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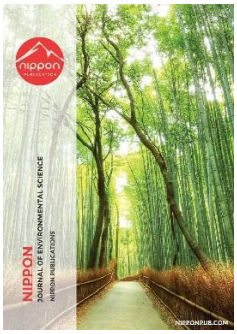

Full Length Research Paper

Management of water resources in a micro-basin of the western region of Mexico

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Abstract. In reference to the evolution of the administration of water resources in Mexico, it is possible to observe variations from centralist models to structures where there is social participation and a certain transparency in the management of resources. This work was developed with the purpose of analyzing the evolution of local water management in the last 25 years by the users of a micro-basin located in the South-Highlands region of the state of Jalisco Mexico. Through the concepts and methodology of the Analytical Framework of Governance, with which the most urgent problem is detected, the actors with the greatest influence, the places of management, the norms or rules of the game as well as the level of social participation in making decisions that affect the quality and availability of water in the study region includes interviews, surveys, and field trips. The results expose: strategic actors with resources and sufficient power to influence decision-making, few management spaces, variability in water rates, social perceptions that express concern about the quality and availability of drinking water, as well as the risks for human health by discharges of untreated wastewater, both from domestic and commercial origin, as well as from livestock farms and industries to the sources of supply of the micro-basin.

Keywords: Highlands of Jalisco, Micro-watershed, Water management

1. INTRODUCTION

In the world, more than 1.1 billion people do not have direct and constant access to safe water. Similarly, more than 2.6 billion people lack basic sanitation facilities, most of these people are in China and India, which highlights flaws dramatic in water management and governance processes at the global level (WHO, 2015).

At the third World Forum (2003) by the Global Water Partnership (GWP), the need to incorporate effective governance models in water management was emphasized, as the institutional failures of governments current water deterioration (UNESCO, 2009). In addition, the United Nations Environment Program (UNEP) has designed water governance models in Latin American countries with institutional problems, including economic support (Mayorga and Cordova, 2007).

In Latin America and the Caribbean, public policies aimed at coordinating actions for the development of mankind, using a river basin as a base of management, have had different approaches, as well as unequal evolution. Since 1990, however the issue has regained its validity once the countries of the region have formally focused on achieving sustainable development by reconciling economic growth, equity and environmental sustainability.

Watershed management is the basis for adequate environmental management in countries (ECLAC, 2010).

In the current times, the themes of opening up to the outside world, such as the globalization of markets, open regionalism, international insertion, foreign investment and free trade agreements, tariff reforms and export promotion, among others, therefore it is of great relevance that each country consolidates management systems for its natural resources, as well as to specify clear treaties and avoid counterproductive interventions, due to lack of management or lack of knowledge (UND, 2014).

Openness to the outside will only be positive to the extent that each country knows exactly the consequences both in its environment, in its society as in its current and future economy. Knowing how to manage and control undesirable aspects at the watershed level is a way to acquire solid negotiating elements.

The management of natural resources at the level of watersheds requires local participation, which can also give space to deal with social aspects, seeking to consolidate a true democracy with class consciousness, to carry out actions of major collective interest, achieving equity among its components. Those who know their environment and only they will know how far it can be intervened without causing damages that lead to an irreversible collapse (Dominguez, 2012).

Contemporary social movements (Genoa 2001; Argentina 2001; water war in Bolivia 2000; Zapatismo in Mexico 1994; Seattle 1999; landless rural workers of Brazil 1985), as well as the terrorist attacks of September 11, the destructuring and restructuring of global capitalism, the spatial reorganization of production, and the diminishing power of trade unions, have shown the evident contradiction between transnational capitalism and territorial forms of government, marketizing the spheres of social life (Sader, 2008).

In summary, there is a general rejection of this "commodification of the world", in favor of the radical democratization of power in the global space, as opposed to the escalation of repression in defense of human rights, from a multicultural perspective, freedoms democracy and democracy itself (Gómez, 2004).

Although there have always been conflicts over water and, considering the gas war in Bolivia (2003), the social movements for water in Cochabamba (2000), the privatization of water in Uruguay (1992), among other events, it can be assumed that the "next world war will be for water" as it is proclaimed by Ismael Serageldin (World bank vice president) (Seoane, 2006). Where the most unprotected communities, especially the indigenous ones (Ecuador, Bolivia, Brazil and Mexico, for example), are increasingly affected by the mismanagement and contamination of this "blue gold", which is water, as well as with dams construction and aquifers overexploitation.

Central themes in both the fourth world water forum held in Mexico and in the world social forum on the human right to access to water (2006), which support a logic outside the market and profit. In itself, it is clear that neoliberalism confronts the environmental rationality internalized by the new social actors who seek new configurations of alternatives (Castro, 2006).

During the last two decades, environmental degradation in Mexico has become a major issue in the national debate, taking on connotations that affect the governance and sustainability of society as a whole. The problems of soil degradation, deforestation, overexploitation and deterioration of water resources and loss of biodiversity, were no longer considered as mere statistical data, to constitute the cause of numerous social conflicts. This scenario led to a rethinking of other priorities on issues related to water and forest management at national security level in the current agenda (Cotler, 2004).

To explain analytically and methodologically the processes of water governance, some models, mainly European, of the United States of America and Canada (Ostrom, 1990), provide angular elements of analysis such as, the water governance model in Spanish watersheds and watershed management and governance (Arrojo, 2006).

