

# Water Pricing Schemes for Water Saving Conscience

María Gabriela Contreras Hernández<sup>1\*</sup>, Wang Hongwu<sup>2\*\*</sup>

\* College of Environmental Science and Engineering, Tongji University, Shanghai 200092, China email: mgch15991@hotmail.com

DOI: 10.29322/IJSRP.9.05.2019.p8984

<http://dx.doi.org/10.29322/IJSRP.9.05.2019.p8984>

**Abstract-** The Urban Water Service requires the adoption of a tariff system that recovers the costs of water resources and the establishment of individual national water-pricing policies that help to achieve sustainable water use. Also, water rates (tariffs) can be used as an auxiliary tool for consumption control, seeking efficiency and sustainable resource use. In this research, the study of Bolivar State (Venezuela) different regional, social, economic, political and climatic aspects is presented, analyzing the behavior of consumption of domestic water during the period September 2018 to March 2019, in order to check whether the current rates conform to the state of resources and the objectives of the Urban Water Service and Industry, and furthermore, develop the main objective of this investigation that is a Customized Sustainable Water Pricing Scheme, that includes financial criteria, economic criteria, and above all, environmental criteria, to create specific guidelines that can help to correspond the local contextual factors of water supply and demand. The main conclusion of this work is that Venezuela, invests in the water sector is very sporadic, reflecting the fluctuations in oil prices, also, water billing its subsidized by the government and cost recovery is not considered as a priority; the perception achieved through this study is worrisome because the system slightly covers the water service; altogether there has to be an urgent reformation of the water pricing schemes in order to make it industrial and environmentally sustainable. The critical conclusion and recommendation focus on the rearrangement of the current guidelines, by implementing new technologies, transparency in water measuring, transforming from a fixed rate to an Increasing Block Tarif, and including community reeducation.

**Index Terms-** water tariffs, water sustainability, water governance, Venezuela.

## I. INTRODUCTION

Water is a necessity for human life and a prerequisite for people's wellbeing. Drinking, cooking sanitation and many more domestic as well as industrial processes depend on this resource. The access to clean water and sanitation is also reflected in Goal 6 of the Sustainable Development Goals set by the United Nations. However, many parts of the world face water scarcity. It is even expected that water will be the driver of future wars. This situation strongly calls for sustainable use of water. Including water conservation, ensuring safe and quality supply and justice allocation.<sup>(1)</sup>

A commonly accepted tool for the management of water consumption in households is the implementation of different water pricing schemes. These base on the assumption that, according to their willingness to pay, consumers will respond to higher prices with a reduction of their consumption.

Setting the price for water goes beyond the rules of supply and demand. Water price policy includes more targets, which can be roughly summarized within three.<sup>(5)</sup>

1. Economic efficiency to ensure safe and quality supply of water and prevent wasting
2. Conservation of water to ensure the persistent availability of water resources
3. Justice allocation to guarantee the human right of access to clean water and fair sharing of its cost

To combine those targets in a water pricing scheme is a big challenge for policymakers. It requires sophisticated research taking into account environmental, social, economic, political and climatic aspects.

Water tariffs are applicable at different levels: they can be set either at the service provider level or by national (or local) governments. Tariffs can be categorized in consumer categories and classes, and they can be designed within a policy framework that addresses the needs of the poor.<sup>(9)</sup> Policy makers need to decide which objectives have the highest priority, and where possible, use a range of instruments. Involvement of local communities in the tariff setting process is essential to identify the real, local needs, the costs of providing an excellent quality service, and the best ways to recover the costs incurred<sup>(2)</sup>.

It can be deduced, that countries with Fixed Charge Price Schemes have right now problems with reduced service levels which decreases the will to pay, low tariffs and inadequate income, low investment on infrastructure and human resources, infrastructure deterioration and loss of staff, there's no complete coverage of costs to improve the water standards.

On the other hand, we have countries the Two-Part Tarif Scheme; those countries have adequate water tariffs allow cost recovery, which is very important to assure well-functioning water and sanitation systems, affordable tariffs and improved collections, output based approached to management, interim funding for technical and human capacity. Moreover, those who have Increasing Block Tarif, we can say that they are in-between.<sup>(8)</sup>

In contrast with developed countries where the provision of drinking water to households is overwhelmingly achieved through utilities, access to drinking water in developing countries encompasses many forms. Other forms of provision include direct access to a water source (underground or surface); access to alternative sources of water, typically provided by the private sector (e.g., water tankers, water carts, kiosks, bottled water); and access to piped water through community taps or standpipes. In many countries, households have to rely on more than one of those sources of water. This is the case even for families connected to the public network because of limitations to the services provided by utility companies, which can take many forms depending on the local context: rationing of particular areas; low water pressure; periodic shortages; or leaks in the network <sup>(7)</sup>.

## II. GENERAL OBJECTIVE AND KNOWLEDGE GAP

From the study of different regional, social, economic, political and climatic aspects, at Bolivar State, Venezuela; develop a Customized Sustainable Water Pricing Scheme, which will include financial criteria (cost recovery), economic criteria (efficiency pricing based on marginal cost) and above all, environmental criteria (incentives for water conservation); in order to create specific guidelines that can help to correspond the local contextual factors of water supply and demand.

Based on the water pricing theory and practice at home and abroad, the supply and demand balance analysis of the water quality and quantity should be analyzed and should combine with the relationships between water pricing and water saving. Through analysis and comparison of various water pricing methods, a flexible price system should be established to encourage water saving.

However, despite the considerable effort that has been made on the research of water pricing schemes. The following questions remain unclear and need to be clarified further:

Is there any 'right' water pricing policy and if there is, which one?

Which water pricing scheme is the most efficient? Which one is the most just? Which one is the most environmentally sustainable one?

Which one is the best compromise of all these?

What are the effects of different policies on water saving?

How to value different parameters that need to be considered when designing a water pricing scheme. (regional, social, economic, political and climatic aspects)

How to determine system parameters of different price schemes? (How to determine the lifeline threshold. How to determine excess consumption threshold? How to set prices in particular?)

## III. RESEARCH DATA

The objective of this theoretical framework is to provide the concepts related to WPS in correspondence with the approach of the problem. In this way, an approach to the research background was made, then concepts of WPS and relationship with society were provided, the international and national organizations involved in the subject were mentioned, the impact of water pricing on saving and the regulatory aspects were discussed, and the main stakeholders in Venezuela were counted in. Likewise, some references are included about the national and international legal framework, agreements and laws concerning the problem.

As a selection from different prices schemes, we briefly present the most important regarding the research concern. These represent standard tariffs that have been used for a long time in many countries as well as models that have been recently implemented and are being tested <sup>(3)</sup>.

