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Articles

Integrated tactical analysis of the problems of the drinking water supply committees of Toluca

Análisis táctico integrado de la problemática de los comités de agua potable de Toluca

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Abstract

The problems of sociopolitical, economic, environmental, and technical-operational nature faced by the 27 drinking water supply committees –of ethnic-origin– of Toluca were analyzed to identify the key indicators that require immediate attention. This study employed archival research, documentary analysis, and cabinet reviews, utilizing the Delphi Consultation Group Technique. The methodology employed a unique combination of instruments and methods from participatory strategic planning and integrated water resources management. A total of 52 key indicators were identified, delineating the management system of the drinking water supply committees of Toluca. Of these, 24 key indicators pertain to the economic subsystem (46.4 %), 19 to the technical-operational subsystem (35.1 %), and 9 to the sociopolitical subsystem (18.5 %). These findings hold practical value for the committees, aiding in the identification of actions and alternative solutions. It was deduced that key indicators related to the will, participation, and commitment of stakeholders and water users are crucial for enhancing decision-making and addressing the issues faced by the drinking water supply committees of Toluca.

Keywords: community water supply management, PSP-IWRM methodology, cross-impact matrix, DPSIR indicators, structural systems analysis.

Resumen

Se analizaron los problemas sociopolíticos, económicos, ambientales y técnico-operativos que padecen los 27 comités de agua potable —de origen antiguo— de Toluca, para identificar los indicadores clave que deben ser atendidos prioritariamente. Este trabajo se realizó con investigación de archivo —trabajo documental y análisis de gabinete— a través de la Técnica de Grupo de Consulta Delphi, basado en una metodología original de combinación de instrumentos y métodos de planeación estratégica participativa con un enfoque de gestión integrada de recursos hídricos. Resultaron 52 indicadores clave que modelan el sistema de gestión de los comités, de los cuales 24 indicadores corresponden al subsistema económico (46.4 %); 19, al subsistema técnico-operativo (35.1 %); y 9, al subsistema sociopolítico (18.5 %). Los resultados encontrados son de utilidad operativa para los comités y pueden ser considerados en la identificación de acciones y alternativas de solución. Se concluyó que los indicadores clave sobre voluntad, participación y compromiso de los actores y usuarios del agua son elementos prioritarios para mejorar la toma de decisiones y resolver la problemática de los comités de agua potable de Toluca.

Palabras clave: gestión comunitaria del agua, metodología PEP-GIRH, matriz de impactos cruzados, indicadores FiPEIR, análisis estructural de sistemas.

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Introduction

The Fraction III of Article 115 of the Political Constitution of the United Mexican States (CPEUM) establishes the functions and public services that are the responsibility of Mexican municipalities (CPEUM, 2014, p. 107). These governmental entities, generally due to their inefficiency and insufficient technical, administrative, and financial capacity, fail to provide hydraulic infrastructure to vulnerable areas, such as poor and marginalized neighborhoods. Historically, inhabitants of these areas, through self-management and governance practices, have found different organizational alternatives to supply themselves with water, as is the case with drinking water supply committees (Anzurez, 2020, p. 1).

In Mexico, there is a great diversity of types of drinking water supply committees operating in rural, peri-urban, and urban areas, within which coexist: 1) ethnic-origin committees—these are incorporated or part of the social system known as the civic-religious charge system (Korsback, 2009, pp. 215-242; Campuzano, 2015, pp. 37-44); 2) formal committees—those formed as Civil Associations for drinking water supply; 3) illegal committees—those not legally recognized by the State; 4) recently created committees—located in urban areas or new urban developments; and finally 5) committees in special situation—those that result from water transfers to Mexico City: Lerma System and Cutzamala System (Ramírez, 2020, p. 91; Anzurez, 2020, p. 182).

In this work, we focus on the ethnic-origin drinking water supply committees, which are the most widespread in indigenous communities historically inhabited by ethnic groups with Mesoamerican characteristics. These committees have demonstrated having built good water governance, largely due to their sociocultural structure (social organization, identity, customs, knowledge, family structures, and culture), resulting in good self-management practices that remain in effect (charge systems, water committees, ejidos, community work) (Campuzano, 2019, pp. 52-84).

The exact number of ethnic-origin committees and their distribution in the country is unknown, despite their widespread presence and importance in drinking water supply. However, it has been observed that they coexist with other types of committees and with Drinking Water Supply Operating Agencies. Nevertheless, these committees provide water services with limited management capacities, particularly in identifying technical and operational deficiencies, in addition to administrative and financial ones. Likewise, the lack of internal regulations, insufficient economic resources, integrity issues, transparency, and accountability problems are detected.

In most ethnic-origin committees, there is a prevailing sociopolitical conflict with the neoliberal State, stemming from the lack of: 1) legal recognition; 2) economic resources; 3) negotiation and agreements; 4) incorporation of users; and 5) co-management (Hernández, 2016, pp. 79-86).

In response to this situation, the state authorities, especially municipal ones, have magnified the problems of the committees, seeking to weaken them, and if possible, even eliminate them with the intention of taking over their hydraulic infrastructure and obtaining economic benefits derived from controlling water supply management. In general, authorities at all three levels of government ignore the water rights of the committees and their customary modes of operation, which they derogatorily qualify as a historical anachronism of water self-management, deemed inoperative and unsustainable in the long term, according to them, not allowing for the guarantee of drinking water supply (Anzurez, 2016, p. 138).

It is worth noting that municipalities and Drinking Water Supply Operating Agencies have also been unable to achieve sustainable water supply management, as they also face serious issues of lack of integrity that manifest in various forms (bribery, regulatory capture, nepotism, impunity, misappropriation of funds, or complicity) at all stages of drinking water supply and sanitation service management (granting of water rights, discharge of wastewater, illegal connections, hydraulic works, incomplete information), which has hindered access to water and the fulfillment of this human right (Bolaños, Toledo, & Osorno, n.d., pp. 14-51).

Therefore, the objective of this work is to analyze and prioritize the water-related issues faced by the 27 ethnic-origin drinking water supply committees in the Municipality of Toluca (DWSCT), to identify key indicators that must be considered and addressed as priorities in defining actions and alternative solutions.

The present work is based on the methodology of Integrated Water Resources Management (IWRM) (Díaz-Delgado *et al*., 2009), modified by Romero *et al*. (2015) with theory of social organization and water governance. It is supported by fieldwork evidence (interviews with key stakeholders) and participatory work (empirical-practical knowledge). This served for the localization, contextualization, characterization, and identification of the components of the DWSCT related to the management and administration of the water service (structure, organization, operation, democracy, governance, identity).

Thus, the analysis and prioritization of the water issues of the 27 DWSCT are approached from an integrated perspective (IWRM) based on a participatory strategic planning process – in its tactical planning phase- (PSP): *the methodological process PSP-IWRM* (Díaz-Delgado *et al*., 2009; Díaz-Delgado *et al*., 2017). This is achieved through the Delphi Consultation Group Technique (Godet, 1993; Godet & Durance, 2011), which involves the review, reflection, and analysis of a wide range of validated studies and research already discussed and validated at the Inter-American Institute of Water Technology and Sciences (IITCA-UAEMéx) (Romero *et al*., 2015), to identify consensus among the group of experts and propose the best solution decisions for the water issues of the 27 DWSCT.

From the previous methodology, 52 priority key indicators resulted (34 linking, 16 driving, and 2 resulting) that model the water supply management system of the 27 DWSCT, of which: a) 24 key indicators (19 linking and 5 driving) correspond to the economic subsystem; b) 19 indicators (10 linking, 8 driving, and one resulting) to the technical-operational subsystem, and c) 9 indicators (5 linking, 3 driving, and one resulting) to the sociopolitical subsystem.

It is concluded that the *linking indicators* related to the *will, participation, and commitment of water stakeholders and users* are the most crucial elements that must be considered and addressed to resolve the water issues of the 27 DWSCT, to improve decision-making.

The present work aims to contribute to solving the drinking water supply management issues faced by the 27 DWSCT, from an IWRM perspective and a PSP process, to enhance good water governance and water governability, especially by respecting the history and customary water rights of indigenous communities and their DWSCT.

In the subsequent sections, a concise overview of the DWSCT is provided, followed by an introduction to the background information, theoretical approach, and concepts utilized in this study. Subsequently, the methodology, results, discussion, and conclusions are presented.

Drinking water supply committees in Toluca

The drinking water supply committees first emerged in the municipality of Toluca, State of Mexico, during the 1930s with the drilling of 5 wells, and then increased in the 1950s with the drilling of 3 additional wells (Estrada, 2003). From that decade until 1970, the committees multiplied along with the wells in the communities of Toluca, initiated by the municipal president, Yolanda Senties de Ballesteros, with the approval and support of the Mexican State (Hinojosa, 2014; Campuzano, 2015).

By granting the population consent over water resources, the committees were governed by the customs and traditions of each town or community, exercised through customary law (*informal Mesoamerican legal framework*), which includes social norms, moral sanctions, unwritten agreements, community assemblies, and honorary positions.

The municipality of Toluca is part of the cultural macro-area of Mesoamerica and has Otomi indigenous presence in 24 delegations, where the 27 DWSCT are located: Cacalomacán, Calixtlahuaca, San Andrés Cuexcontitlán, San Antonio Buenavista, San Buenaventura, San Felipe Tlalmimilolpan, San Juan Tilapa, San Lorenzo Tepaltitlán, San Marcos Yachihuacaltepec, San Mateo Oxtotitlán, San Mateo Otzacatipan, San Pablo Autopan, San Pedro Totoltepec, Santa Ana Tlapaltitlán, Santa María Totoltepec, Santiago Tlacotepec, Tecaxic, Tlachaloya (Figure 1).