In recent years, Latin American countries such as Mexico and Brazil have begun to integrate governance models into their water policies for their basin councils (Aguilar, 2015). Also, some authors believe that there is an incipient development of effective mechanisms to promote social participation and citizen empowerment in our country (Colter, 2004; Musseta, 2009; and Castro, 2006, among others).

Nevertheless, barriers such as the self-management associations of irrigation users and urban water management models through the operators still prevail in general terms (Palerm, 2005). It can be observed that the participation of the users in the irrigation districts is conditioned and delimited by the public politics from the central administration (Barkin, 2006).

The Highlands are located in the north-eastern arm of the Mexican state of Jalisco, (Figure 1) is relatively flat, the average height is 2,000 meters above sea level, serving as a transition space between a humid sector of the center of the country and the arid north, is politically integrated by 19 municipalities covering an area of approximately 15,500 km², contains five of the 19 urban centers of Jalisco.

This region is divided into two zones: High-North and High-South; the first with a total area of 8,882.23 km² and High-South with an area of 6,677.36 km² (8.33% of the state's surface), both regions are located in the hydrological region "Lerma-Santiago".

The High-South region (Figure 2) has an aquifer defined in the Acatic-Tepatitlán-Arandas area, with an approximate surface area of 6,000 square kilometers, which is widely exploited, especially by the municipalities of Tepatitlan and Arandas, due to their geo-hydrological characteristics, the depths of the wells in the area vary between 200 and 500 meters.

The sources of water pollution in these regions are directly related to the socio-economic activities in each area. In general, livestock farms (porcine, poultry and livestock), temporary agriculture and a growing processing industry (Inlay, dairy, tequila, among others), in reference to the livestock inventory in Jalisco and the study area (Table 1), for the year 2014 the following was reported.

This reflects the importance of the Highlands area, both in the national livestock production, as well as in the generation of organic waste and wastewater. A high degree of eutrophication of the reservoirs water that serves as watering for regional agricultural, the livestock and in the dams, whose waters are used as a supply of drinking water for municipalities such as Tepatitlan, where contamination problems have already been identified and eutrophication (Ramirez et al., 1997).

Table 1: Livestock inventory 2014 in number of heads (Source: OEIDRUS Jalisco with information from of SAGARPA).

Species livestock	Jalisco	Highlands	Tepatitlán
Cattle for milk	995,298	541,650	56,014
Beef Cattle	2,413,874	630,763	103,300
Porcine	6,830,868	3,598,103	533,312
Egg poultry	80,352,803	56,430,282	17,059,746
Meat poultry	22,042,833	10,259,502	2,341,942
Goat	200,358	92,672	6,080

According to the secretary of the environment and social development of the state of Jalisco (SEMADES, 2018), all municipalities in the Highlands of Jalisco present problems of surface water contamination, by pouring untreated wastewater into the river network, also agricultural production systems have also been identified as sources of non-point pollution for the bodies of surface water (Flores et al., 2009).

More dramatic is the situation because these contaminated water resources of the Highlands region are planned to be used in cities such as Guadalajara in Jalisco or León in Guanajuato. Problems of overexploitation of aquifers (CONAGUA, 2013), accentuated by the extraction of deep groundwater with a high content of fluorides and arsenic (Hurtado and Gardea, 2006), with the consequent negative effect on the health of the population and the reduction of water for human consumption.

The main pollution-related factors in these regions are as follows:

1) Excess nutrients contained in agrochemicals, food consumed and animal excreta.
2) The exit of nutrients and suspended solids via surface runoff.
3) Physicochemical soil processes associated with phosphorus and nitrogen nutrients.
4) The management of manures and organic wastes.
5) Water erosion of grazing areas.
6) The long-term residual effect of constant manure application.
7) The intensity of grazing or overgrazing.
8) The proximity of grazing animals to water currents,
9) Untreated wastewater discharges.

According to data published by CONAGUA (2007), of the 59 aquifers identified in the state of Jalisco, eight are not available or are overexploited, among them Tepatitlan.

The purpose of this study was to analyze the evolution of local water management in the last 25 years by users of a micro-basin located in the Highlands of the state of Jalisco Mexico, through the basic concepts and processes of the Governance Analytical Framework (GAF).

Figure 1: Geographical location of The South Highlands region at Jalisco, Mexico (Source: https://commons.wikimedia.org/w/index.php?curid=45923233).

Figure 2: Situation of aquifers in The Highlands of Jalisco. (Source: CONAGUA, 2013)

2. MATERIALS AND METHODS

Governance in general refers to the processes of interaction between the actors involved in a public matter, leading to decision making or the formulation of social norms, thus it is assumed that there are processes of governance present in any society, which can be observed and analyzed from a non-prescriptive and / or normative perspective.

Using the approach of Cultural Ecology, since it analyzes the relations between a certain society and its environment, that is to say, it studies the "ways by which a cultural change is introduced to adapt to the environment", since in the present investigation it is of interest the processes by which social systems (population) adapt to their environment (availability / quality of water resources). Through the analytical units contained mainly in the Governance Analytical Framework (GAF), the work is carried out in the Microwatershed of Jihuite (MJ) in the municipality of Tepatitlan Jalisco.