- Fixed charge FC: The bill does not depend on the quantity of water consumed.
- Uniform rate UR: All units (cubic meters) are priced at the same rate, independently of total consumption.
- Increasing block tariff IBT: The marginal rate increases with the block.

The criterion suggested by the American Water Works Association is to design and evaluate conservation pricing with effective communication of the price signal through consumer billing <sup>(4)</sup>. To influence water demand, conservation pricing must be understood by customers. Households should be able to estimate changes in their water bills because of increases in water usage. Many Florida utility companies describe their water rates on their websites and through newsletters to their customers. However, this information is often limited. For example, the survey of customers of sixteen Florida utilities, conducted by Whitcomb (2005), showed that 39 percent of respondents are not knowledgeable about water rate structures (i.e., number, size, and prices of the blocks). At the time of the survey, only five of the sixteen participating utilities printed their water rates on their bills, which partially explain this lack of customer knowledge <sup>(3)</sup>.

## IV. GENERAL INFORMATION ABOUT THE RESEARCH ZONE

Venezuela is a Federal Republic located in the northernmost part of South America, northern hemisphere, in the middle of the intertropical zone, closer to the Equator than of the Tropic of Cancer. It is relatively close to some of the centers of the economic and political decision of North America and with a geographical position of easy access by sea to markets in Central America, North America, Northwest Europe, and South America. <sup>(6)</sup>

Currently, the minimum salary in Venezuela is meager compared to other countries. Not to mention the inflation that the country's economy is suffering. With the current exchange rate of Bolívar, it is hard to compare the salary of a dollars, euros or yuan month base, however.

Unquestionably, the price of the dollar in Venezuela (official), is the value resulting from the DICOM exchange rate in the auctions. However, in the country, there is the price of the parallel dollar (unofficial market), which is traded between individuals and companies, given the shortage of foreign currency. <sup>(4)</sup>

The Bolivar state has an area of 240,528 km<sup>2</sup>, which represents 26.24% of the national territory, limits to the North separated by the Orinoco with Delta Amacuro states, Monagas, Anzoátegui and Guárico; to the South with the Republic of Brazil and the State of Amazonas; to the East with the state Delta Amacuro and the Zone in Claim that separates us with the Republic of Guyana and to the West with the States of Apure and Amazonas. With a population Census 2011: 1,413,115 <sup>(10)</sup>

The Potable Water and Sanitation Service (AP and S) in Venezuela have been framed in the public area and the entities or servers, of these network services, have been formed by State Owned Enterprises (EPE).

*Table 1 relationship between water payments and water reception*

<b>Water reception</b>	<b>Average price (Bs/\$) month/unit</b>	<b>Average consumption per day</b>	<b>Average consumption per month</b>	<b>Total monthly bill</b>
<b>Residential (fixed rate)</b>	29/0.009 month	900L	27,000L	29Bs / 0.009\$
<b>Social Tariff (fixed rate)</b>	11/0.003 month	450L	13,500L	11Bs / 0.003\$
<b>Tankers</b>	500/0.15 1m <sup>3</sup>	230L	6,900L	3,500Bs / 1,05\$

The cost of production of domestic water m<sup>3</sup> is 370 bolivars, therefore what they pay does not cover the production of the service, the fundamental basis of autonomy is in the adequate collection of the provision of services so that the company covers a reasonable percentage (higher than 70%) operating costs.

As we can deduct from table 1, rates do not cover the costs of the service, and this affects the high-water consumption per capita: 400 liters per day LPD average, while the International standard tends to 200 lpd.

## V. FINDINGS

Below are the results obtained from the investigation, as well as its analysis. From the application and analysis of the survey, several points could be determined. In this way, a decoded information derived from the application of the instrument is presented. In principle, a detailed summary of the obtained answers organized by categories of analysis referred to the analysis of the categories.

- I. Household Information
- II. Opinion About Water Administration
- III. Environmental Commitment
- IV. Use of Water in the Household

Under them, a series of new sub-categories emerge from the analysis of the exposed summary, in conjunction with inferences generated by the most typical characteristics observed in the information collection process.

Category I: Household Information

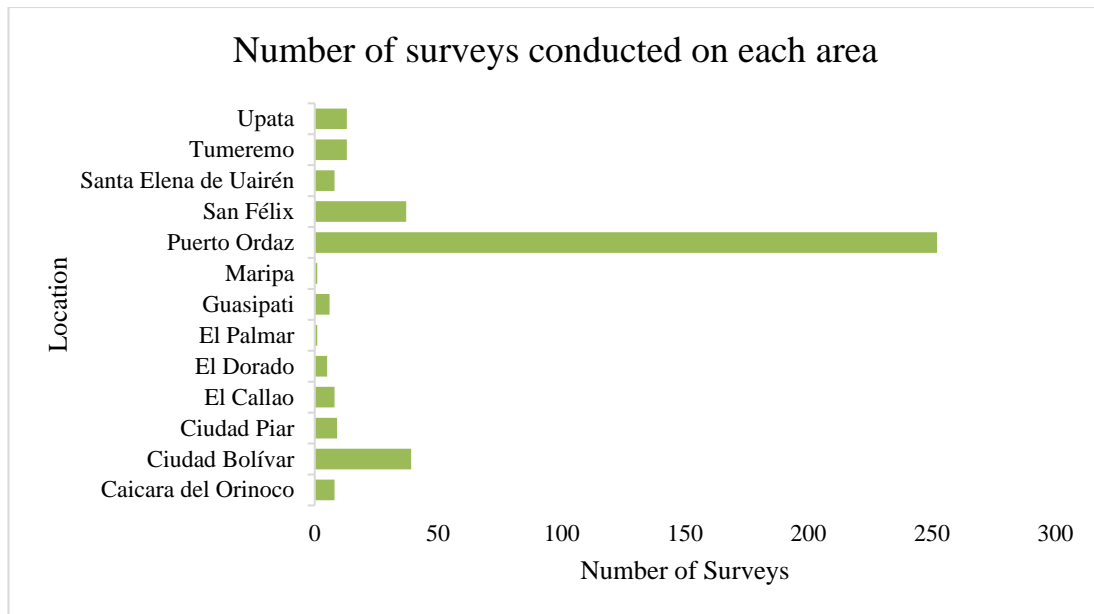


Figure 1 Number of surveys conducted on each area

We can observe that most of the sample taken was in the cities of Puerto Ordaz with 252 surveys (63%), San Felix with 37 (9.3%) and Ciudad Bolivar with 39 (9.8%), these cities are one of the most developed and planned cities in the state, thus this would mean that most of the survey results will have access to clean and direct water.