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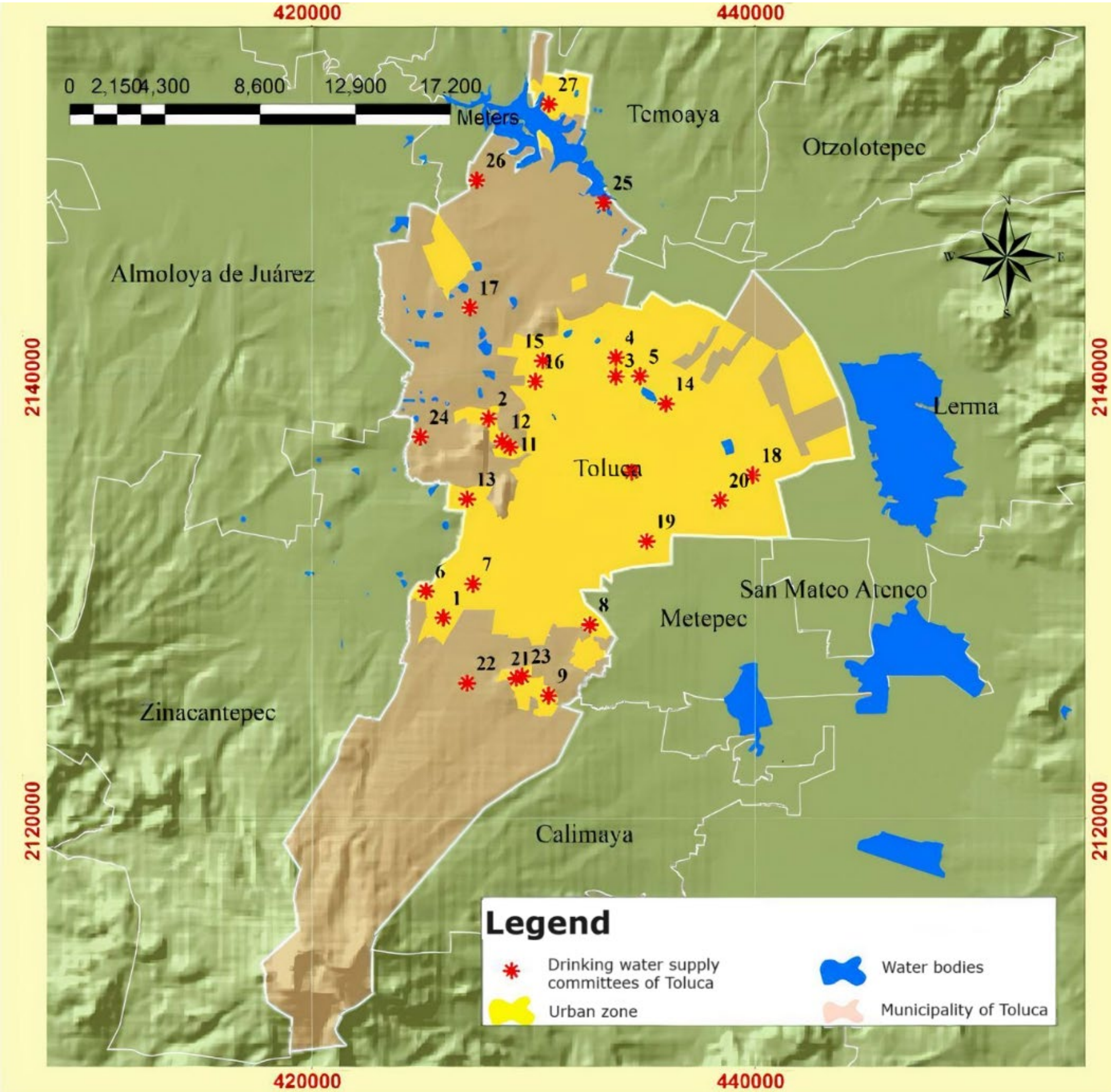

Figure 1. Geographic location of the 27 drinking water supply committees of Toluca. Source: Authors' elaboration based on Anzurez (2020, p. 96).

These 27 DWSCT are in 18 indigenous communities with Mesoamerican characteristics (community identity, general assembly, honorary positions) and have a historical tradition of water governance. Additionally, they are integrated into a social system known as *the civic-religious tasks system*, which is the most significant social structure of ancient origin in Mexico (Korsback, 2009; Estrada & Franco, 2004; Hinojosa, 2014; Campuzano, 2015; Gómez, 2016; Campuzano, 2019).

These DWSCT, with a historical persistence of self-management, provide drinking water to more than 51 % of the population of Toluca through the operation of 34 wells, a branch of the Cutzamala System, springs, and tanker trucks. As a general characteristic, the DWSCT are managed by the users themselves, who, through consensus and voting in the general assembly of the community, select the committee that will administer, operate, and maintain the water systems for a specified period (Hinojosa, 2014).

Community water management

Previous studies on community water management in Mexico and Latin America (Ostrom, 2000; Ampuero, Faysse, & Quiroz, 2005; Aguilar, 2011; Hinojosa-Peña, Romero-Contreras, & Hernández-Téllez, 2013; Becerril-Tinoco & De Alba-Murrieta, 2014; Díaz, 2014; Escobar, 2015) have been approached from various disciplines (anthropology, sociology, human geography, planning), often focusing on a single sector and based on different theoretical perspectives such as networks, social capital, common goods, collaborative management, or co-management. These studies consistently emphasize: 1) the potential, advantages, and benefits of self-organized community management; 2) the importance of community general assemblies; 3) the need for legal recognition; and 4) the efficiency and effectiveness of organizational arrangements and democratic practices to achieve local self-government and overall governance. However, most of these studies lack a systemic approach (Galindo & Palerm, 2007; Giménez & Palerm, 2007; López, Martínez, & Palerm, 2013; Bastian & Vargas, 2015; Vargas, 2015).

Other research on community water management has documented several key aspects: 1) the handling and management conducted by drinking water supply committees in relation to water utility organizations and municipal departments; 2) the participation of women in decision-making processes; and 3) the controversies arising from the municipalization of the water supply service (Galindo & Palerm, 2007; Sandoval, 2011; Pimentel, Velázquez, & Palem, 2012; Galindo & Palerm, 2012; Sandoval & Griselda, 2013; Gutiérrez, Nazar, Zapata, Contreras, & Salvatierra, 2013; Galindo & Palerm, 2016; Anzurez, 2016; Gómez, 2016; Gómez, Romero, & Vizcarra, 2017; Cadena & Salgado, 2017; Cadena & Morales, 2020). Despite the breadth of these background studies, they tend to homogenize the social organization of water management as if it were a uniform approach across different countries and regions. However, in general, these studies lean towards two opposing viewpoints. The first favors the independence of the committees, citing their effectiveness in managing conflicts, ensuring equitable resource distribution, promoting participation in decision-making, and implementing social sanctions and penalties effectively. Conversely, the second viewpoint seeks to abolish drinking water supply committees, deeming them inefficient and ineffective in resource management due to a lack of legal recognition from the State and operation outside the current national water legislation. Both perspectives offer few concrete solutions to the water problems faced by the committees, as they fail to analyze them through systemic processes, resulting in fragmented knowledge and limited understanding of the interrelations between water-related issues.

Integrated water resources management (IWRM)

The World Water Association defines the concept of IWRM as a process that promotes the coordinated development and management of water, soil, and associated resources, aiming to maximize economic and social benefits equitably without compromising the sustainability of vital ecosystems (Díaz-Delgado *et al*., 2009, p. 30).

The concept of IWRM has evolved as has the relationship between water, society, and the environment. The origins of the concept emerged and have been present since the first International Water Conference in Mar del Plata (Argentina) in 1977, where the need to promote coordination in the water sector was underscored. This was in response to global issues of water scarcity, climate change, increasing pollution, and concerns that freshwater resources are under threat due to population growth (WGF, 2009, p. 11; Manzano, 2017, p. 53).

Various authors agree with the open and flexible integrated approach of IWRM, which involves coordinated knowledge of a diversity of systems that must be considered simultaneously, across different disciplines, conceptions, and research, as well as the perspectives of several stakeholder-interest groups (social, political, economic, academic, governmental), to implement efficient, equitable, and sustainable solutions, and make balanced decisions (Díaz-Delgado *et al*., 2009, p. 31).

The current trend in IWRM considers "local or community" work as an opportunity to develop practical experiences. Similarly, it appreciates that the participatory anthropological approach is more sustainable and efficient both from an institutional and technical standpoint, as it addresses the needs and priorities of users. Water management planning, decision-making, and policy proposals should be based on the needs and priorities of local communities, considering the participation of all stakeholders (women, youth, farmers, and indigenous peoples) at the community level within the framework of a national economic development policy (Manzano, 2017, p. 58).

Participatory strategic planning (tactical phase) (PSP) and IWRM

Strategic planning is a reflective process that allows for organizing and structuring the required actions for an organization to reach a desired future position, considering its internal and external aspects within which it operates and interacts, focusing on what needs to be done to achieve the expected outcome. Manzano (2017, p. 59) points out that when strategic planning is open to all interested stakeholders in the organization, not just limited to the managerial sphere, it is then referred to as participatory strategic planning (PSP). Indeed, this is a systematic and systemic process that integrates the development of intuitive and analytical knowledge through the participation of the involved stakeholders-groups of interest, who are in turn influenced by the implementation of a strategic plan (Díaz-Delgado *et al*., 2009, p. 27).