This strategy of analysis is based on social disciplines that serves to diagnose collective processes, supported by analytical units that seek to constitute a logical and coherent methodology, its main analytical units are:

1) Contextual definition of the problem; From the GAF a problem is established at the time that a conflict concerning public affairs is detected, which must be addressed. In particular, the use of this method is oriented towards issues related to governance, such as water pollution in a watershed for example (Hufty, 2010).

2) Standards; A central dimension of governance is, the construction of the rules of the game. The arrangements between the actors explain the institutionality determined, conformed by different norms (formal and informal) that guide the decisions and / or the behavior of its actors. The norms assume a double role in the analysis of the governance, they orient the behavior of the actors and they are modified by the collective action.

3) Actors involved; by dynamically analyzing governance, norms guide the behavior of actors and are modified by collective action, social norms are intimately linked to actors, their behaviors and interactions and conditioned by their nature, power, interests, ideas and its history. In order to characterize the interrelations between actors, it is possible to design a "map of strategic actors", to recognize the complexity and nature of the actors involved, their expectations, values and strategies, as constitutive factors of the mechanisms (explicit or implicit) of interaction.

In this approach it is necessary to consider: the characterization of the actors of interest, all those affected or likely to be affected by the activities of an initiative, the strategic actors, and the resources used by them, and the nature of the transactions involved in them relations. GAF proposes a situational analysis of the relative power of the actors and requires a map that considers the relational situation.

4) Nodal points; basically, they are the "social interfaces" defined in physical or virtual spaces (for example, a negotiating table, the communal council, the neighborhood committee), where several processes, actors and norms converge, producing effects, in isolation or in interaction with others, on which they are part of the network of spaces for decision-making.

5) Processes; they are continuations of states by which a system evolves. Thus, for a given object (or a nodal point), it is possible to identify sequences that allow to evaluate the direction by which those processes are transformed and to locate the factors favorable to the change. The analysis of the processes of change seeks to identify

the evolutionary patterns of nodal points, the network of interactions between actors and their relation to changes in the rules of the game (norms) (Hufty, 2010)

In order to identify, classify and access the required information, semi-structured interviews were applied to all the actors involved. In addition, surveys were carried out in different residences (houses) without gender differentiation, both in the microcatchment (rural) itself and in the population of Tepatitlan (urban), randomly covering a predetermined sample size. The sample size for two strata (urban and rural) was a total of 164 houses, according to the pre-established statistical criteria: Confidence level 95%, Standard deviation 0.5 and Error by sampling 10%.

2.1. Design and development of research

The research work was carried out under the following terms: 1) Analysis of water problems in the micro watershed, describing the socio-environmental situation in relation to water management. Secondary information and cartography of the micro-watershed in official databases (INEGI, CONAGUA, CEA-JALISCO, and ASTEPA, among others); 2) Identification of the actors and their processes (field trips, semi-structured interviews with open questions on water problems, their participation in the solution of conflicts, surveys, communication with authorities, etc…), 3) Location of nodal points and their rules, recognizing the spaces where the issues are discussed and possible conflicts over water. Analysis of norms, regulations and laws on water management, at different levels, and 4) Perceptions of users in relation to water, social participation and water culture.

The study of social perceptions of water and social participation at the local level was carried out using surveys, in order to know the perceptions of the population, both of the micro-watershed (MJ) and of the users in the City of Tepatitlán (CT), where was able to recognize certain conflicts over water.

Perception analysis is an important component of governance processes, as it reflects the level of knowledge that water users have, as well as their willingness to be part of decision-making for problem solving (Sanchez, 2008).

The surveys were structured to describe different issues such as: a) location b) personal data, c) special knowledge of the micro watershed, 4) perceived water resources and perceived changes in urbanization, 5) water use and management, and 6) perception and knowledge about water management in the micro watershed. The general format of the questionnaire consisted of 52 questions grouped into 5 modules: 1) Personal data, 2) Identification of water problems, 3) Problems in drinking water service, 4) Government perception of water management, 5) Citizen participation and water culture.

On the other hand, the interviews were semi-structured, designed to deduce the specific relationship and impact of social actors in relation to water in the study area, in a diachronic and synchronous manner, seeking the following characteristics of the interviewees: 1) be of age, 2) live in the study area, and 3) belong to the group of social actors of interest.

In the year 2010, total population in the municipality of Tepatitlan was 136,123 inhabitants, 91,959 in the City of Tepatitlan (municipal head) (INEGI, 2015), whereas in the same period in the micro-basin of the Jihuite there were 1,222 inhabitants in 231 houses (CONAPO, 2015).

The selection of the sample size, according to the pre-established statistical criteria: 1) 95% confidence level, 2) standard deviation 0.5, and 3) sample error 10%, appear in Table 2.

It should be mentioned that the surveys were structured to describe different issues such as: a) location, b) personal data, c) special knowledge of the micro watershed, d) perception of water resources and perceived changes in urbanization, e) about uses and water management, and f) perception and knowledge about water management in the micro watershed.

Table 2: Sample size in the study strata.