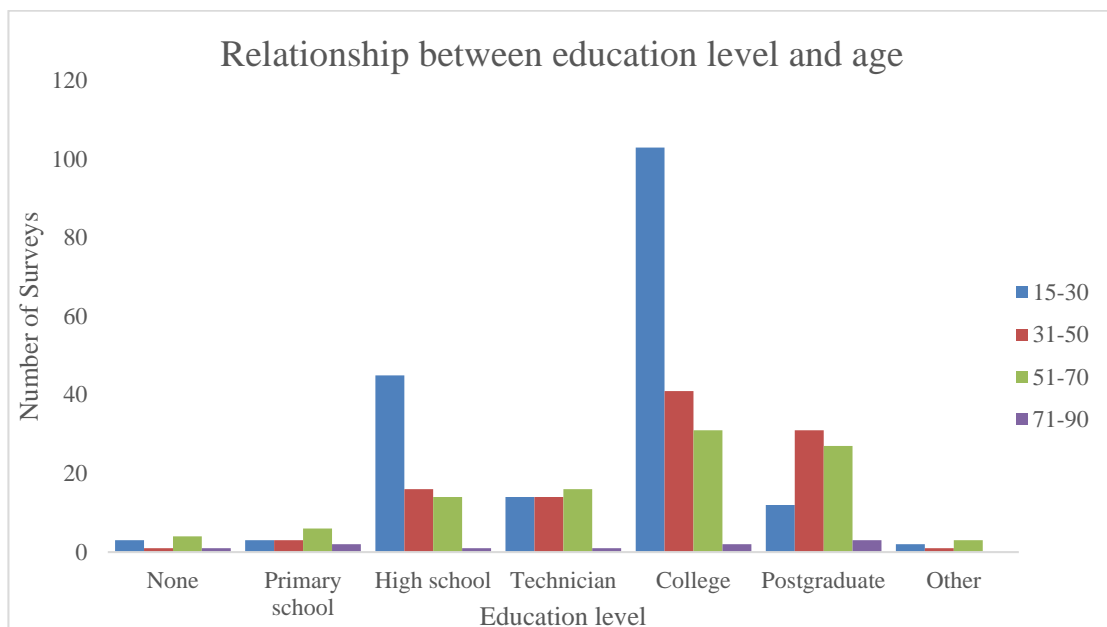


Figure 2 Relationship between education level and age

As we found the younger and middle-aged population was the most interviewed, from 15 to 30 years old, the surveys went up to 182 (45.5%), and the highest education level we can see is a college with 177 (44.25%) and followed by high school. This relation is directly linked to the previous sub-category since we can observe that most of the sample were literate, university and even reaching postgraduate level due to their closeness to the planned city standards, even regarding the age mainstream that was young between 15 and 30 years old. Among the “other” education levels we could find on a doctoral thesis, civil aviation.

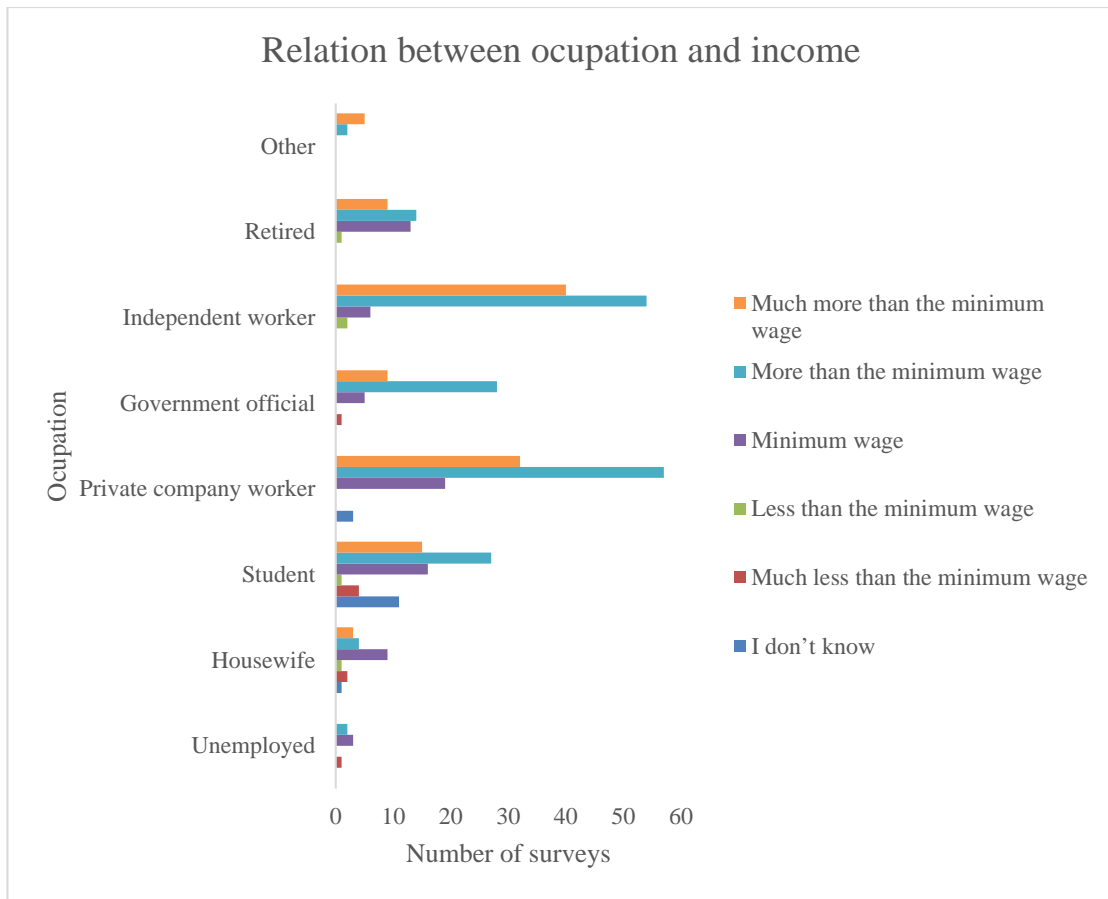


Figure 3 Relation between occupation and income

We can relate this time occupation, that has 111 (27,75%), with total income in the household that is more than minimum wage reaching 188 (47%) surveys, followed by more than minimum wage. This is one of the most essential items in the research due to its direct relationship with the pricing of water, and how is money spent in the household regarding this subject, most of the surveys were taken as a household compound so we can observe that as a compound the majority of the interviews work or study, just a small quantity is employed, however the vast majority has an income more superior than the minimum wage in the country of approximately 5.46\$, but this counts as the summation of all the salaries at home.

