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Articles

Legal mechanisms for compliance with regulations on wastewater discharges in Mexico: An evaluation for Baja California Sur

Mecanismos legales para el cumplimiento de la normatividad sobre descargas de aguas residuales en México: una evaluación para Baja California Sur

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Abstract

In the comprehensive management strategy for water resources in Mexico, wastewater has received little attention. Despite the extensive



sewage regulations and its relevance for the quality and availability of water for human consumption; the control on wastewater discharge, its safe reuse, and pollution prevention is a pending task. This evidences the relevance of evaluating the effectiveness of regulations on wastewater discharge in the country, especially in regions with water stress where the human right to water and a healthy environment is compromised. Thus, in the case study of Baja California Sur, the sources of that regulation were identified, ranked, and characterized, and administrative acts of control were analyzed; such as the frequency of surveillance, inspection, corrective measures, sanctions imposed, and complaints filed from 2009 to 2018 in this region. The results show that the problem lies with administrative and institutional deficiencies to enforce compliance by the authority, rather than an ineffective legal framework, and with the lack of a public policy for the enforcement of regulations regarding wastewater discharges. Therefore, it is necessary that the authorities of the three levels of government evaluate and coordinate their strategies and orient them towards national and international objectives.

Keywords: Wastewater, legal framework, enforcement actions, compliance.

Resumen

En la estrategia de gestión integral de los recursos hídricos en México las aguas residuales han recibido escasa atención. A pesar de su centralidad en la disponibilidad y calidad del agua, y al extenso marco legal que las



regula, una tarea pendiente es controlar su descarga, promover su reutilización de manera segura y prevenir la contaminación. Esto sugiere la pertinencia de evaluar la eficacia de la normatividad en materia de descarga de aguas residuales en el país y, especialmente, en regiones con estrés hídrico, donde incluso se compromete el derecho humano al agua y a un ambiente sano. Así, se identificó, jerarquizó y caracterizó el sistema de fuentes de esa normatividad, y se analizaron actos administrativos de control, como frecuencia de vigilancia, inspección, medidas correctivas, sanciones impuestas y denuncias presentadas de 2009 a 2018 en Baja California Sur, región que se emplea como caso de estudio. Los resultados muestran que, más que un marco legal ineficaz, hay deficiencias administrativas e institucionales para exigir el cumplimiento por parte de la autoridad, y que se carece de una política pública para la aplicación de la normatividad en cuanto a las descargas de aguas residuales. Por lo tanto, es necesario que autoridades de los tres ámbitos de gobierno evalúen y coordinen sus estrategias, y las orienten hacia los objetivos nacionales e internacionales.

Palabras clave: aguas residuales, marco regulatorio, agua, cumplimiento legal.

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Introduction

Wastewater plays a central role in the problem of water availability and quality. As water demand grows worldwide, the volume of wastewater and its level of contamination also increases (UNESCO, 2017). In this sense, wastewater is a problem of national concern that must be analyzed from the municipal, state and federal levels of government for proper management. This paper refers to Baja California Sur (B.C.S.) as a case study. Located in Mexico's northwest this state is representative of regions that suffer from water scarcity and where the human right to this vital element is compromised (Graciano, 2019). Larger populations and environmental pressure from economic growth have been combined, in recent years, with the lack of water, and this scarcity has been identified as a limiting factor for this region's economic growth (Wurl, Imaz-Lamadrid, & García, 2013). The main sources of water pollution in this state are the discharges of municipal, industrial and agricultural water without any previous treatment, the low efficiency of treatment plants, infiltration of septic tanks and garbage dumps in inadequate places and landfills (Texas-Alvarez, 2013).

So far, the issue of wastewater has been understudied in B.C.S., despite the fact that its great impact on the availability. A paradigm shift is yet to be achieved to deem wastewater as an alternative source of water, going from its mere "treatment and disposal" to contemplating it as "reuse, recycling and recovery of resources" (UNESCO, 2017). Various countries, including Mexico, have adopted sustainable development goals (SDG) of the 2030 Agenda for Sustainable Development of the United Nations Organization, which set comprehensive goals for water that includes water supply issues and sanitation (AGNU, 2015). Target 6.3 of the SDG establishes that the signatory countries commit to: "By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally" (AGNU, 2015).