	Stratum A MJ	**Stratum B CT**
Type	Rural	Urban
Houses with service of potable water.	231	30,081
Sample size	68	96
Total 164		

3. RESULTS AND DISCUSSION

Accor ding to the methodology used (GAF) the main results obtained are: 20 actors involved in the MJ can be classified in; 8 strategic, 8 relevant and 5 secondary. the strategic actors are: Consejo de Cuenca del Río Santiago (COCURS), Comisión Estatal del Agua (CEA Jalisco), Comisión de Derechos Humanos Jalisco (CDHJ), Secretaria

de Salud Jalisco (SSJ), Ayuntamiento de Tepatitlan (AT), Agua y Saneamiento de Tepatitlan (ASTEPA, the water utility of Tepatitlan municipality), Dirección Ecología de Tepatitlan (DETEPA) and Universidad de Guadalajara (UG). The strategic actors are those with sufficient resources to prevent or disrupt the operation of the rules or procedures for decision-making and collective dispute resolution for the management and governance of the water resources of the MJ. Interviews were conducted with incumbents and representatives of identified actors.

Nodal points (management spaces): The progressive deterioration of the water quality contained in the Jihuite dam has mobilized various sectors of society, interacting in different locations, some of these spaces can be considered as nodal points in water management of the MJ and the CT. The main managed management spaces are: COCURS, Secretaría de Medio Ambiente y Desarrollo Territorial (SEMADET), ASTEPA, UG and Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias (INIFAP).

In the MJ the following processes of change in water management have been identified and grouped:

a) Administrative; Which include actions such as; Feasibility of drinking water for developers (technical feasibility committee), fixation / modification of tariffs (tariff committee, state government, neighborhood committees) and requests for wastewater discharges (CONAGUA).

b) Operational / technical; Such as the purification of surface water (Jihuite dam / Carretas dam), extraction of groundwater (wells), distribution of drinking water (leaks), collection of domestic wastewater (sewage) and wastewater treatment. C) Strategic; Mainly in policies for; New sources of water supply (projects), reuse of treated water, sanctions for water wastage, water and legal training and culture; Such as the legal basis for the provision of the service and the rights and obligations of users.

In reference to water quality in the MJ, the following points are highlighted:

-A high degree of eutrophication of the water of the reservoir was observed, with an inorganic nitrogen content during the rainy season from 3.67 milligram/liter (mg/l) to 6.8 mg/l, fecal coliform bacteria and total from 1.9 to 17.000 Most Probable Number / 100 milliliters (MPN/100 ml), causing water to be in some periods of time, not recommended for human, agricultural or recreational use (Flores, et al., 2012).

-Residues of herbicides and insecticides; among pesticides with high levels was found; Lindane with less than 2 micrograms /liter (µg/l), methoxychlor with less than 20 µg/l and 2-4 DDT with less than 30 µg/l.

-High content of organic matter; its origin is attributed to pig farms located in the basin, as well as to the surface runoff of agricultural and cattle graze areas, from where sediment is carried to the vessel of the dam.

-Deforestation of land for livestock or agricultural purposes; which together with the practices of grazing and conventional tillage have caused that 99% of the surface of the basin present some degree of erosion, in this respect 30.7% of the surface of the basin have erosion smaller than 2.2 tons per hectare per year, 58% of the area has soil losses of 2.2 to 10 tons and 7.54% of the area has erosion with more than 10 tons with an allowable limit of 6.7 tons (Flores, 2007).

In the same sense, several physicochemical analyzes of the National Water Commission have reported that the water of the Jihuite dam has a quality far below what is allowed for human consumption, being mainly contaminants of the type pesticides and insecticides, which are dragged by the rains, also eroding the adjacent land, as well as by animal excreta from the farms (CONAGUA, 2017).

On the other hand, and in several occasions, great mortality of fish in the vessel of the Jihuite dam, such as that of august 27, 2009 (Figure 3), have been detected, when they hawk floating more than 7 tons, the causes of this event according to the authorities could be contamination by discharges of farms and industries, or by the excessive application of herbicides and/or fertilizers in the crops of the zone that the rains dragged until the reservoir.

Figure 3: Images of the fish mortality in the Jihuite dam (2009). (Source: semanario7diastepa.wordpress.com)

3.1.1. Management Indicators (ASTEPA)

As the operator organism is of very recent creation only the following data are available; Table 3 presents the main management indicators for the years 2013, 2014 and 2015 of ASTEPA (Ayuntamiento de Tepatitlan, 2020), compared to the national average of 2013, where positive progress can be observed in some of the indicators (Table 3), it should be mentioned that in the same year (2015), a change of municipal president was made in Tepatitlan and consequently change of the directive of the operator organism.

The contrasts between the periods 2014 and 2015 can be attributed to the following possible reasons:

a) Increase of irregular housing in the municipality.

b) The treatment plant of the town of Capilla de Guadalupe (20 l/s) was received.