Category II: Opinion About Water Administration

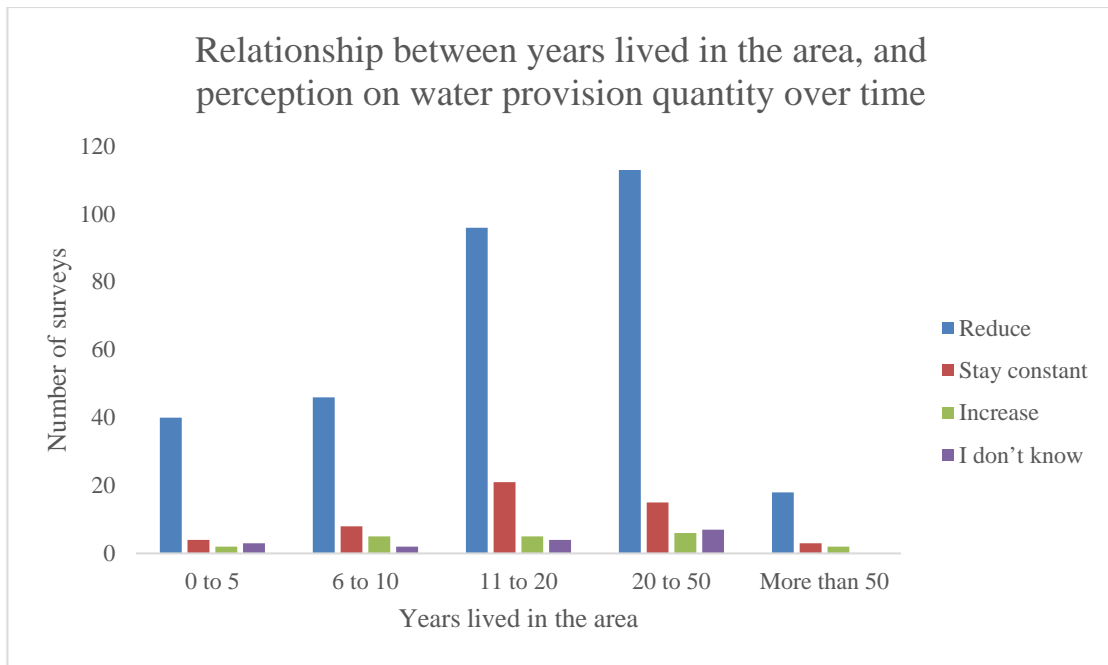


Figure 4 Relationship between years lived in the area, and perception on water provision quantity over time

Here we can observe the relationship between the years lived in the area that was mostly from 20 to 50 years with 141 (35,25%) surveys followed by 11 to 20 years, and the perception on water provision that was mostly tended to reduce with 313 (78,25%) surveys, followed by “remained”. This can explain how people that have lived fewer years in the do not know or do not consider that water provision has reduced, but on the other hand, regarding of the time lived in the area most of the people agree that the water provision has tended to reduce. This is a real problem because, on the concern of water billing, the population will mostly think it is not worth what they pay on the water billing, so, regarding this research, they will tend up to waste probably more water when the service it is active.

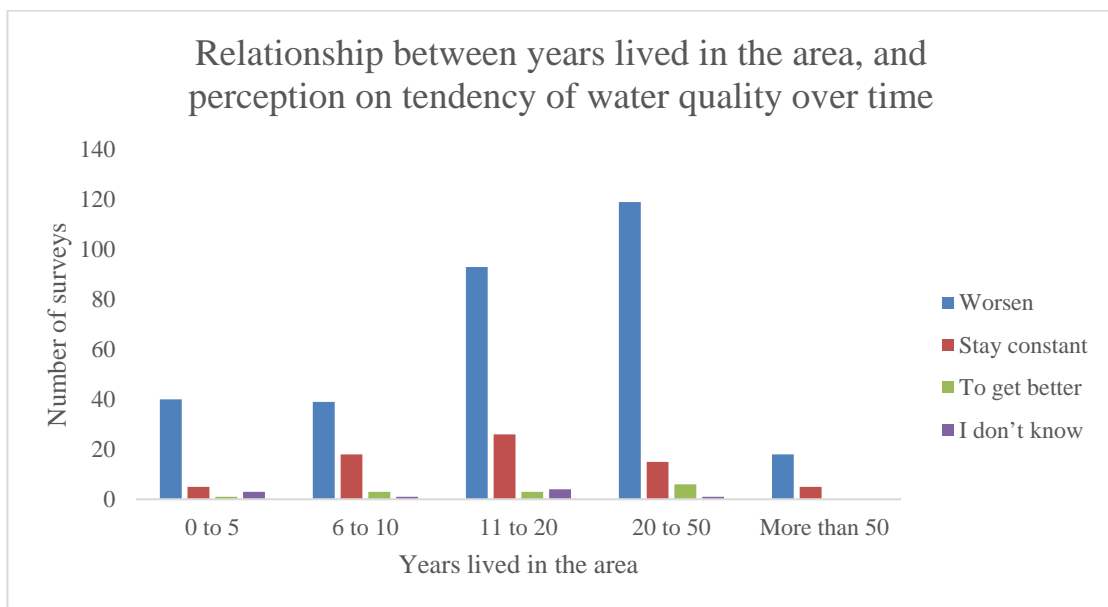


Figure 5 Relationship between years lived in the area, and perception on tendency of water quality over time

As the previous sub-category, we can see that most of the surveys had that the years lived in the area exceeded 11 years, also this time in relation with the quality of the water service the majority of the answers leaned to say that it has worsened with 309 (77,25%) disregarding the time lived in the area. Also, this remarks a problem in the community, not only for the water billing per se but also for the household health, if their health is compromised by the water quality, then the total household income will be depreciated, and at the end, it will end up trying not to pay over the billings.