According to Díaz-Delgado *et al*. (2017), *both processes (PSP and IWRM) maintain a holistic perspective and focus on what really matters (key factors and their main interactions)*, in order to promote sustainable development and coordinated management of the socio-ecosystem to maximize socio-economic benefit. The PSP-IWRM process facilitates consensus-building and commitments among the involved stakeholders to recognize and share values and principles, leading to the cause-and-effect analysis of the situation for the identification, selection, and alignment of strategic objectives, recognizing priorities and their best solution routes: tactical and long-term planning (Díaz-Delgado *et al*., 2009, p. 29).

Tactical planning is based on a more analytical approach than intuitive, aiming to define specific short-term actions to achieve high performance (efficiency and effectiveness). This type of planning is used to organize and outline high-impact programs, projects, and actions that focus on addressing specific problems, the solution of which poses a change in the "state" of the entire system in the short term (Díaz-Delgado *et al*., 2009, p. 28).

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DPSIR indicators

The indicators are methodological tools that can be used in a process of participatory strategic planning with a systemic approach (PSP-IWRM). They help measure and evaluate the progress of sustainable development, playing a dual role: 1) as knowledge builders and 2) as instruments for the design, implementation, and evaluation of public policies (Díaz-Delgado *et al*., 2009, p. 33).

Indicators provide signals that relate complex messages, potentially from countless sources, in a simplified and useful manner. These indicators must possess the following characteristics: 1) a clear and unambiguous definition; 2) measurability in qualitative or quantitative terms; 3) feasibility of implementation in terms of available resources; 4) relevance to the subject matter; and 5) sensitivity to changes that may occur in current legislation (Díaz-Delgado *et al*., 2017).

Indicators have been employed at different stages of environmental assessment and have progressed from simple indicator systems (*PES: Pressure-State-Response*) to more comprehensive systems like the DPSIR system (*driving forces-pressure-state-impact-response*), aiming to offer the most systemic overview possible. The DPSIR indicator model aims to establish cause-effect interconnections among the dimensions of systemic analysis (economic, social, and environmental sectors). Its general logic suggests that certain driving forces (D) lead to increased pressure (P) on natural resources, subsequently altering or modifying their natural state (S) in terms of quality and quantity, resulting in impacts (I), both positive and negative, on society and the environment (scarcity, excess). Subsequently, these subsystems respond (R) with environmental adaptations and with actions, policies, and strategies in the case of the social subsystem, to prevent, minimize, or mitigate negative impacts and leverage positive ones (Díaz-Delgado *et al*., 2017).

The DPSIR indicator system offers greater advantages for the development of a strategic planning process within the framework of IWRM because it provides useful information to: 1) improve understanding with a socio-ecosystem vision; 2) build consensus around shared objectives and goals to intervene in its processes; 3) diagnose, evaluate, and monitor the results derived from these interventions (Díaz-Delgado *et al*., 2009, p. 33).

The indicators of the DPSIR system describe a causal chain that facilitates the analysis of the origins, consequences, and responses to changes that may occur in the management system of the 27 DWSCT. The simplification of DPSIR indicators is possible through structural system analysis (Godet, 1993; Godet & Durance, 2011), which facilitates the identification of the most influential and dependent indicators for system evolution, that is, *the prioritized key indicators*.

Structural system analysis

Structural analysis is a way of thinking that allows for obtaining a broad representation of a system. That is to say, reality is modeled to understand and study the structure of the relationships between the variables that characterize a system. For this, it is considered that a system is a set of elements related to each other, and the structure of the system is the network of relationships between the elements, which is essential to understand its dynamics and evolution, since that structure retains certain permanence (Godet, 1993, p. 73).

Structural analysis is a systematic, matrix-based method for analyzing the relationships between the constituent variables of the system under study and those of its explanatory environment. The objective of this method is to highlight the main influential and dependent variables and then identify the key variables causing the system's evolution (Godet & Durance, 2011, p. 64).

Structural analysis of systems is divided into three successive stages: 1) inventorying the variables; 2) describing the existing relationships between the variables; and 3) identifying the key variables (Godet, 1993, pp. 75-106; Godet & Durance, 2011, pp. 64-68).

1. **Inventorying the variables**: consists of making an inventory of the variables that characterize the studied system and its environment (internal and external). The precise definition of each variable is essential for the subsequent analysis of interrelation and allows for easier establishment of the necessary basis for all prospective reflection.
2. **Describing the existing relationships between the variables**: a variable only exists through its interrelation with other variables. Structural analysis allows for identifying these relationships between variables using a two-entry table called the "structural analysis matrix." Filling the matrix is qualitative through a pairwise evaluation of variables, asking: Is there a positive influence relationship between variable *i* and variable *j*? If the answer is negative, 0 is placed. If the answer is positive, 1 is placed.

3. **Identifying the key variables:** involves pinpointing the essential factors for the system's evolution. Initially, identification is straightforward, relying on direct classification. Subsequently, an indirect classification method, known as "Cross-Impact Matrix Multiplication Applied to Classification" (MICMAC), is applied after powering the initial matrix. By comparing the hierarchy of variables across different classifications (direct, indirect, and potential), we confirm the importance of certain variables and uncover others that play a predominant role, even if they haven't been detected by direct classification. The results of the MICMAC method are represented by their positions in the quadrants of a Cartesian plane with axes of influence vs. dependency. In this representation, five types of variables can be distinguished: 1) driving, 2) link, 3) resulting, 4) excluded, and 5) from the "peloton" (cluster of indicators located around the mean values of influence and dependence axes and they do not have significant influence on the system) (Figure 2).

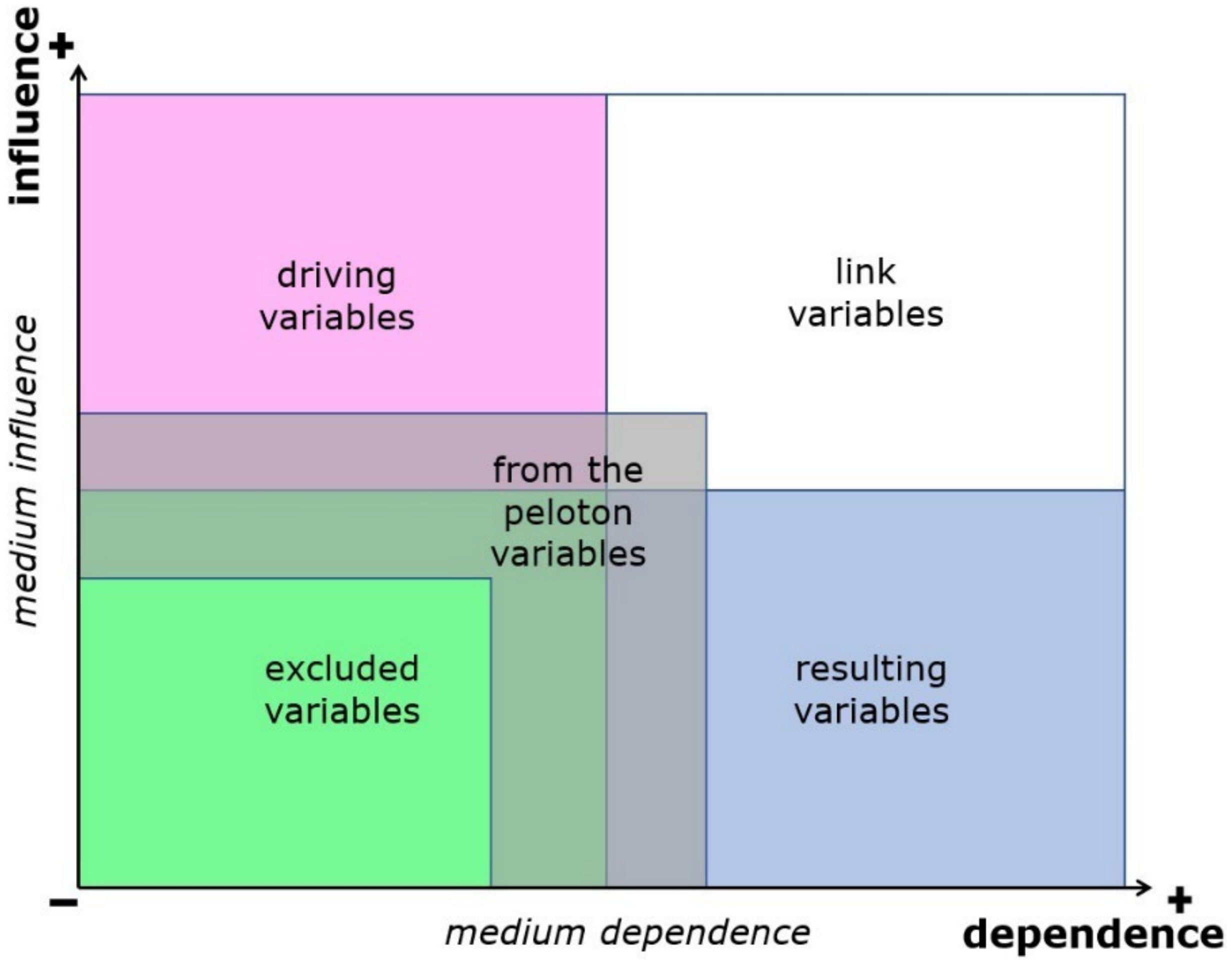

Figure 2. The different types of variables on the influence-dependence plane. Source: Authors' elaboration based on Godet and Durance (2011, p. 67).

According to Figure 2, the *excluded variables* (lower-left quadrant) exert neither influence nor dependence on the rest of the system. Their modification also has no significant consequences on the system. The evolution of *resulting variables* (lower-right quadrant) is a consequence of the driving force of the variables in the upper quadrants (driving and link variables), as they are their main causes. The behavior of *driving variables* (upper-left quadrant) conditions the system's dynamics since they influence the rest of the system's variables, while few or none influence them. *Link variables* (upper-right quadrant) influence the behavior of other variables (resulting), but they also receive influence from other variables within the system (driving). These variables are unstable because any action on them will have repercussions on others and on themselves due to a feedback effect that enhances or reduces their initial momentum. *Variables from the peloton* are those that cannot be clearly defined as influential or dependent, and their modification has no significant consequences on the rest of the system. For this reason, *excluded and peloton variables* are ignored and omitted from the identification of key variables (Godet & Durance, 2011).