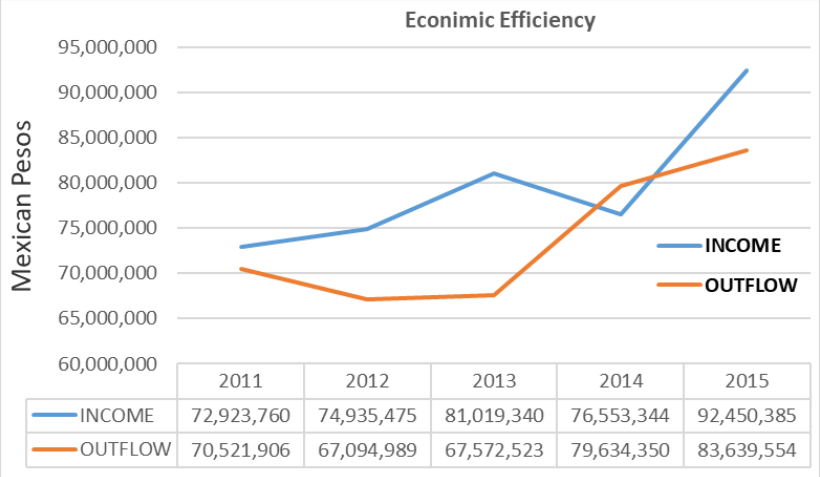
c) The macro meter register was updated resulting in a considerable amount of equipment out of operation and / or in poor condition.

d) Interference with the updating of the macro meter pattern in the sources of uptake.

Likewise, the financial results of the organization, that is to say the amounts of cash collected and operating expenses carried out from 2011 to 2015, can be seen in graph 1.

Table 4: Main ASTEPA management indicators (ASTEPA, 2016)

Indicator	ASTEPA			National Average *
	2013	**2014**	**2015**	**2013**
Coverage of drinking water (%)	97.3	98.5	97.61(a)	95.1
Sewer cover (%)	97.3	98.5	98.78	86.8
Sanitation coverage (%)	40	40	58.07(b)	50.7
Coverage of macro measurement (%)	83.21	92.7	73.33(c)	87.6
Micro measurement coverage (%)	95.2	98.1	98.67	54.2
Physical Efficiency (%)	54.9	54.1	37.34(d)	57.9
Commercial Efficiency (%)	80.2	96.4	81.15(e)	72.7
Overall Efficiency (%)	44.03	52.14	30.30(f)	45.7
Labor Index (employee / 1000 CH)	4.9	5.1	5.21	5.2



Graph 1: Economic efficiency (Source: ASTEPA, 2017)

It is worth mentioning that in 2014 the municipality of Tepatitlan was changed to the concessionaire scale within the CONAGUA user pattern, placing it at a higher contribution rate, which led to a substantial increase in the payment of usage fees of water from wells, in addition to increases in the costs of electric energy and other inputs, with a current expenditure higher than the budgeted revenue

In reference to social participation in the governing body of the operator, that is, members with a voice and vote that do not belong to any level of government, it has fluctuated between 18 and 22%. There are proposals to increase this percentage, either by allowing the participation of more representatives of organized society, or by reducing government representation.

Social participation increases when there is some conflict over water, since when the different actors feel affected, they act collectively.

Both residents of MJ and those of the CT have experienced, as pollution of water resources has increased substantially in the recent 5 years, by more than 100%, according the surveys carried out; which directly or indirectly has impacted on their lifestyle, that it is very important to consider the way in which they perceive the particular problems of the study area, as well as the analysis of the ways of social participation to face the challenge of water sustainability in the region.

In order to evaluate the perception of social actors, as well as the systems and mechanisms for their participation in the current problems of the water resources of the study area, surveys were carried out both in the MJ and in the CT, by means of a random stratified sampling, the most outstanding results are as follows;

Pollution and the low level of supply are the main problems that are perceived in the applied surveys; High percentages; 78 (CT) and 66% (MJ) of the respondents recognized a certain degree of contamination in the water bodies, for more than 5 years, being the cause of this contamination: peasants and farmers (37%, MJ, 21% CT), industries (32% MJ, 42% CT) and discharges from the population drains (25%, MJ and 34% CT) (Figure 4).

In terms of which institution or organization should be the main responsible for solving the pollution problem in water bodies in the region, the results were: Municipal government (31% CT, 45% MJ), State government (25% CT, 36% MJ) and the Federal government "CONAGUA" (40% CT, 15% MJ) (Figure 5).