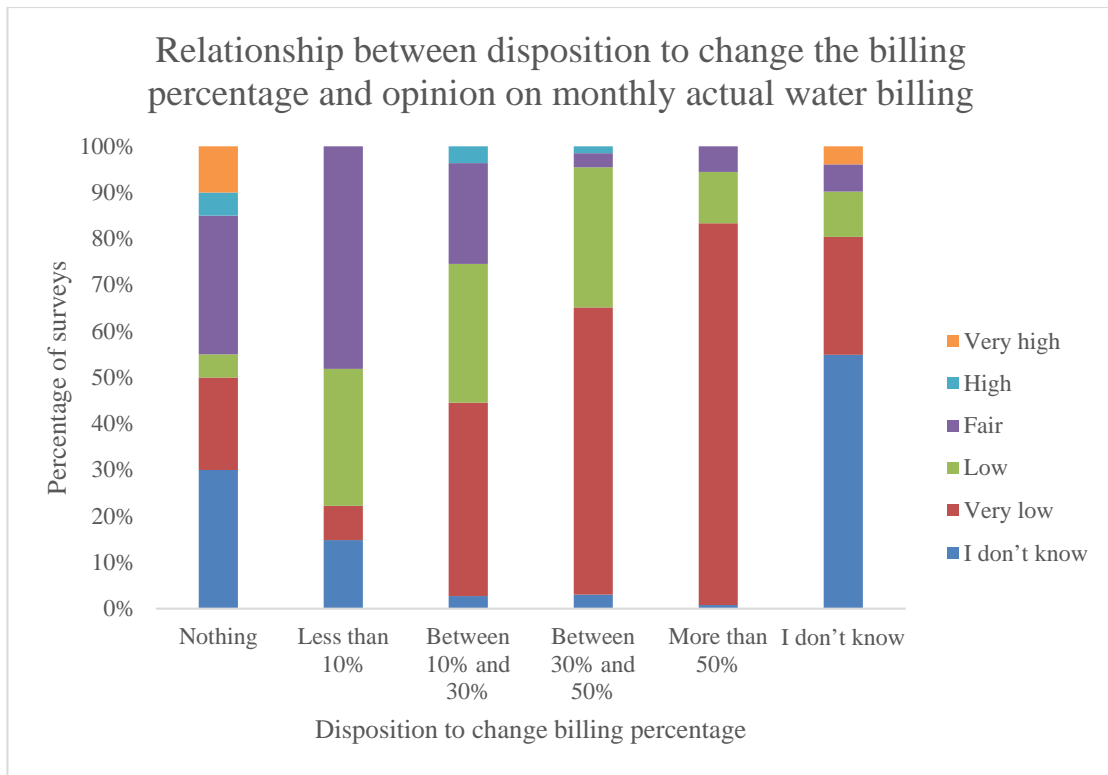


Figure 6 Relationship between disposition to change the billing percentage and opinion on monthly actual water billing

It could be assessed that population, in general, believe that the water billing is very low with 210 (52,5%) surveys, followed by the ones who also think it is “low”; this, related to the fact that also most of them believed that the water billing should increase in more than 50% with 126 (31,5%) surveys, we can deduct that the population might be considering that one, water quality and quantity depends on water billing, and this is the reason why they believe that by increasing the rates the water provision and quality will rise in conjunction, or two, they have an environmental consideration and know that water has to be highly billed so people can have consciousness of what they spend.

### Category III: Environmental Commitment in the Household

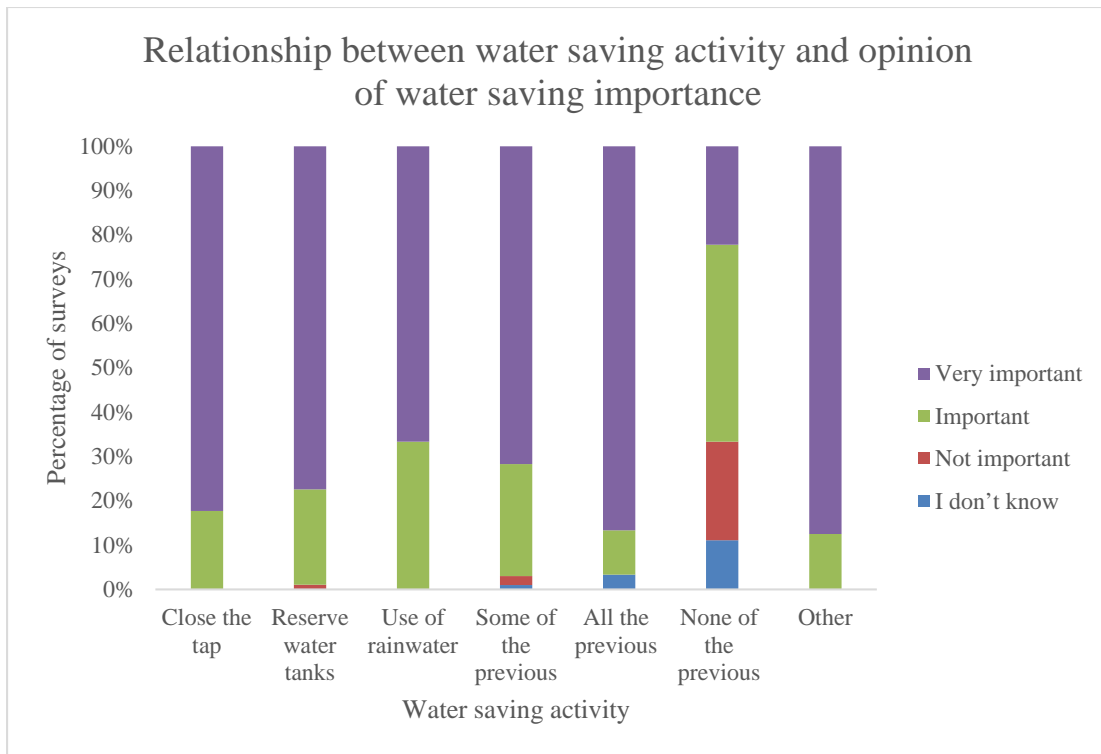


Figure 7 Relationship between water saving activity and opinion of water saving importance

Here we can observe an astonishing 310 (77,5%) surveys that believe that water saving it's imperative, this takes us to the linked category, thus, if the household considers that water saving its essential, even if they are not educated about it, it will be easier to introduce a new concept or practice a different water administration regarding water sustainability. So, the linked category is that most of the people, do the water saving consciousness or maybe for lack of water supply regularly close the tap with 158 (39,5%) in total, followed by the reserve of water tanks.