Structural analysis allows for reducing the complexity of the studied system and identifying key variables. Its utility lies in stimulating reflection and interpretation on the counterintuitive aspects of a system's behavior. The purpose of this tool is to enable the structuring of collective reflection, reducing inevitable deviations (Godet & Durance, 2011, p. 68).

Methodology

This work was carried out through archival research - documentary work and cabinet analysis - based on the *Delphi Consultation Group Technique* (Godet, 1993, pp. 144-147; Godet & Durance, 2011, pp. 76-78), which involved the review, reflection, and analysis of a wide range of studies and research on social organization and water governance already validated and discussed at the Inter-American Institute of Water

Technology and Sciences (IITCA-UAEMéx), to identify consensus by a group of experts (authors of postgraduate theses), and thus make better decisions regarding the water issues of the DWSCT, specifically in the completion of data matrices.

An original and innovative methodology structured by Díaz-Delgado *et al*. (2009) and Díaz-Delgado *et al*. (2017) was employed, combining instruments and methods of participatory strategic planning - tactical phase - with an integrated approach. This allowed for the methodological sequence of four analysis phases (PSP-IWRM process).

Phase 1. Identification of Planning and Coordination Strategic Areas (PCSA): this phase involved defining the strategic areas that best encompass the analysis of the issues.

Phase 2. Identification of critical success factors (CSF): this phase entailed identifying sets of problems, which were classified for each of the PCSA according to the SLOT analysis (strengths, limitations, opportunities, threats). Subsequently, conceptual models of the water issues were built - one for each PCSA - to have a comprehensive view of the problems and identify the relationships between them. Finally, the sets of problems - one for each PCSA - were analyzed and reduced using the *cross-matrix of importance* to obtain the CSF. To accomplish this, matrices were built - one for each PCSA - and all problems were compared against each other. Each matrix was filled by asking: Is the critical problem placed in the row more important than the one placed in the column? If the answer was positive, a "1" was placed; otherwise, a "0" was placed (Table 1).

Table 1. Cross-matrix of importance.

Is the critical problem placed in the row more important than the one placed in the column?	**Critical Problem 1**	**Critical Problem 2**	**Critical Problem 3**	**Critical Problem 4**	**Critical Problem 5**	**Critical Problem 6**	**Critical Problem 7**	**Critical Problem *n***	**Total**
Critical Problem 1		1	0	0	1	0	1	1	4
Critical Problem 2			0	0	1	0	1	1	3
Critical Problem 3				1	1	1	1	1	5
Critical Problem 4					1	1	1	0	3
Critical Problem 5						0	1	1	2
Critical Problem 6							1	1	2
Critical Problem 7								0	0
Critical Problem *n*									0
Vertical sum	0	0	2	2	0	3	0	2	
Horizontal sum	4	3	5	3	2	2	0	0	
Total	**4**	**3**	**7**	**5**	**2**	**5**	**0**	**2**	

Source: Authors' elaboration based on Zepeda (2017, p. 98).

In each matrix, the total number of ones in each row and the total number of zeros in each column were added up. Then, both results were summed to obtain the total sum of zeros and ones. Finally, the top three problems with the highest total sum obtained were selected, constituting the Critical Success Factors (CSF).

Phase 3. Identification and definition of the driving force-pressure-state-impact-response (DPSIR) indicator System: given that the previous phase identified the Critical Success Factors (CSF), the next phase of the process consisted of identifying and defining a set of indicators under the DPSIR scheme. This allows for identifying and understanding the cause-effect network of water issues. However, due to its analytical complexity in identifying and defining DPSIR indicators, a support template was developed to define and obtain a quantitative or qualitative assessment of each indicator. The template recorded the type of Planning and Coordination Strategic Area (PCSA), the CSF, the SLOT condition, and the questions that each of the DPSIR indicators must answer (Figure 3).

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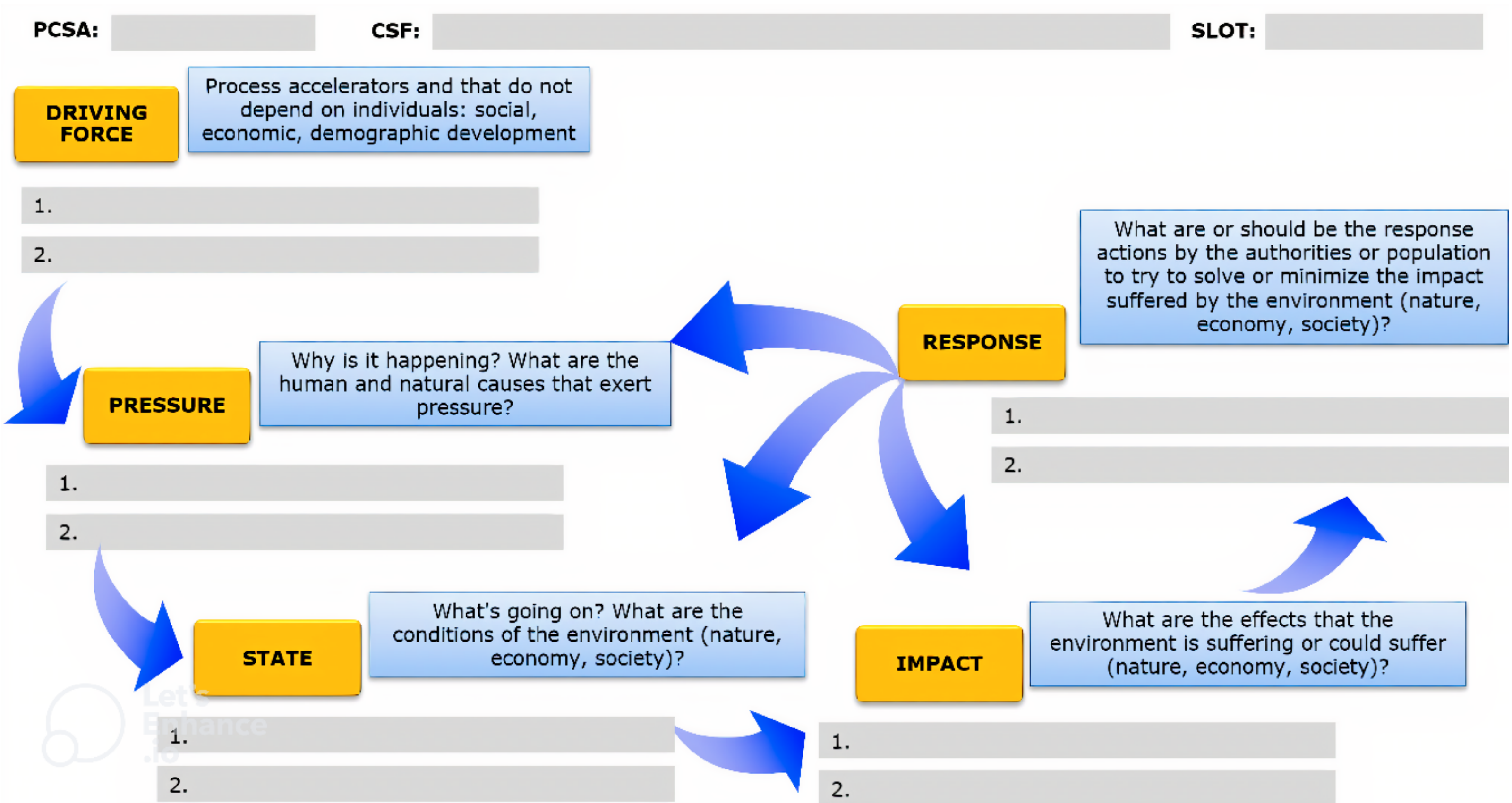

Figure 3. Support template for the identification and definition of DPSIR indicators. Source: Authors' elaboration based on Díaz-Delgado *et al*. (2009, p. 34).

This systemic approach tool allowed for thorough reflection and analysis -without deviations- of the causes, consequences, and responses to the changes of each CSF, while also helping to understand the network of cause-effect relationships within the system.

Phase 4. Structural systems analysis: involved reducing the system's complexity and identifying key indicators, which was achieved through three steps: 1) inventory of system indicators; 2) description of relationships between indicators; 3) identification of key indicators (Godet, 1993; Godet & Durance, 2011).

1. Inventory of system indicators: Corresponded to the set of indicators obtained in the previous phase.

2. Description of relationships between indicators: involved identifying, analyzing, discussing, and reaching consensus on relationships between pairs of indicators through the cross-impact matrix, where rows "X" and columns "Y" listed the indicators that model the system. A pairwise evaluation of indicators was conducted, asking: Does a positive change in the status of the first indicator (listed in the row) directly imply a positive change in the status of a second indicator (listed in the column)? This question was applied to each indicator with respect to all others to obtain a cross-evaluation of all indicators against themselves (Godet, 1993; Godet & Durance, 2011). If the answer was affirmative, a 1 was placed; otherwise, a 0 was placed. This logic of zeros and ones was used to decisively determine if there is a direct influence relationship in each evaluation (Manzano, 2017, p. 86; Díaz-Delgado *et al*., 2017).

The filling of the structural analysis matrix was done with the support of the *MID Fill* software application (Manzano, 2017), which provided the matrix of direct influence (MID) of zeros and ones. The sum of the values in each indicator's line represented the magnitude of influence to positively modify the system's status, and in turn, the sum of the values in its respective column represented the dependence of its improvement, which was subject to positive changes in other indicators (Díaz-Delgado *et al*., 2017).