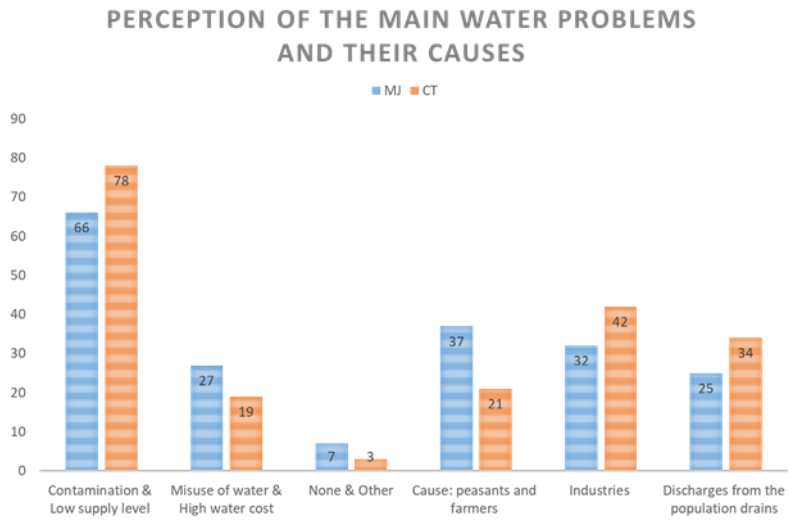


Figure 4: Perception of the main water problems and their causes

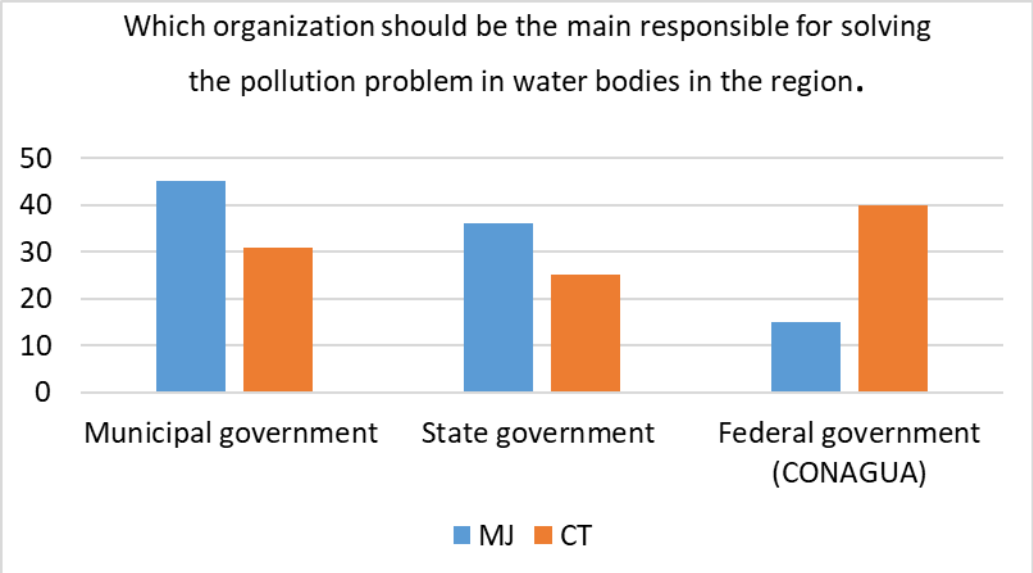


Figure 5: Which organization should be the main responsible for solving the problem of contamination in bodies of water in the region

In reference to the quality of drinking water service, it was found that in the MJ the majority of the inhabitants (49%) consider it regular, while in the 65% of CT it is considered acceptable (it should be mentioned that the survey has several options for evaluation among them "not acceptable").

The tariff for monthly drinking water in the housing scale of 13 to 20 cubic meters (m^3) in the CT (2015) was 9.04 pesos per m^3. The cost in the MJ is variable since the service is administered by different neighborhood committees, prices for residential service range from 6.60 to 10.4 pesos per m^3 (the average is 7 pesos / m^3).

In the PT the drainage service is considered as good, it is recognized the existence of at least one wastewater treatment plant (43%), while there are serious deficiencies in the MJ, since in its entirety there is no sewage system, as well as wastewater treatment systems, mostly use septic tanks.

The results on the perception of the authorities acting in reference to the water resources management indicate that 67% of the respondents of the CT comment as regular, while 48% of the MJ says that it is acceptable (Figure 6).

Regarding questions about whether the authorities should modify some aspect of their behavior, the preferences in the PT were that (71%) and should be: 37% improve service (mainly leaks), 22% Drainage system, and 15% optimize the distribution network in the MJ, 42% believe that the authorities should change their actions, mainly in: better distribution of water 26%, drainage coverage 21% and water costs 15% (Figure 7).

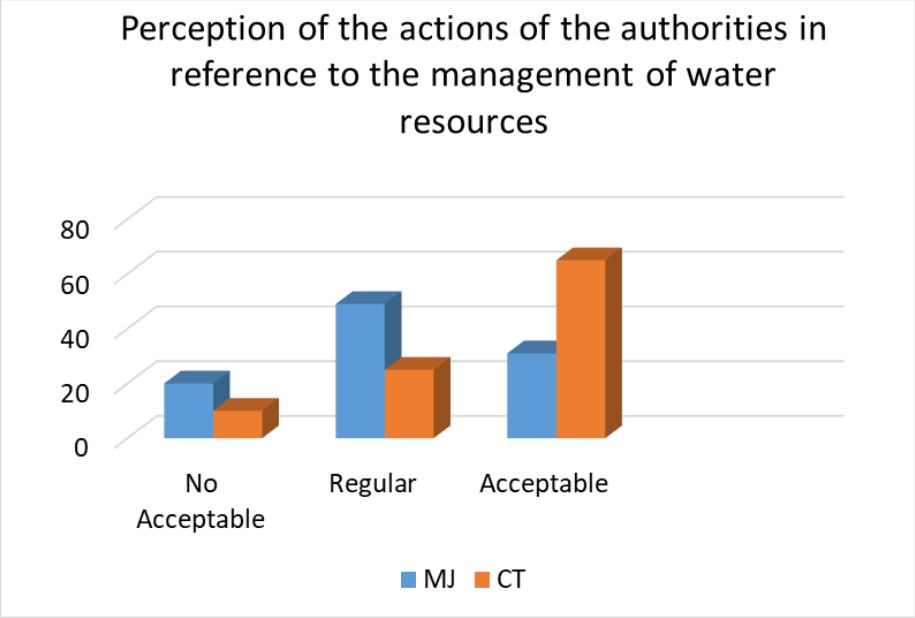


Figure 6: Perception of the actions of the authorities in reference to the management of water resources.