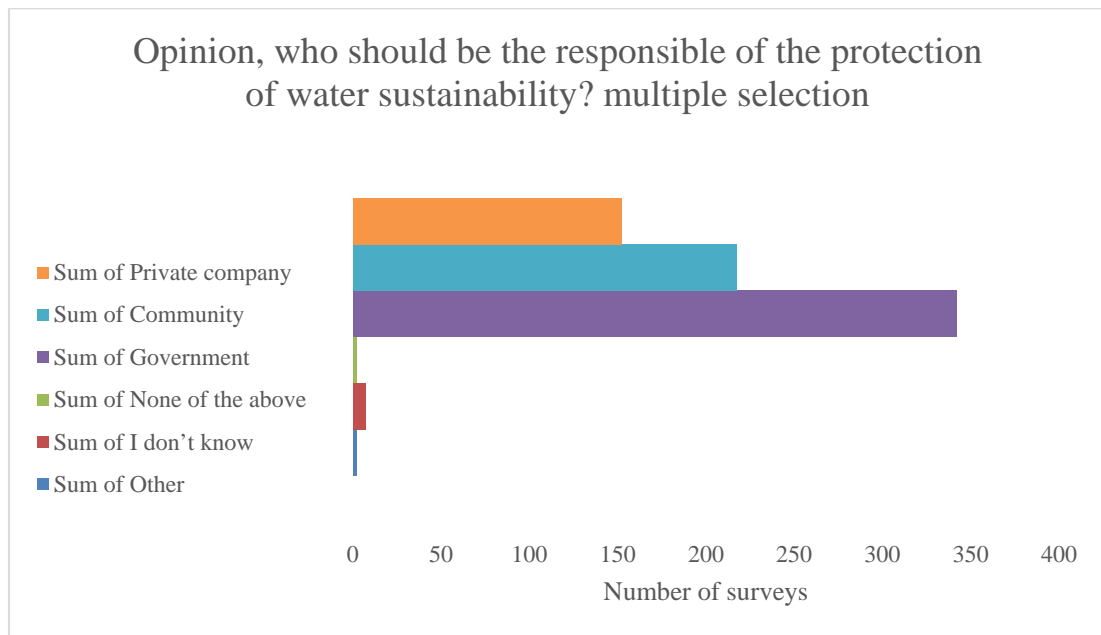


Figure 8 Opinion, who should be the responsible of the protection of water sustainability? multiple selection

Despite the meager participation on water saving programs, people still believe that the water sustainability issue should be a matter for a conjunctive work between Government, Community, and Private company, giving more weight of responsibility to the government with 342 (85,5%) surveys among the multiple-choice statistic. Between the "other" answers were, Hidrobolivar, Hidroguayana.



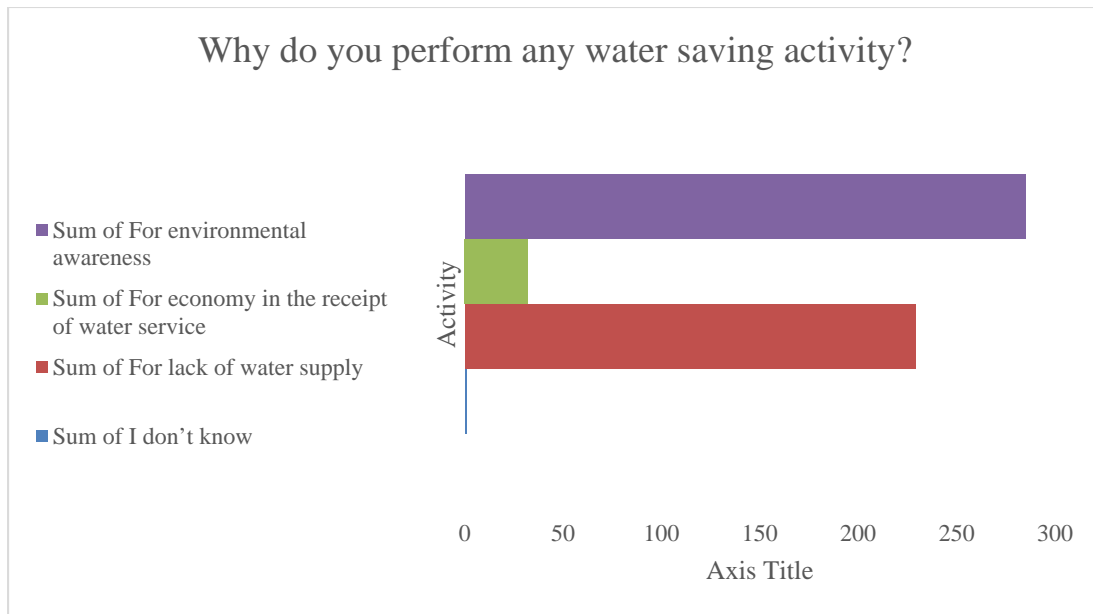


Figure 9 Why do you perform any water saving activity?

When asked about why do they perform water saving activities most of the people (in a multiple selection statistic) said that it is for environmental awareness, this could be true due the fact and intertwined of the previous answers that were mainly leaned to water saving, however we have to take into consideration that very carefully after this choice, they also considered that the lack of water supply is a primary factor for water so it can be deducted that despite there is a significant percentage of water sustainability consciences, there is still a problem of supply that directly affects peoples manage of water, and that, if in the direct future this problem is solved, people might stop saving water. Between “other” solutions where was, The bath rate downloads only necessary., I try to save water by taking a bath and doing the dishes, Repair of faults in the domestic system, Use pots that use less water, have washing machines that use less water, use water with awareness in day to day, Conscious use of water, Reuse water, Not have water, Rational use, the excess water from the washing machine is collected to be used to lower the toilet.

Category IV: Use of water in the household

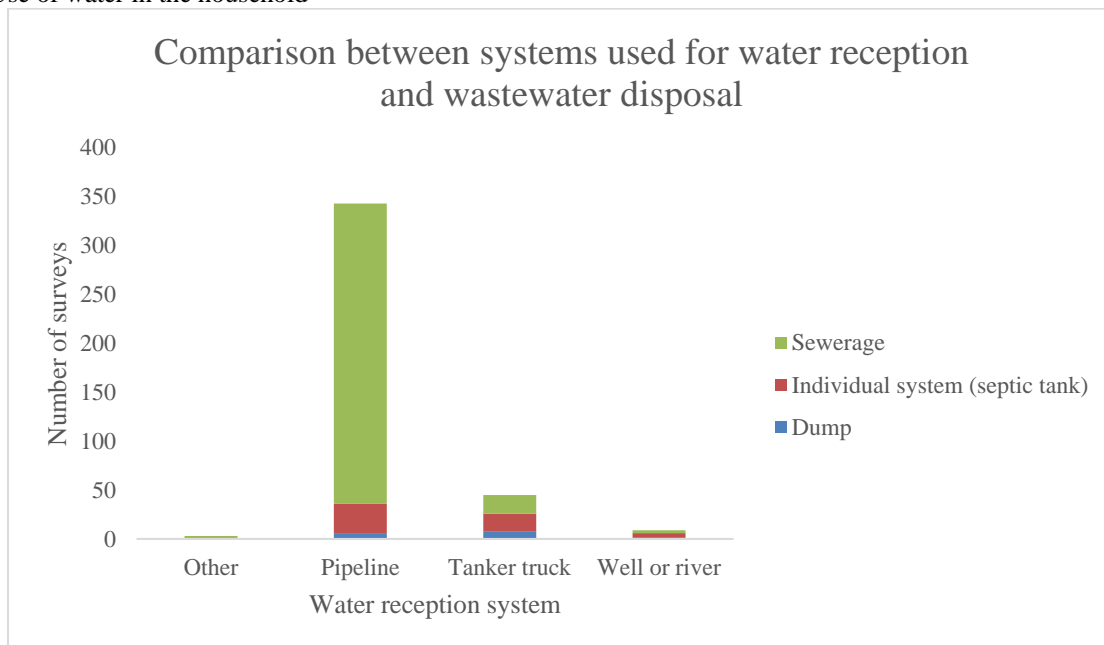


Figure 10 Comparison between systems used for water reception and wastewater disposal