The current management of wastewater in Mexico does not allow its safe reuse and represents a source of contamination and health risk. Although 94 % of water supplied to population is at least disinfected, only 58.3 % of the water collected through sewage systems receives treatment to improve its quality before being reused or returned to a body of water (Conagua, 2017a). As a result, surface and groundwater for human consumption is contaminated by pathogenic microorganisms, mainly by fecal coliforms (Carabias & Landa, 2005).

The challenge to achieve the SDG lies with the existence of an effective legal framework that regulates wastewater in a comprehensive



manner, that clearly establishes the responsibilities of the different actors, and that individuals and organizations comply with, acting in accordance with the collective interest (UNESCO, 2017). In Mexico, there is a complex and extensive legal framework on wastewater, characterized by the overlapping of different regulatory layers at the federal, state and municipal levels. These ordinances regulate wastewater discharges through different pollution control instruments, such as discharge permits, payment of rights, the application of wastewater quality standards or land use zoning (UNESCO, 2017). Moreover, provisions that regulate the collection, treatment and reuse for different purposes are also applicable, in addition to the regulation of urban services that include the supply of drinking water and the management of municipal wastewater (UNESCO, 2017).

To achieve compliance with regulations, authorities exercise legal mechanisms as administrative acts that the competent authorities require compliance with. These mechanisms include inspection and verification visits, which may lead to the imposition of preventive measures and sanctions, criminal or citizen complaints, and the environmental audit program. The obstacles to the application of the regulations regarding wastewater are diverse and range from institutional weakness, complexity of the regulatory framework, conflicts of competences between authorities, lack of institutional coordination, unawareness of the regulations, and legal gaps, among others.

The understanding of the effect of the application of environmental legislation is critical for measuring the effectiveness of the norm to solve the wastewater problem and as to what policies should be formulated or modified. In this paper, the inductive method, pertinent to legal investigations, was used in order to carry out the systematization of the legal sources regarding wastewater and their hierarchy at the federal, state and municipal levels, in order to outline the distribution of power among authorities related to the control and regulation of wastewater. This methodology was complemented with the schematization of the legal mechanisms available to the administrative authority to achieve compliance with the legislation on wastewater. In this regard, the information was organized and is presented on diagram tables of administrative mechanisms, such as the frequency of surveillance, inspection, corrective measures, imposed sanctions, and filed complaints. To determine the applicable legal mechanisms, we took as a reference, the legislation applicable to the case study, literature and government programs that are described in the background section of this paper.

Based on such information, conclusions were obtained regarding the different degree of wastewater legislation application. When the results are compared over time, it is possible to measure the positive or negative effects of control measures used by the authorities to achieve compliance (Profepa, 2001); for instance, regarding annual inspection visits to wastewater facilities. Such information helps understand whether it is the authorities' lack of execution or its weak demand of compliance the reason

for the lack of application of the law; or whether failures within the legal framework itself imply an obstacle and the law must be reformed (CCA, 1999).

Conceptual framework

The legal framework and its compliance

Macías-Gómez (2006) points out that the "application and compliance with the rules is a matter of the effectiveness of the law". The term *application* refers to the legal procedure through which, in this case, administrative authorities make regulated entities comply with the rules. In turn, *compliance* is the process through which the persons or entities that carry out activities (such as the use or affectation of a natural resource or the environment) comply with the environmental provisions established (Macías-Gómez, 2006). Now, the law is ineffective when, being adequate for the regulation of a certain situation, it is incapable of



reversing the existing social problem; that is, when the norm cannot transform a certain social action into one that is carried out within the law (Brañes, 2004). Therefore, the norm will be effective when it achieves its objective through compliance, either voluntarily or coercively through the application of a sanction or by force.

Sultana and Loftus (2014) indicate that the rights to water and sanitation imply compliance with three obligations: “the obligation to respect”, according to which the State must refrain from any action that interferes with these rights; “the obligation to protect”, whereby the State is obliged to prevent third parties from interfering with those rights, such as protecting society from the resource pollution; and “the obligation to comply”, according to which the State must demand compliance (Sultana & Loftus, 2014).