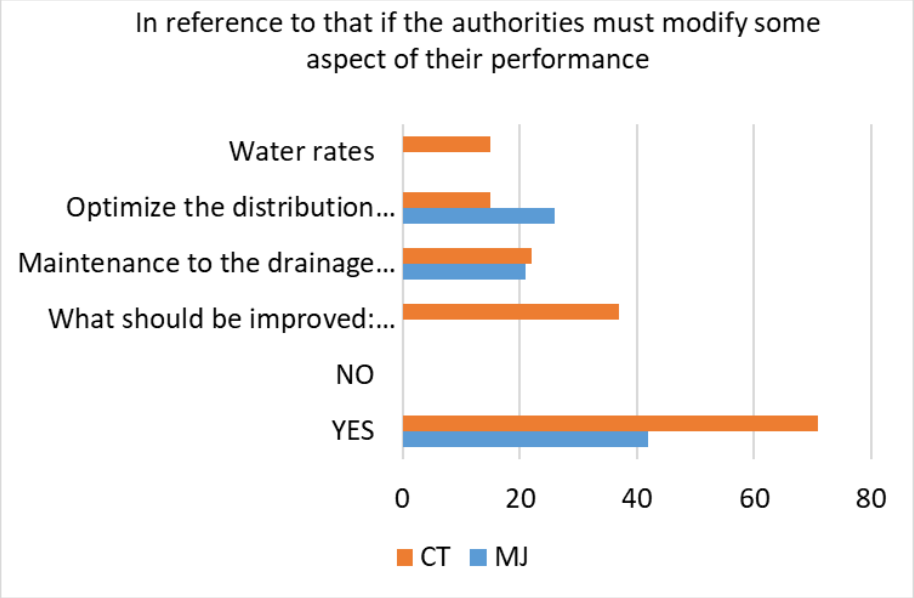


Figure 7: In reference to that if the authorities must modify some aspect of their performance.

Regarding the participation in events of water culture this is relatively limited, however in the CT it is reported an availability to participate in 65% (Figure 8).

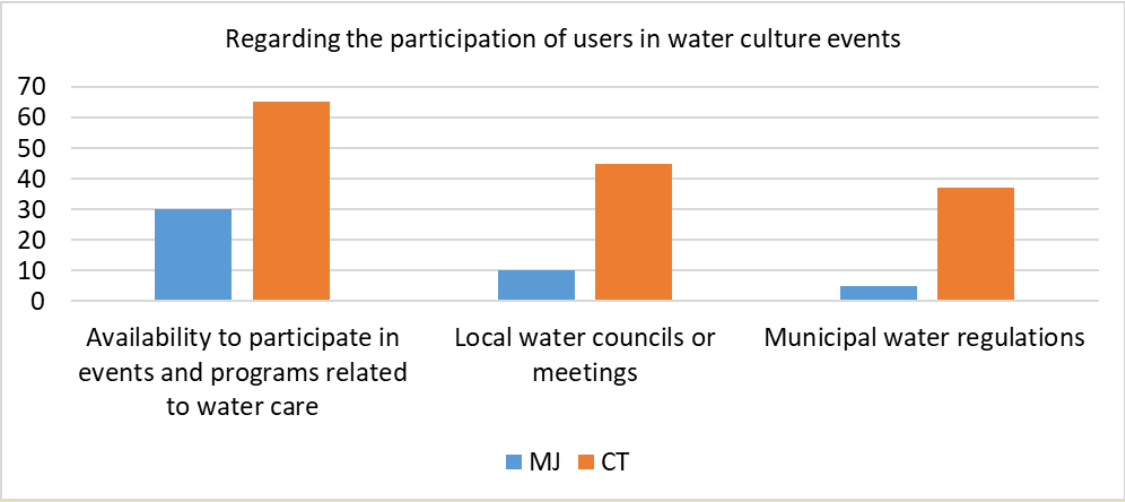


Figure 8: Regarding the participation of users in water culture events

3.2. Discussion

In reference to studies on governance and social participation in water management in rural areas of Mexico there is little information, however in 2010 a project was developed where the processes of water governance are analyzed from the intervention of the different actors social and institutional mechanisms developed for decision-making on the use and exploitation of the resource, this work was developed in the El Cangrejo micro-basin region(CM), at Autlán de Navarro municipality, Jalisco, through GAF approaches, identifying that for this micro-basin located in the southwest of the state of Jalisco, the main problem was the lack of water in many populations, likewise there is social participation to make agreements, but no government agency participates, therefore the laws established in these localities do not apply.

Another problem consists of the demand for water for agricultural activities, where despite the fact that formally regulated common land (ejido) meetings are held, they are not spaces where the participation of government actors is promoted, nor are there specialized water technicians, only interests are pursued private.

In the case of the demand for water for urban areas, the opposite happens, decisions are made in the council room of the Autlán de Navarro city council, following the formal legal and institutional framework. However, although there are mechanisms for consulting public problems, it is not possible to articulate with the water committees in the common lands of the CM upstream, this problem is consistent with that found in our study micro-basin and that prevails in many areas, not only from the state of Jalisco (Guerrero, 2011), but throughout the Mexican Republic.

In the same way, in the CM there is no citizen participation, not even of the communal lands holder in decision-making, none of the three identified nodal points (water committee, communal lands meetings and council sessions in town hall) are interrelated, each one satisfies their needs without having a basin vision and comprehensive planning, so access to water for the future is at risk.