As we pointed out in the first category (household) most of the people possess the direct pipeline water service to their houses 343 (85,75%) surveys and also the sewage system of disposal with 331 (82,75%), this is related to the fact that most of the surveys where in the city, however, there’s still a large number of household that has the septic tank and tanker truck system, which sometimes is more

expensive to maintain than the direct one. Between “other” answers about water, receptions were, Buy a bottle, Water filters, Boiling water.

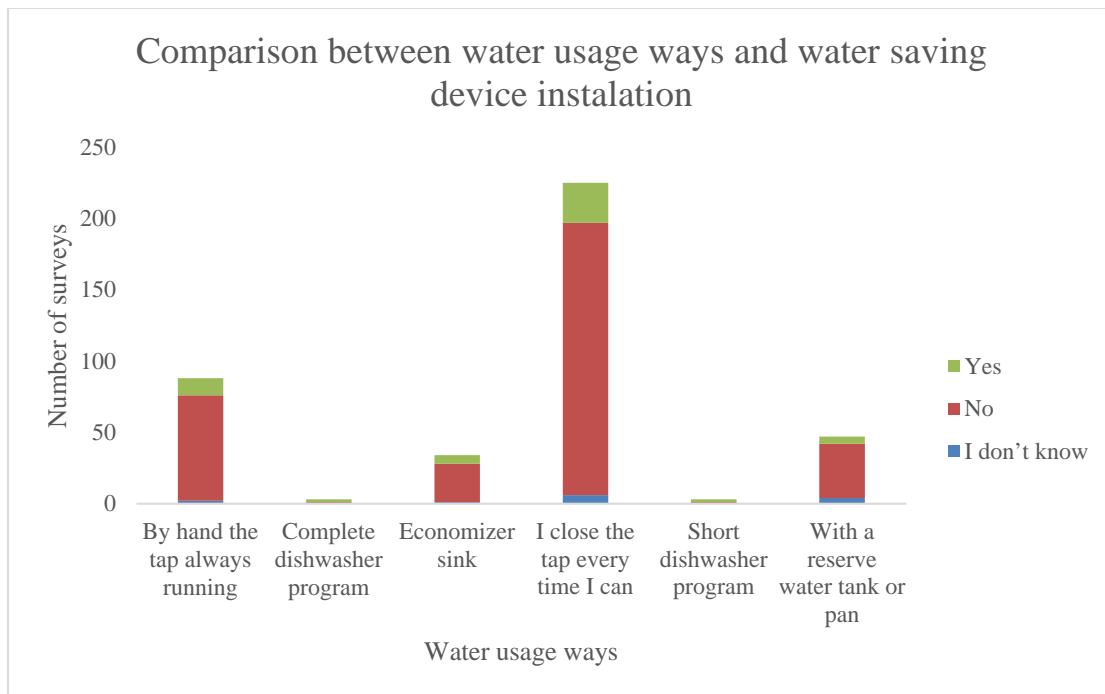


Figure 11 Comparison between water usage ways and water saving device instalation

In this case, we can see that most of the interviewees do not have a water saving device with up to 332 (83%), this is worrisome because it is directly linked to the disposition an individual or group has to invest part of their household income in a water saving strategy. At the same time we notice that most of the people, despite not having water saving systems, they apparently create their ways to save, like closing the water tap every time they get when they are washing, with up to 225 (56,25%) and other solutions like using a reserve water tank or pan.

## VI. ANALYSIS

The respondents are people from Bolivar State, where the majority live in the metropolitan area, and smaller groups live in adjacent rural areas. However, they are all located in the area where the water is supplied by pipes of the city’s hydraulic system.

Likewise, the survey displays a large amount of working age population, in a 15 to 50 y/o range with a bachelor degree and active independently or in the private sector, suggesting that the housing market corresponds to recently build compounds or apartments, possibly acquired with own income as skilled workers or given by the previous generation, taking into account that 50% defined themselves as householders and another 50% as direct family members.

This salary range is above the minimum wage established by the Venezuelan Law and, even when it is one of the lowest among the continental region, it still allows respondents to have access to modern home appliances, e.g., water tanks, water ozonizers and other commodities.

Among the family group, the study reveals that most of its members work and that the income is distributed among itself. It is also important to mention that the surveyed families have been living in this location for many years, leading to a strong opinion on how the water supplied has improved or worsen along the years in their zone.

When the political opinion is consulted, results show a big part of the surveyed defined themselves as Moderate, but it is thought that this is to avoid political labels due to the nowadays polarized environment in the country. The survey was designed to identify political slants and its possible effect as well as to encourage solutions since the first could conceal facts on service performance over personal preferences.

About the price of the water supply service, a significant number of the ones polled consider that such price is too low in comparison to the investment needed to ensure the supply; but even though results indicate that most of the population consulted is not willing to pay for adjustments over 50% in their bills, this might be caused by the perception of not receiving an improvement in the service at a short-term period.

It is worth mentioning that none of the respondents seemed to have received proper material, studies, courses or lectures about sustainable water usage, indicating that the topic is absent in most of the levels of the educational system and the information of public management. There is a trend that shows how people interested in supporting sustainable initiatives is, but the methods to achieve this might not be clear for most, forcing vague answers such as “closing the tap,” without knowing other water saving mechanisms.

Even when the ones surveyed have heard about water saving ideas from public offices such as the City Halls, Ministries, and other departments, the majority thinks that the responsibility of a rational water use is directly related to public entities of the State, even though a considerable amount of people think the private sector also has an essential share of responsibility in the issue as well.

When consulted which of the activities is thought to be necessary for the area water savings, the answers are heterogeneous, leading to the conclusion that there's no particular preference, but it does prove that the polled has particular knowledge of projects and plans implemented in the community and suggests that knows at least the basics of the presented options, knowing how to distinguish it from one another. This may prompt the main reason to apply such initiatives is due to environmental awareness, followed by the constant adaptation people has as a consequence of unreliable water supply or water scarcity.