Cory and Rahman (2009) acknowledge that the process of implementing and enforcing environmental legislation is complex. One of many reasons is that few authorities must monitor the activities of hundreds of possible offenders and determine which offenders and for which administrative, civil or criminal violations they should be prosecuted. They point out that this is why the enforcement action of authorities is selective and offenders are rarely prosecuted or sanctioned correspondingly to the cost of non-compliance (Cory & Rahman, 2009). Heyes (2000) advances that the cost-benefit evaluation of a law with which full compliance is expected is doubtful when there is uncertainty in its implementation. Therefore, he considers that laws will not work unless

they are enforced, since a law, no matter its objective, will not be effective without a compliance program (Heyes, 2000). Hence, the importance of research regarding the relationship between the law and its compliance.

Legal mechanisms for compliance

States have the right to demand law compliance through administrative acts (Béjar & Salazar, 2018). Among those administrative acts are the ones regulating a specific case, and those pertaining to general and abstract regulations or policies (UNAM, 2012). An administrative act consists of "a unilateral manifestation of the administrative will that creates specific legal consequences on an individual, in the exercise of a power of administrative law" (Béjar & Salazar, 2018). The concept of administrative act is very extensive and brings together various mechanisms available to authorities, with a specific purpose based on a legal regime (UNAM, 2012). To determine the legal mechanisms that the authority has to verify and demand compliance with regulations on wastewater discharges, it is necessary, *first*, to determine the obligations that the regulated people and entities must comply with according to the applicable legal regime.

Anyone that discharges wastewater must comply with various obligations contemplated in the applicable regulations (of the three levels of government), such as: having permits and authorizations to discharge wastewater, paying rights, complying with the maximum limits allowed for contaminants, treat wastewater prior to discharge, use measurement equipment and submit reports to the competent authority, among others. Given this, and in accordance with the provisions of the applicable legislation, the authority has the following mechanisms to demand compliance: inspection and surveillance, sanctions and precautionary measures, criminal complaints, popular or citizen complaints, and environmental audits.

Background

In 1999, the North American Commission for Environmental Cooperation (CEC) published the *Indicators of Effective Environmental Law Enforcement. Memory of a Dialogue in North America*. Annex 1 of that document, relative to the “System of Indexes of Compliance with Environmental Regulations” of the Federal Attorney for Environmental



Protection (Profepa), aimed at informing about the degree of compliance with environmental legislation. Such document provides basic elements that the authority considers for the evaluation of environmental regulations, namely (CCA, 1999):

1. Regulations that imply effective protection of the environment.
2. Effective corrective measures, adequate deadlines, and persuasive sanctions.
3. Verification of compliance and the corrective measures issued.
4. More frequent inspection and verification in case of non-compliance.
5. Sufficient and systematic inspection programs.
6. Compliance consideration in determining inspection frequency.

In order to develop Profepa's action program for the period 2014-2018, and in accordance with the National Development Plan 2013-2018, the "Environmental Justice Prosecution Program 2014-2018" was issued (Semarnat & Profepa, 2014). This Program establishes that to ensure compliance with environmental regulations, Profepa must (Semarnat/Profepa, 2014):

1. Promote environmental compliance through knowledge of environmental regulations and the promotion of voluntary compliance.
2. Verify compliance and discourage illicit behavior through the dissemination of cases of non-compliance and their consequences.
3. Carry out inspection visits and verification of compliance with current environmental regulations applicable to each case.

4. Apply the law through administrative procedures in case of non-compliance and file the corresponding criminal complaints.
5. Verify that the measures ordered are complied with by offenders.
6. Communicate results to inhibit illicit behavior and foster a culture of compliance.

In this context, Profepa exercises the "police power" (Azuela, David-Gidi, Leal, Hojer, & Saavedra, 2006) in terms of law application, and it does so through a program that implies the use of any of the following procedures (Azuela *et al.*, 2006):

1. Prosecution of environmental crimes.
2. Administrative verification procedure, the imposition of security measures and/or sanctions.
3. Voluntary environmental audit procedure.