3. Identification of Key Indicators: it was carried out with the support of the MoSoPEP-GIRH&CMI software (Zepeda, 2017), where the MID - the result of the previous step - was the primary input to process and automatically generate three matrices (indirect influence, result, and total influence), four planes (direct influence, indirect influence, displacement, and total influence), and a graph of the system's network of relationships. Likewise, the software classified the indicators into five groups: 1) driving, 2) linking, 3) from the peloton, 4) excluded, and 5) resulting, which were graphically represented by their position in the quadrants of a Cartesian plane with axes of influence vs. dependency.

The previous PSP-IWRM methodological sequence allowed for the identification, analysis, and understanding of the water issues of the DWSCT with an integrated approach; the identification and prioritization of critical problems (CSF); the identification and definition of the DPSIR indicator system; the reduction of the number of indicators; and the identification of key indicators.

The proposed methodological framework has been adjusted and refined by Romero *et al*. (2015) through its application to postgraduate thesis studies focusing on water governance theory and social organization within the research line of integrated water management at the IITCA-UAEMéx. Thus, the study of the DWSCT was based on fieldwork evidence (interviews with key informants) conducted intensively during the research projects of Campuzano (2015) and Gómez (2016). These studies served for the identification and description of the DWSCT (structure, organization, functioning), which were also analyzed as part of the socio-religious leadership system related to the social management of water: identity, equity, cooperation, participation, democracy, and governance.

Meanwhile, Anzurez (2016) and Anzurez (2020), with empirical-practical knowledge of participatory work in a DWSCT, identified and characterized the water issues of the DWSCT, gathering information from: 1) statewide newspapers (*El Sol de Toluca*, *Milenio*, *El Gráfico*, *La Jornada*, *Impulso*) during the period 2014-2020; 2) the 2nd and 3rd Seminar-Workshop "Issues and studies on water in the State of Mexico"; 3) the Forum: "What water law does Mexico need to guarantee the human right to water?", as part of the activities of the "critical water studies" network, developed at the Autonomous University of the State of Mexico (UAEMéx) from August 2017 to February 2019.

Therefore, this work did not require further field research but used data and information already validated and discussed in previous postgraduate theses on water governance, community management, self-management, community identity, cooperation, among others. These served for the state of the art in the conceptualization and interpretation of theoretical-conceptual information, as well as in the identification and definition of water issues.

The study of DWSCT through systemic processes is theoretically and methodologically linked to other postgraduate theses developed at the IITCA by Manzano (2007), Zepeda (2012), García (2016), Manzano (2017), Zepeda (2017), and Bernal (2017). They employed the PSP-IWRM approach, systemic indicators (PSR, PSIR, DPSIR), and structural analysis of systems in hydrological and hydrosocial watersheds.

Additionally, they developed *software*, hydro-geomathique models, and tools to support the PSP-IWRM methodological process.

Results

Four Planning and Coordination Strategic Areas (PCSA) were identified and defined to address the analysis of the water issues of the 27 DWSCT: 1) sociopolitical, 2) economic, 3) environmental, and 4) technical-operational, which constituted the minimum dimensions of analysis based on the three interconnected pillars of sustainable development. The fourth axis incorporated the level of organization and capacity regarding knowledge and information (Table 2).

Table 2. PCSA Defining the Water Issues of the DWSCT.

PCSA	Content
Sociopolitical	It comprehends internal and external aspects of the DWSCT: social, historical, cultural, political, governance, governability, identity, equity, self-management, gender, participation, organization, operation, co-management, decision-making
Economic	It incorporates financial aspects of the DWSCT both internally and externally: economic situation, expenses, water payments, backlog, exemptions, sanctions, penalties, integrity, transparency, accountability, corruption
Environmental	It includes the environmental aspects (internal and external) of the DWSCT: water sources, water quality, water availability, wastewater discharges, water treatment
Technical-operational	It includes the technical and operational aspects (internal and external) of the DWSCT: capacities and skills of the actors, hydraulic infrastructure (drinking water distribution networks, water leaks, volume of water extracted), knowledge, availability of information, user registry, household connections, served population, supply

Source: Authors' elaboration based on Anzurez (2020, p. 102).

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A list of 89 problems afflicting the 27 DWSCT was identified, which were classified for each SLOT category and for each of the four PCSA: 29 problems in the socio-political PCSA; 18 in the environmental PCSA; 23 in the economic PCSA; and 19 in the technical-operational PCSA (Table 3, Table 4, Table 5, and Table 6).

Table 3. PCSA sociopolitical: SLOT analysis of critical problems of the DWSCT.

Strengths	**Limitations**	**Opportunities**	**Threats**
1. Long-standing socio-historical context	1. Social inequity in water supply	1. Recognized customs and traditions in the Mexican Constitution	1. Socio-political conflicts related to water
2. Civic-religious charge system	2. Social inequity in water payment	2. Support from NGOs and research centers	2. Lack of cooperation with government agencies
3. Committee legitimacy among users	3. Social inequity in tariff establishment	3. Diversity of ethnicities in rural and urban areas	3. Lack of legality of the committee before the State
4. Community general assembly	4. Gender inequality in committee positions	4. Service and infrastructure in urban areas by committees	4. National water law
5. Community identity	5. Lack of internal regulations in the committee	5. Increase and diversity of committee typologies	5. Areas with marginalization and extreme poverty
6. Methods for selecting committee actors	6. Limited social participation in assemblies and committee positions	6. Good water governance	6. Migration and population growth
7. Self-management	7. Few assemblies held per year		7. Lack of good water governance
	8. Lack of concession titles		
	9. Social exclusion due to lack of community identity		

Source: Authors' elaboration based on Anzurez (2020).

Table 4. PCSA environmental: SLOT analysis of critical problems of the DWSCT.

Strengths	Limitations	Opportunities	Threats
1. Water rationing 2. Environmental governance	1. Water leaks 2. Lack of treatment 3. Lack of simple treatment of domestic wastewater 4. Lack of proper disposal of domestic wastewater	1. Rainwater harvesting 2. Use of springs 3. Drilling deeper wells	1. Overexploitation of aquifers 2. Aquifer contamination 3. Contamination of surface water bodies 4. Clandestine wells, illegal taps, and irregular connections 5. Water scarcity and poor water quality 6. Climate change 7. Drought 8. Soil erosion 9. Changes in land use

Source: authors' elaboration based on Anzurez (2020).

Table 5. PCSA economical: SLOT analysis of critical problems of the DWSCT.

Strengths	Limitations	Opportunities	Threats
1. Discounts or payment facilities for users in special situations 2. Voluntariness of committee actors 3. Modification and adjustments of tariffs in assembly 4. The Tequio (community work) 5. Short administrative periods	1. Historical debts to CONAGUA, CAEM, and CFE 2. Financial insufficiency 3. Low tariffs 4. Low collection 5. Lack of payment to committee actors 6. Lack of integrity of committee actors 7. Lack of transparency and accountability mechanisms 8. Payment exemptions for social institutions and elderly users 9. Lack of mechanisms to improve collection 10. Lack of internal regulations to penalize integrity violations 11. Extended administrative periods	1. Surveillance Council, Review Commission, Honor and Justice Council 2. Social pressure to cover water fees 3. Co-management with municipal authorities 4. Support from NGOs and research centers	1. Delinquent users and arrears in their payments 2. Clandestine water withdrawals and irregular connections 3. Costs of expansion and maintenance of drinking water distribution networks

Source: authors' elaboration based on Anzurez (2020).

Table 6. PCSA technical-operational: SLOT analysis of critical problems of the DWSCT.

Strengths	Limitations	Opportunities	Threats
1. Internal organization created and designed by the users themselves 2. Voluntariness of committee actors 3. Hiring specialized services 4. Water rationing 5. Self-management 6. Empirical-practical knowledge of committee actors	1. Deficient and insufficient hydraulic infrastructure 2. Scarcity of reliable and accurate data and information 3. Shortage of actors in the committee 4. Lack of specialized personnel in water matters 5. Absence of an organization and functioning manual for the committee 6. Lack of electronic systems for data and information management 7. Manual methods of recording, control, and administration 8. Absence of operation guides and technical procedures	1. External participation related to the committee 2. Support from NGOs and research centers 3. Use of electronic systems for handling digital data and information	1. Lack of comprehensive advice and training for committee actors 2. Demand and expansion of water distribution networks due to population growth

Source: Authors' elaboration based on Anzurez (2020).

After identifying and defining the problems of the DWSCT in the SLOT matrices by PCSA, conceptual models were constructed to improve system understanding, provide a comprehensive view, and identify the existing relationships between the problems. Due to space constraints, only one conceptual model is shown (Figure 4).