Also, 90% confirmed that pipelines are the primary system used for water supply, and just a small percentage said water is provided by tanker trucks. This implies that even when there is a considerable amount of people living in rural areas, most of the population still enjoy proper aqueducts in the outskirts of both cities, yet people spend some time-saving water in tanks due to rationing, adapting their daily routine to the supply schedules in the less-favored areas. In the most impoverished zones, access to water is more limited, and its population pays more for the supply of tankers or water wells.

Most of the housing options have 1 to 2 bathrooms, and by collating this to the percentual graph of the number of family members versus the number of bathrooms, a correlation seems to be found. Accordingly, the relation of the number of family members and the times of toilet discharge shows an average of 6 to 8 times per person, meaning there is directly proportional interaction.

The frequency of showers taken per person per day shows a pattern of 6 to 10 weekly; the meaning is common to shower once a day. The periods used for the showers reveal a consistent 6 to 10 minutes among most of the ones polled.

Water usage for dental care averages typical dentist's recommendation of 3 times a day and even cases are taking more times a day than this, suggesting great importance to healthy habits in this group.

#### SUMMING UP

Water supply service must attend different factors: institutionalizing the supply companies, regain skilled personnel to manage them, proper infrastructure maintenance and adequate investment in equipment and the before mentioned aspects. The goal is to achieve a water supply service that fulfills the following features:

1. Continuity: an uninterrupted supply with minimal fluctuations.
2. Quality: water flow that satisfies national and international sanitary standards accordingly (industrial use, residential use).
3. Equitable: proper server for all the regions of the country, both urban and rural.

## VII. CONCLUSION

The conclusions of the analysis can be summarized in three significant aspects, from the which also present the strategies that are considered appropriate for the overcoming the problems raised, as well as the policy instruments who can support such strategies, the type of investments needed, the activities that it is necessary to develop in the short and medium term, and finally the indicators that they are considered more appropriate to measure the results of the proposed actions:

### The management of the resource

Although the country began many years ago actions, if they want to be advanced in natural resource management issues, due to various deterioration situations institutional and financial, these initiatives were left aside, and currently, the environmental management does not meet the primary objectives to preserve the principles of social equity, economic benefit, and environmental sustainability.

### Adequate and timely availability of water

Venezuela is one of the countries with the highest availability of water resources in Latin America, but its abundance is relative, given the seasonality of it and the intensive occupation of the national territory in areas with less available water resources. This is compounded by the tendency to decrease availability as a result of intervention processes in the upper basins and the increasing contamination of bodies of water. If this process continues in the current trend, there will be a crisis of water availability in the short term in the regions with the highest urban-industrial occupation.

### The infrastructure for the use and control of water resources

Despite having built a large amount of service infrastructure in previous decades, which allowed improving the conditions of public health, the exodus of peasants to the cities, coupled with the abandonment of maintenance programs, caused a collapse of services,

which has not yet been overcome. On the other hand, the fiscal crises that the country has suffered in recent years have consequently resulted in a significant lag of the investments necessary for the full use and control of water resources at the national level.

The proposal is implementing the following conceptual model by linking contextual conditions, implementation, system governance and components of water scheme functionality., call it a “Sustainable WPS.”

The key elements for the development of this Guide should focus on:

1. Criteria to determine the potential beneficiaries (mainly income and valuing others): Government and subsidized water supply industries
2. Procedures (agile, efficient and straightforward) of individualized validation of the beneficiary: import of new technologies with the Venezuelan international relations and to cover at least 85% of the service.
3. Amount of aid (based on affordability conditions): transparency in water measuring and training personnel to deal with the considerable demand for monitoring and evaluation.
4. Methods of economic support (tariff structure, solidarity funds or others): utilize an INCREASING BLOCK TARIFF that rewards water saving and connects population with quantity and scarcity
5. The setting of sustainable objectives and monitoring compliance: long term objectives are in order, also community reeducation and the gradual incursion of the water projects for local action.

#### REFERENCES

- [1] Allen, A., Dávila, J. D., & Hofmann, P. (2005). Gobernabilidad y Acceso al agua y saneamiento en la interfaz periurbana: análisis preliminar de cinco estudios de caso. Cuadernos del CENDES, 22(59), 23-44. Aguas de Mérida. (s.f.). obtained from <https://www.aguasdemerida.com.ve/https://venezuelanalysis.com/analysis/14092>
- [2] Boland, J. J., & Whittington, D. (2000). Water tariff design in developing countries: disadvantages of increasing block tariffs (IBTs) and advantages of uniform price with rebate (UPR) designs. World Bank Water and Sanitation Program, Washington, DC, 37.
- [3] Borisova, T., Asci, S., Unel, B., & Rawls, C. (2014). Conservation pricing for residential water supply. University of Florida Institute of Food and Agricultural Science. Report Number FE756.
- [4] En Gaceta Oficial N° 41.452 derogatoria de Ley de Ilícitos Cambiarios a partir del 6 de agosto de 2018.
- [5] ERM, R. C. (2003). Financing and cost recovery. Thematic Overview Paper. IRC: International Water and Sanitation Centre, Delft, The Netherlands.
- [6] Health in the Americas 2017. (2019). Venezuela (Bolivarian Republic of). [online] Available at: [https://www.paho.org/salud-en-las-americas-2017/?page\\_id=163](https://www.paho.org/salud-en-las-americas-2017/?page_id=163) [Accessed 4 Feb. 2019].
- [7] Le Blanc, D. (2007). Providing water to the urban poor in developing countries: the role of tariffs and subsidies. Innovation briefs, 4.
- [8] Whittington, D. (2003). Municipal water pricing and tariff design: a reform agenda for South Asia. Water policy, 5(1), 61-76.
- [9] Whittington, D., Boland, J., & Foster, V. (2002). Water tariffs and subsidies in South Asia: understanding the basics. Water and Sanitation Program Paper, 2.
- [10] XIV CENSO NACIONAL DE POBLACIÓN Y VIVIENDA Resultados por Entidad Federal y Municipio del Estado Bolívar. (2014). Venezuela, Bolivarian Republic of: National Institute of Statistics INE, General Management of Demographic Statistics Population and Housing Census Management, pp.7-13.

#### AUTHORS

**First Author** – María Gabriela Contreras Hernández, College of Environmental Science and Engineering, Tongji University, Shanghai 200092, China email: [mgch15991@hotmail.com](mailto:mgch15991@hotmail.com)

**Second Author** – Wang Hongwu, National Engineering Research Center for Urban Pollution Control, College of Environmental Sciences and Engineering, Tongji University, 588 Miyun Road, Shanghai, 200092, P.R.C. Email: [wanghongwu@tongji.edu.cn](mailto:wanghongwu@tongji.edu.cn)