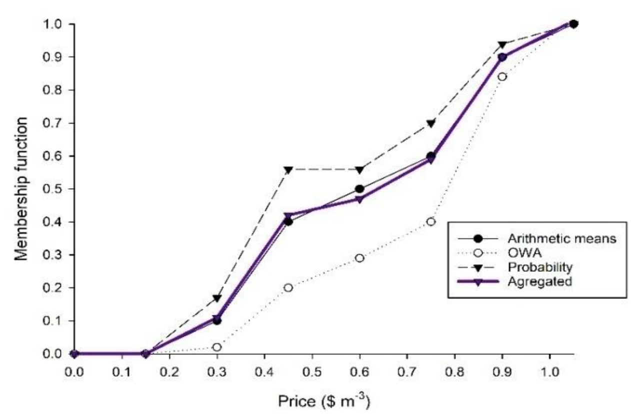

Fig. 4. Water supply function

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C. Equilibrium Price.

Figure 5 shows the equilibrium price of the water as a result of the intersection of the previously calculated demand and supply functions. The equilibrium price presents high doses of subjectivity because of the aggregated operator chosen. In this paper, we have taken the intersection.

This intersection allows obtaining an equilibrium price of \$0.5650 m^{-3}(0.016ft^{-3}), with a membership function is 0.4540. The shape of these supply and demand curves depends on the attitude towards risk of the experts consulted [35]. It should also be noted that a greater membership function of the price obtained indicates weaker preference uncertainty.

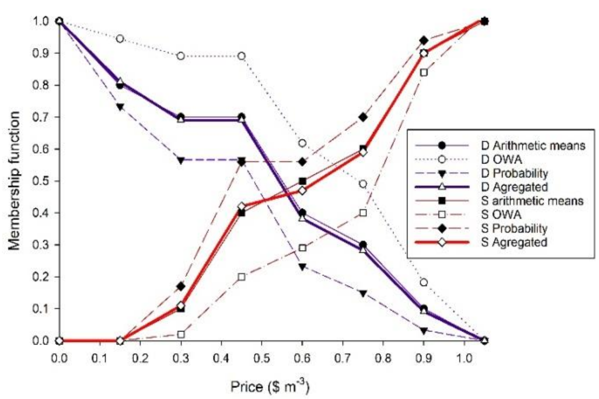

Fig. 5. Equilibrium price from water demand functions (D) and water supply functions (S)

The obtained results are in line with those obtained by Rodríguez and García [25]. They analysed the water services payment in sugar cane in the Guayalejo Basin Tamaulipas, concluding that the price of water could be \$ 0.39 m^{-3}(0.011ft^{-3}). On the other hand, Chávez and Mancilla [35] proposed a water rate applied to water users in the Pixquiac River, in Veracruz, Mexico, for which the opportunity cost method was used to assign value to the forest, obtaining a price of \$ 0.473 m^{-3} (0.0134ft^{-3}) (see Figure 2). Other works show different willingness to pay, mainly due to the peculiarities of each area. For example, Barrantes [37] in the Savegre river in Costa Rica applied the cost per opportunity methodology and obtained a value of US \$ 0.0010 m^{-3}(0.000028ft^{-3}). In Mexico, Rodríguez and García [25] studied in the Guayalejo Basin in the south of Tamaulipas, how they benefited from the water coming from the "Heaven Biosphere Reserve, obtaining \$ 0.39 m^{-3}(0.011ft^{-3}). Finally, Chávez and Mancilla [36] proposed a water tariff applied to water users in the Pixquiac river in Veracruz, obtaining a value of \$ 0.473 m^{-3}(0.0134ft^{-3})

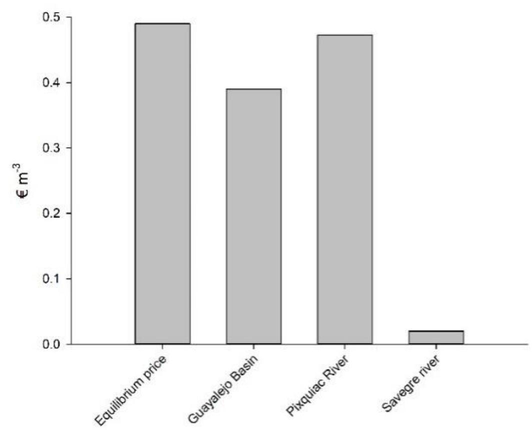

Fig. 6. Comparison prices

It should be noted that the application of this methodology has allowed determining the equilibrium price through the willingness to pay and willingness to accept. Furthermore, the use of linguistic labels allows the experts to express their opinions more naturally, and as a result, the estimation will be more accurate.

The introduction of OWAs allows graduation the final result according to different degrees of optimism or pessimism in the model. Furthermore, the introduction of probabilities to each expert can improve the estimation quality because not all experts deserve the same trust, either because of their knowledge or because of their interest in obtaining favourable results.

We are aware that it is only an approximation, mainly because, on numerous occasions, experts indicate their willingness to pay. Something quite different is what they would do if they had to pay. Therefore, the introduction of fuzzy numbers and OWA extensions should improve the accuracy of the estimation.

IV. CONCLUSIONS

The main objective of this work has been to determine an equilibrium price for water in the Tancítaro area using both the willingness to pay and the willingness to accept. Several aggregation methods have been used, considering the high doses of uncertainty inherent in the responses. Experts from the lower and middle basin areas (densest strip of avocado as the fruit with the highest water consumption) have been selected for the willingness to pay. On the other hand, to obtain the willingness to accept, inhabitants of the high basin (protected area) have been required to express their opinions and interest of those who directly experience the effects of ecosystems and low water retention in the area. They believe that all the efforts made by government authorities to maintain balance and protect ecosystems are valuable. As currently, it is carried out by the Purépecha Region of Cherán, Michoacán, where the organized community is implementing public, social, economic and environmental policies (indigenous peoples) autonomously in search of recovery of native natural areas and their ecosystems [15].

The aggregation methods proposed have been the arithmetic mean, OWAs and probabilities. In the first method, all the experts have been considered with the same weight, in the second, the experts providing the highest opinions have been allocated with higher weights, and finally, in the third one, the weights have been constructed using their confidence degree that we have allocated each one according to their experience or the level of knowledge.

The fuzzy logic has been introduced in how the experts express their opinions, using linguist labels. This methodology increases the model's flexibility since it allows the experts to answer in a dichotomous way (yes or no) and graduate their opinions.

According to classical theory, the intersection between the supply and demand functions provide the equilibrium price. Still, the level of uncertainty is high, and the equilibrium price obtained from the average water demand and supply curves can increase or decrease. In subsequent work, we will deal with the wide range of possibilities. In addition, we want to point out that this is preliminary work, and we have used only probability OWAs and means. Still, we are working on applying some OWAS extensions to the water demand and supply, such as induced OWAs. Anyway, the use of intuitionistic fuzzy numbers, and hesitant fuzzy numbers, will improve the quality of our research.

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