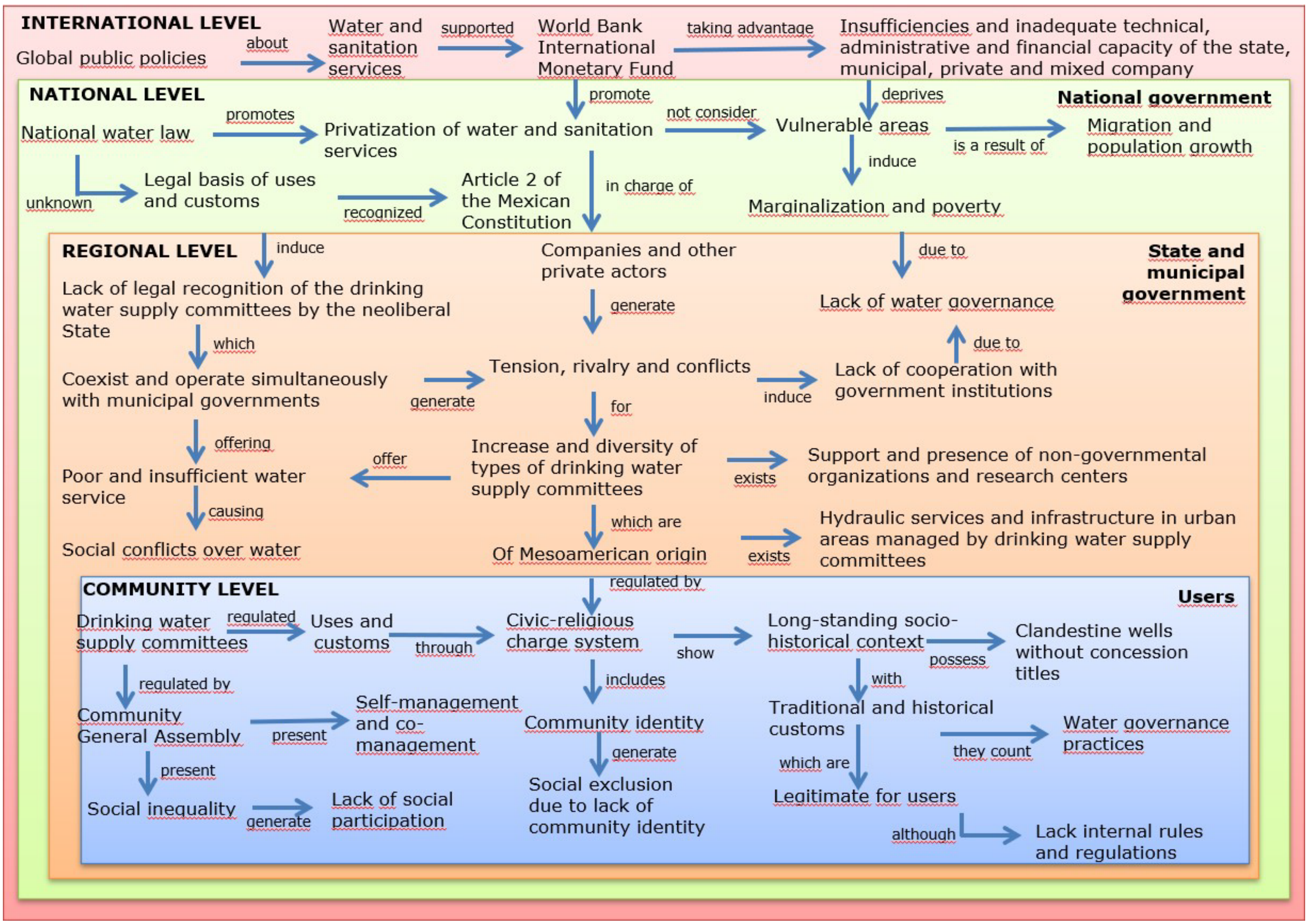

Figure 4. Conceptual model of critical problems of the DWSCT: Socio-political PCSA. Source: Authors' elaboration based on Anzurez (2020, p. 111).

The problems are interconnected by a word that reflects their relationship, starting from the international level with the regulatory agencies of water and sanitation services, then descending to the national and regional level where governments (national, state, municipal) responsible for the same service are located, and ending at the community level where water committees are found.

After analyzing the issues by PCSA through conceptual models, four *importance matrices* were constructed -one for each PCSA- to reduce the number of problems and obtain the set of critical success factors (CSFs). Due to the size of the four matrices, it was not possible to display them, but in each one, the total of ones in each row and the total of zeros in each column were added. Finally, both results were summed to obtain the total sum of zeros and ones. In this way, the 12 CSFs - 3 for each PCSA - with the highest scores were selected (Table 7).

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Table 7. Key Prioritized CSFs of the DWSCT by PCSA.

ID	Key prioritized CSFs	SLOT	PCSA	Score
CSF_1	Areas with marginalization and extreme poverty	Threat	Sociopolitical	27
CSF _2	National Water Law	Threat	Sociopolitical	26
CSF_3	Lack of good water governability	Threat	Sociopolitical	26
CSF_4	Shortage of internal regulations to penalize integrity violations	Limitation	Economical	20
CSF_5	Lack of transparency and accountability mechanisms	Limitation	Economical	18
CSF_6	Clandestine water withdrawals and irregular connections	Limitation	Economical	18
CSF_7	Contamination of aquifers	Threat	Environmental	16
CSF_8	Water scarcity	Threat	Environmental	16
CSF_9	Climatic change	Threat	Environmental	16
CSF_10	Deficient and insufficient hydraulic infrastructure	Limitation	Technical-operational	18
CSF_11	Lack of comprehensive advice and training for committee actors	Limitation	Technical-operational	17
CSF_12	Scarcity of reliable and accurate data and information	Limitation	Technical-operational	16

Source: Authors' elaboration based on Anzurez (2020, p. 120).

These 12 CSFs were modeled through 120 **DPSIR** indicators (with a systemic approach): 10 indicators for each CSF (2 for **D**, 2 for **P**, 2 for **S**, 2 for **I**, and 2 for **R**), which helped understand and improve the knowledge of the cause-effect network of the DWSCT management system (Anzurez, 2020, pp. 129-140). However, due to space constraints, only 5 DPSIR indicators of 4 CSFs - one CSF per PCSA - are presented (Table 8, Table 9, Table 10, and Table 11).

Table 8. DPSIR Indicators of CSF_1: Areas with Marginalization and Extreme Poverty (Sociopolitical PCSA).

DPSIR	Indicator	Definition	Unit of measurement / method of calculation
D	Rate of population growth	Percentage growth (or decline) of the population over one year, due to natural increase and migration	RPG (%)
P	Homes without piped water	Percentage of inhabited private households without piped water availability within the dwelling in a year	(#Homes without piped water i / Total homes i) * 100, where i represents the time period
S	Sociopolitical conflicts over water	Percentage of socio-political conflicts over water (domestic and urban public use) resolved within one year (complaints, disagreements, and social demands) in the municipality of Toluca	(#Socio-political conflicts resolved i / #Socio-political conflicts occurred i) * 100, where i represents the time period
I	Cumulative incidence due to water-related causes	Percentage of inhabitants who fall ill in a year due to water-related causes (scarcity, abundance, contamination)	(#People sick due to water-related causes i / Total population i) * 100, where i represents the time period
R	Drinking water coverage	Percentage growth of water service coverage in one year in the municipality of Toluca: operator agency and water committees	(S_{ij}-$S_{i(j-1)}$) (100) where $S_{i\,i}$ is the water management system, and $_j$, the time period

Source: Authors' elaboration based on Anzurez (2020, p. 129).

Table 9. DPSIR Indicators of CSF_6: Clandestine Water Withdrawals and Irregular Connections (Economic PCSA).

DPSIR	Indicator	Definition	Unit of measurement / method of calculation
D	Population density	Average number of inhabitants in an urban or rural area in relation to the total surface area of the municipal territory	(#inhab/Km^2 $_i$ - #inhab/Km^2 $_{i-1}$) (100) where $_i$ is the time period
P	Culture of "non-payment"	Percentage of users who do not pay or are overdue in their payments in a year	(#Users not paying $_i$ /Total users $_i$) (100) where $_i$ is the time period
S	Financial situation	Financial situation of the committee in a year, in relation to expenses and revenue	(Total income $_i$ - Total expenses $_i$) $_i$ is the time period
I	Growth of delinquent users	Percentage increase of delinquent and overdue users in their payments in one year, relative to the immediate previous year	(#Delinquent users #Delinquent users $_{i-1}$) (100) where $_i$ is the time period
R	Water withdrawal regularization	Percentage of regularization of clandestine water withdrawals and irregular connections in one year	(#Regularizations $_i$ / Total inspections $_i$) (100) where $_i$ is the time period

Source: Authors' elaboration based on Anzurez (2020, p. 134).

Table 10. DPSIR Indicators of CSF_7: Aquifer Pollution (DPSIR Environmental)

DPSIR	Indicator	Definition	Unit of measurement / method of calculation
D	Urban growth	Percentage growth of the urban area due to economic development, housing construction, and building	(#Houses/$Km^2{}_i$ - # Houses/$Km^2{}_{i-1}$) (100) where $_i$ is the time period
P	Wastewater disccharges	Total generation of wastewater (municipal and industrial point discharges) in unlined watercourses without prior treatment	($Mm^3{}_i$ - $m^3{}_{i-1}$) (100) where $_i$ is the time period
S	Water quality	Systematic water quality monitoring that allows detecting changes in its usual characteristics	(WQ_i - WQ_{i-1}) (100) where $_i$ is the time period
I	Mortality due to water-related causes	Percentage of deaths due to water-related causes in a year (scarcity, abundance, pollution)	(#Deaths due to water-related causes / total population) (10n)
R	Wastewater treatment	Percentage of municipal and industrial wastewater receiving treatment relative to the water generated within the municipal territory	($Mm^3{}_i$ - $Mm^3{}_{i-1}$) (100) where $_i$ is the time period

Source: Authors' elaboration based on Anzurez (2020, p. 135).

Table 11. DPSIR Indicators of CSF_10: Deficient and Insufficient Hydraulic Infrastructure (Technical-Operational PCSA).