Although there is a normative and institutional framework to prevent its environmental deterioration (Mexican laws and regulations, such as the National Water Law), there is no council that has a comprehensive vision of the management of water resources.

Among the main actors of this micro-basin are; the Ayuquila – Armería Basin Council, SEDER/FIRCO (Secretariat of Rural Development/Shared Risk Trust), JIRA (is an Environment Board made up of 10 municipalities of the Ayuquila-Armería River Basin) and the University of Guadalajara, however, there are no inter-institutional coordination approaches that can influence and support the sustainability of the resource in the region.

In the case of the demand for water for agricultural activities, although common land meetings (formal institution) are held, they are not spaces where the participation of government actors or specialized water technicians is promoted, only private interests are pursued (Guerrero, et al., 2010).

As it is possible to observe both the CM and the Jihuite micro-basin, certain normative and institutional structures suitable for developing comprehensive water management plans are detected, but there is a lack of sufficient technical capacities to attend to the promotion of environmental education programs, culture of water, protection of supplies, control of erosion and floods, as well as promotion of aesthetic values of water. The lack of coordination between

the different levels of government, the absence of integration between institutions and the citizen participation of local rural actors have as a consequence that there is no adequate management of water resources.

In both micro-basins it is important to promote rural organizations, create internal local strengths, as well as raise awareness about environmental problems, this will allow rural groups to generate actions and policies for development and conservation.

Likewise, it is of strategic importance that relevant actors, that is, government institutions, intervene in the decision-making of the water committee of rural localities, although the communal lands holder and the population can solve their problems autonomously, it is essential the intervention and surveillance of government institutions to protect and preserve natural resources that are of public interest.

4. CONCLUSION

In the case of MJ and CT, the processes of water governance found were:

1) Problem: Ensure water sustainability in quantity and quality

2) Strategic actors: 8 actors with low coordination among them. Polarized into two groups: 1) those supporting conservation projects and 2) those who exploit resources for food production.

3) Nodal points: 5 with low participation of all the actors.

4) Standards: With errors in its application at state and municipal level.

5) Social participation: Limited in some nodal points (at local and municipal level) and absent in others mainly at state and federal level.

6) Water culture: There are basic principles and strategies mainly focused on children.

It highlights the absence of most basic governance processes at the micro-watershed level, as well as a poor water culture at all jurisdictional levels. In addition, there is a need for greater social participation at the national, state and micro-watershed levels, as well as an effective application of current regulations. For water management to be sustainable in the micro-watershed through the processes of governance, it is necessary to integrate each and every one of its stages and elements into its different levels of action.

The management of the water service for the communities within the micro-watershed is through neighborhood committees, which operate 5 deep wells (150-300 m deep), with flow rates of 4 to 15 l/s

The regulation of ASTEPA considers aspects for the use and distribution of drinking water. However, it lacks well-defined mechanisms and strategies to promote such issues as social participation (since its formation, non-governmental social representation on its board has averaged 20 per cent), education and the right to information.

Likewise, it can be stated that the operator and the municipality of Tepatitlan do not fully comply with Article 115 of the Mexican Constitution in relation to the human right to sanitation of urban waste water, which are not treated as total waters Domestic residues generated in the municipality.

The actual cost of producing drinking water for the operating agency in 2015 was approximately 12 pesos/m^3. This cost includes water treatment, piping, sewerage, sanitation and final disposal, in the same year, the monthly housing rate was average residential of 9.04 pesos/m^3, to the monthly consumption is added to it; 30% for sanitation, 5% for infrastructure (maintenance) and 16% of VAT (only from the sum of sanitation and infrastructure).

It is evident that in the MJ there are relationships in the basic processes of unfinished water governance (Aguilar, 2006), which generally hinders the full integration of effective and efficient governance schemes designed for sustainable water management. Likewise, as stated by Peniche and Guzman (2012), "the absence or malfunctioning of these principles explains the problems related to water supply and quality, and makes it impossible to exploit them". Water goes beyond the technical, it is a crisis of governance (Barkin, 2006).

In Mexico water is a strategic element, while in other countries this is a matter of national security, there is currently a water crisis in some areas of the Jalisco Highlands, and the vital liquid consumed by cattle in times of drought, comes from the treatment plants, many of them not operating, which is generating a public health problem (Gomez, 2014).

It is possible to appreciate different ways in which the local population adapts to the environmental changes (borders, deep wells, stronger crops and of less water consumption, water in the dam for exclusive use of the municipal head, among others), affecting the Reform of microregions. There is also the technical and legal feasibility for the installation of devices and mechanisms for the management of payment for environmental services in; Areas for water recharge, environmental damage and environmental contingency caused by third parties, these resources should be used in pollution mitigation plans, recovery of water bodies in the micro-watershed and promotion of water culture.

In order to attend to the problems perceived by the inhabitants of the MJ, community meetings are held, with frequency where users express their needs as well as proposals for solutions, making agreements (nodal points).

The main link of the residents of the MJ in reference to water management is in the first instance with the local committees that manage the water and in the background with the officials and technicians of the operator agency and the municipal authorities.

Practically in the MJ, the disposal of the waste water is through septic tanks, there is no adequate system for the treatment of these effluents.

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