DPSIR	Indicator	Definition	Unit of measurement / method of calculation
D	Rate of population growth	Percentage growth (or decrease) of the population over a year, due to natural increase and migration	RPG (%)
P	Financial insufficiency	Scarcity of economic resources for maintenance, operation, rehabilitation, and expansion of hydraulic infrastructure in a year	(Total income $_i$ - Total expenses $_i$) where $_i$ is the time period
S	Water leaks	Response capacity to resolve drinking water waste in drinking water distribution networks	(#Water leaks repaired $_i$ /Total reports $_i$) (100) where $_i$ is the time period
I	Homes without access to water	Private occupied houses without water, whether from the public network, water intake, another house, water tanker, well, stream, or lake	(#Houses without water $_i$/Total houses $_i$) (100) where $_i$ is the time period
R	Investment in hydraulic infrastructure	Economic resources allocated to the maintenance, rehabilitation, and expansion of hydraulic infrastructure in a year	(\$ $_i$) where $_i$ is the time period

Source: Authors' elaboration based on Anzurez (2020, p. 138).

The set of 120 DPSIR indicators was reduced through *structural system analysis* using the cross-impact matrix. This simplification of the complexity of DWSCT management systems was aimed at identifying *key priority indicators*.

The processing of the binary Direct Influence Matrix (DIM) to the 7th power, using the MoSoPEP-GIRH&CMI software, allowed the detection of *52 priority key indicators (34 link, 16 driving, and 2 resultant)*, of which 24 key indicators (19 *link* and 5 *driving*) corresponded to the Economic PCSA; 19 (10 *link*, 8 *driving*, and 1 *resultant*) to the Technical-Operational PCSA; and 9 (5 *link*, 3 *driving*, and 1 *resultant*) to the Socio-Political PCSA. The indicators of the Environmental PCSA were discarded as they were in the *excluded and peloton* indicator quadrants (Figure 5).

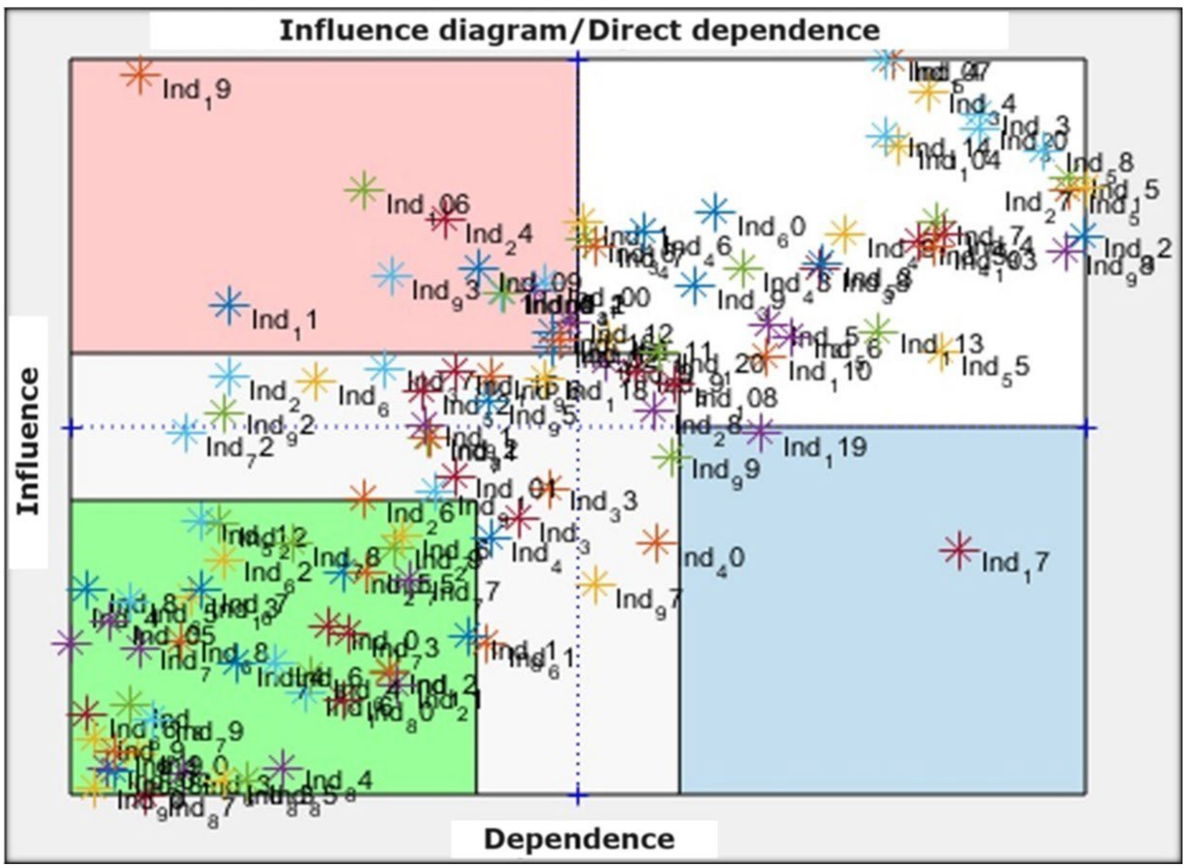

Figure 5. Total influence diagram of the DWSCT management system.

Source: Authors' elaboration based on Anzurez (2020, p. 155).

The *52 priority key indicators* were those that were most influential and dependent, located graphically in the total influence diagram, within the quadrants of *driving*, *link*, and *resultant indicators*. Indicators located in the *excluded* and *peloton* quadrants were discarded as they were not clearly defined, nor did they exert influence or dependence on the rest of the system (Manzano, 2017, p. 151) (Table 12).

Table 12. Priority key indicators of the DWSCT management system by PCSA, indicator category, and level of influence**.**

Id	Indicator number	Indicator name	DPSIR	PCSA	Indicator category	Influence level
1	107	Technical-operational inefficiency of committee actors	I	Technical-operational	Link	114.80
2	54	Administrative inefficiency of the committee	P	Economic	Link	114.75
3	19	Regularization of informal interest group actors	R	Sociopolitical	Driving	112.23
4	34	Willingness of committee actors to hold assemblies	P	Economic	Link	109.76
5	23	Collaborative water management	P	Sociopolitical	Link	106.40
6	30	Incorporation of users	R	Sociopolitical	Link	104.15
7	114	Willingness of actors to generate data and information	P	Technical-operational	Link	103.02
8	104	Willingness of committee actors to receive comprehensive training	P	Technical-operational	Link	101.19

Id	Indicator number	Indicator name	DPSIR	PCSA	Indicator category	Influence level
9	58	Socioeconomic conflictiveness	I	Economic	Link	100.73
10	15	Social conflicts due to changes in current water legislation	S	Sociopolitical	Link	96.49
11	27	Sociopolitical conflict with the governmental sector	I	Sociopolitical	Link	94.76
12	5	Social conflicts over water in vulnerable areas	S	Sociopolitical	Link	94.40
13	106	Professionalization of the committee	S	Technical-operational	Driving	94.37
14	60	Regularization of illegal connections	R	Economic	Link	90.94
15	24	Corruption in the water sector	P	Sociopolitical	Driving	89.85
16	41	Transparency and access to information	D	Economic	Link	89.57
17	57	Financial insufficiency due to illegal water intakes	I	Economic	Link	89.47
18	46	Uninformed users	S	Economic	Link	87.95
19	94	Financial insufficiency for hydraulic infrastructure	P	Technical-operational	Link	87.72
20	48	Financial situation of the committee	I	Economic	Link	87.59
21	32	Water governance of the committee	D	Economic	Link	87.32
22	36	Corruption of committee actors	S	Economic	Link	86.84
23	45	Users' economic trust	S	Economic	Link	86.46
24	47	Opacity of information regarding the financial management of the committee	I	Economic	Link	85.97

Id	Indicator number	Indicator name	DPSIR	PCSA	Indicator category	Influence level
25	103	Inadequate economic resources for comprehensive training of the actors	P	Technical-operational	Link	85.73
26	98	Social conflicts due to deficiencies in the water service	I	Technical-operational	Link	84.85
27	53	Socioeconomic culture of "non-payment"	P	Economic	Link	82.98
28	109	Comprehensive training of committee actors	R	Technical-operational	Driving	82.35
29	38	Inappropriate use of economic resources	I	Economic	Link	82.35
30	43	Social participation in assemblies	P	Economic	Link	82.35
31	93	Lack of technical-operational knowledge among committee actors	P	Technical-operational	Driving	81.21
32	100	Technical-operational training of committee actors	R	Technical-operational	Driving	80.06
33	39	Development of internal regulations of the committee	R	Economic	Link	79.64
34	42	Accountability of committee actors	D	Economic	Driving	78.96
35	31	Integrity of committee actors	D	Economic	Driving	78.90
36	50	Participation of users in cash reconciliation	R	Economic	Driving	78.65
37	44	General assemblies	P	Economic	Driving	78.64
38	11	Regulatory framework on water adapted to IWRM	D	Sociopolitical	Driving	76.58
39	112	Intersectoral sharing of knowledge and information	D	Technical-operational	Driving	74.14
40	35	Delinquent users	S	Economic	Link	73.78

Id	Indicator number	Indicator name	DPSIR	PCSA	Indicator category	Influence level
41	116	Outdated data and information	S	Technical-operational	Driving	72.66
42	113	Financial insufficiency for office equipment and furniture	P	Technical-operational	Link	72.53
43	56	Increase of delinquent users number	S	Economic	Link	71.78
44	111	Transparency and access to technical-operational information	D	Technical-operational	Link	71.46
45	117	Opacity of information and data	I	Technical-operational	Driving	71.31
46	102	Knowledge and information	D	Technical-operational	Driving	70.27
47	120	Generation of reliable and accurate information and data	R	Technical-operational	Link	69.48
48	55	Economic collection	S	Economic	Link	69.47
49	110	Investment in comprehensive counseling and training for the actors	R	Technical-operational	Link	68.53
50	37	Impunity	I	Economic	Driving	66.89
51	119	Investment in infrastructure, equipment, and furniture	R	Technical-operational	Resultant	56.84
52	17	Committees without legal personality providing water services without concession titles	I	Sociopolitical	Resultant	38.80

Source: Authors' elaboration based on Anzurez (2020, p. 156).

It is worth noting that this list of 52 key indicators is not definitive, as it can be simplified if it is decided to work with a group of indicators (link, driving) or select those indicators with the highest level of influence.

The largest number of key indicators belonged to the Economic PCSA (24 indicators), indicating it as the PCSA with the highest weight and level of influence (46.4 %) in the DWSCT management system. Next was the Technical-Operational PCSA with 19 key indicators and 35.1 % influence in the system; finally, the Socio-Political PCSA with 9 key indicators and lower level of influence in the DWSCT management system (18.5 %).

Discussion

In this work, the decision was made to analyze and prioritize the water issues of the 27 DWSCT, which were identified as those committees of ethnic origin (Otomi) incorporated into the ancient social structure: the civic-religious charges system, governed by customs and traditions exercised through customary law. These DWSCT have a historical tradition of governance and self-management in water management, located in indigenous communities, which share similar characteristics of community identity, socio-historical origin, general assembly, honorary positions, structure, organization, and functioning.

At the beginning of the research, it was thought to study the problems of water committees in the Mexican Republic because it was believed that the problems in community water management were homogeneous. However, political, legislative, and administrative differences were identified in each federative state. In some states (Chiapas, Oaxaca, Morelos, Chihuahua, Guanajuato, San Luis Potosí, Tabasco), they have modified their water legislation and have formally recognized and accepted the committees, while others have not (Mexico, Puebla, Nuevo León, Jalisco). Additionally, territorial changes caused by water transfers, industrialization, population growth, demand for public services, religious changes, changes in economic activities, and market movements were added. These further exacerbate the problems of the committees and modify collaborative management and effective water governance.

The above led to delimiting the study area on a smaller scale (State of Mexico, hydro-social watershed). Yet, a large amount and variety of committees (old, recently created, formal, illegal, mixed, special) were identified, as well as differences regarding their water sources (extraction wells, springs, branch of the Lerma and Cutzamala systems, water trucks), water availability (scarcity or abundance), types of land tenure (ejidal, communal, agricultural and livestock, small property), among others.

Although the DWSCT share similar characteristics, different problems were also identified within them, as well as in their relationships with the State. It was thought that the main problem of these committees was the lack of legal recognition by the State, as indicated by various studies on community management (Giménez & Palerm, 2007; Galindo & Palerm, 2007; López *et al.*, 2013; Becerril-Tinoco & De Alba-Murrieta, 2014; Díaz, 2014; Escobar, 2015; Bastian & Vargas, 2015; Vargas, 2015). However, when analyzed through systemic processes, other (internal and external) problems of greater priority emerged.

In this regard, the critical problems (CSF) found in the Economic and Technical-Operational PCSA, according to their SLOT condition, were internal aspects of the DWSCT (limitations) that negatively affect their organization and functioning, as they stem from community management and are the exclusive competence of the DWSCT themselves through self-management, good governance practices, and decision-making in general assemblies: 1) scarcity of internal regulations to sanction integrity breaches; 2) lack of transparency and accountability mechanisms; 3) illegal water intakes and irregular connections; 4) deficient and insufficient hydraulic infrastructure; 5) lack of comprehensive counseling and training for committee actors, and 6) scarcity of reliable and accurate data and information.

On the other hand, the critical problems (CSF) found in the Socio-Political and Environmental PCSA, according to their SLOT condition, were external aspects of the DWSCT (threats) that negatively affect their internal organization and functioning because they come from the outside: 1) areas with marginalization and extreme poverty; 2) national water law; 3) lack of good water governance; 4) aquifer contamination; 5) lack of water availability, and 6) climate change. These problems are external to the DWSCT and are the exclusive competence of the governments (national, state, and municipal) through environmental public policies and water legislation.

Regarding the 120 DPSIR indicators – 10 for each CSF – that model the 12 CSFs, it is possible that the formulation of some of them in quantitative and/or qualitative terms was not perfected, and they also did not meet the characteristics that DPSIR indicators should fulfill. Despite several years of fieldwork and desk analysis (2013-2019) on social organization and water governance, there is not enough data and information to definitively formulate and calculate the indicators. Additionally, the absence of statistical data and information in official sources (water information system, state water system, water and sanitation agency of Toluca) further complicated the formulation and calculation of the indicators.

The absence of governmental data and field information led to the analysis and identification of key indicators based on consultation with "experts" with local knowledge using the Delphi Group Technique, resulting in the definition of indicators and the evaluation of relationships. A total of 14,280 relationships between pairs of indicators (120 by 120) were analyzed, which turned out to be an analytical and thorough process due to the large number of relationships. The cross-impact matrix was then completed. However, this consultation technique cannot replace the information obtained through fieldwork, as it was noted and evident that the "experts" were unaware of several topics regarding the identification and evaluation of indicators, which should have been properly reflected upon, analyzed, discussed, and decided with different stakeholders' groups from the public, social, and private sectors. Similarly, serious difficulties were encountered in conducting participatory workshops (working groups), as established by the PSP-IWRM methodology, such as absences, limited participation, unrepresentative community stakeholders, and vice versa, a high presence of the governmental sector, all of which led to the failure of said workshop technique.

As a result of the aforementioned methodology, there was a bias in the information and evaluation of relationships between pairs of indicators, as it was not possible to carry it out as required by the PSP-IWRM methodology, which may be very difficult or impossible. However, it is considered that to achieve a common vision and build consensus around the water problems of the DWSCT, it is necessary to eliminate the proposal of participatory workshops and increase the time of fieldwork with all water actors, to ensure their vision within the study and for the definition of indicators in all stages of the PSP-IWRM process.

Despite the aforementioned challenges, 52 key indicators (34 linking, 16 driving, and 2 resulting) were obtained, representing the *essential elements that must be considered and addressed in identifying governance and integrity strategies to resolve the water problems of the DWSCT*. In this regard, actions and alternative solutions will observe to the prioritized key indicators to enhance the management system of the DWSCT and preserve the water resources.

The linking indicators that had the highest level of influence on other indicators, but also received a lot of influence from others directly or indirectly, were:

1. PCSA economic: Administrative inefficiency of the committee; willingness of committee actors to hold assemblies; socio-economic conflict; regularization of illegal intakes.
2. PCSA technical-operational: Technical-operational inefficiency of committee actors; willingness to generate data and information; willingness to receive comprehensive training.

3. PCSA sociopolitical: Collaborative water management; user involvement; social conflicts due to changes in current water legislation; socio-political conflict with the governmental sector; social conflicts over water in vulnerable areas.

These linking indicators were related to the lack of capacities and skills of the actors, and the lack of human resources in the committees that hinder efficient and effective work in their organizations and water systems. Any action on these indicators will have consequences on the others and on themselves due to a feedback effect that either enhances or reduces their initial momentum.

The driving indicators that exerted significant influence on other indicators, but at the same time were influenced by few others (low dependency), were:

1. PCSA sociopolitical: Regularizations of informal interest groups.
2. PCSA technical-operational: Committee professionalization; comprehensive training of committee actors.

These driving indicators were decisive and drove the dynamics of the rest of the system. The regularization of informal actors was related to the need for legal recognition of the committees in the current national and state water legislation, to achieve their formal operation and guarantee the human right to water.

While professionalization and comprehensive training of the actors were driving indicators to improve the operation and administration of the DWSCT, it was identified that in indigenous communities, civic values – both individual and collective – of the actors and users are more relevant, such as honesty, responsibility, respect, and trust, which are promoted through good water governance practices, i.e., transparency, accountability, cooperation, equity, democracy, and voluntary user participation in decision-making.

Based on the results obtained in the PSP-IWRM methodological process, actions and alternative solutions can be formulated in order of priority or group of indicators. However, although this article was limited to the analysis stage of the PSP-IWRM process (analysis of the problem, identification of critical issues, identification of key indicators), the preparation of a subsequent article is envisaged, where actions and alternative solutions will be proposed by PCSA or group of indicators, and a proposal for an ideal community management model for the Toluca drinking water committees will be made.

Conclusions

The scientific theoretical basis with the definition of its operational concepts (theoretical-methodological) were fundamental for the understanding and interpretation of the data and information obtained with the PSP-IWRM procedure, which facilitated the identification, analysis, and prioritization of the water issues of the 27 DWSCT.

The theoretical approach to community water management (socio-historical, common goods, and co-management) allowed for understanding and analyzing the socio-political, cultural, and historical processes and relationships that gave rise to the DWSCT, and identifying their essential characteristics to have greater certainty in the processing of data matrices.

Fieldwork (interviews with key informants) and participatory work (empirical-practical knowledge) were fundamental instruments for the analysis, collection, and interpretation of data and information from the DWSCT. However, workshops and the Delphi consultation group technique, presented inconsistencies and deficiencies in formulating and calculating the indicators definitively.

While this methodology provides valuable insights into identifying, analyzing, and prioritizing water issues in DWSCT, limitations have also been identified in the process. *The joint participation of actors in a working group* -composed of community-level users (farmers, indigenous people, ejidatarios) and actors from the public (state and municipal government) and private (industries) sectors- is very limited in the participatory approach, with much work still needed to enhance people's willingness to participate.

Despite challenges, the PSP-IWRM methodological process proved effective in identifying and prioritizing water issues in the 27 DWSCT with an integrated approach. All its stages led to a situational analysis that improved understanding of the system through data matrices. The results obtained through this process were linked to the social structure of the 27 DWSCT and provided key elements (economic, sociopolitical, and technical-operational) of great operational utility for them. These elements can be considered for identifying specific actions and improving participation and decision-making in the water governance of their communities.

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