Azuela *et al.* (2006) point out that the generation of indicators of compliance with regulations is important, and that the last two procedures are the most relevant for the generation of information (Azuela *et al.*, 2006). He analyzed two types of indicators: those of performance, which refer to the effectiveness of the work carried out by the authority; and those of management, which deal with the amount of work done. As management indicators, Azuela takes the following (Azuela *et al.*, 2006):

1. The number and results of inspections to verify compliance with regulations, carried out by Profepa. This indicator allows knowing the magnitude of the work carried out by Profepa and its generic results and trends.

2. The total number of infractions related to environmental issues to identify the most important issues by sector and the number of sources identified by the authority. This demonstrates the effectiveness of the authority in identifying the sources of potential contamination.
3. The number of establishments within the voluntary environmental audit program.
4. The number of existing wastewater treatment plants and the percentage of the total wastewater generated in the country that would receive treatment.

Study area: Baja California Sur

B.C.S. is a semi-desert entity located in northwestern Mexico, occupying the southern half of the Baja California Peninsula. B.C.S. extends over an area of 73 909.4 km², which represents 3.8 % of the country's surface (INEGI, 2018). Rains range between 0 and 400 mm per year, with an average of 700 mm in the mountains, and a total average annual rainfall of less than 200 mm (INEGI, 2018). The climate is dry-desert in the lower parts; the average annual temperature is from 18 to 22 °C, with the



highest average temperature being 35 °C and the lowest being 9 °C (INEGI, 2018).

With 712 029 inhabitants, B.C.S. is politically divided into five municipalities: Mulegé, Loreto, Comondú, La Paz and Los Cabos. During the 2000-2010 decade, the population increased 50 %, thus reducing the availability of per capita water per year to a value of only 785 m³; which made it be a part of groups of states with water scarcity (Wurl *et al.*, 2013). The tourist boom in Los Cabos has encouraged immigration from various parts of Mexico and abroad, which has increased the demand for water, especially in the urban areas (Wurl *et al.*, 2013; Graciano, 2019). In B.C.S., aquifers are the only reliable source of fresh water, which are recharged by intense rainfall from seasonal tropical storms. However, overexploitation of groundwater in B.C.S. contributes to seawater intrusion, thus compromising water quality and availability in this coastal region (Wurl *et al.*, 2013).

Wastewater discharges in B.C.S.

Wastewater is understood as “water of varied composition coming from discharges from urban, domestic, industrial, commercial, service,



agricultural, livestock, treatment plants and, in general, from any use, as well as the mixture of them” (LAN, 1992. art. 3 fr. VI) (DOF, 2020). Wastewater discharges are classified as municipal and non-municipal. The municipal ones are generated in population centers and collected in sewage systems. Non-municipal wastewaters are those discarded after other uses, such as from industries, and are discharged directly into national water bodies without being collected by municipal sewage systems (Conagua, 2017b). Municipalities collect water from cities and send it to the municipal water treatment plants. When these treated water discharges are dumped into a national water body, they become federal jurisdiction.

In B.C.S., wastewater is one of the main sources of pollution (Tejas-Álvarez, 2013). As shown in Table 1, most of municipal wastewater treatment plants discharge wastewater placing health and ecosystems at risk. There are 29 municipal wastewater treatment plants (WWTP) in B.C.S., and the total volume of treated water reaches 4 965 meters per second (m/s) (Conagua, 2017b).

Table 1. Municipal wastewater treatment plants in operation in B.C.S., as of 2016.

Municipality	Location	Plant name	Process	Installed capacity (l/s)	Treated Flow (l/s)	Receiving body or reuse	Remarks (Conagua, 2014)
Comondú	Benito Juárez (Buenavista)	Benito Juárez	Stabilization Ponds	3.0	1.0	Soil Infiltration	
Comondú	Ciudad Constitución	Batallón	Stabilization Ponds	60.0	45.0	Fodder irrigation	Wastewater pond system replacement
Comondú	Ciudad Constitución	Vivero	Stabilization Ponds	50.0	35.0	Fodder irrigation	Poor operating conditions
Comondú	Ciudad Insurgentes	Ciudad Insurgentes	Stabilization Ponds	50.0	20.0	Agricultural irrigation	Poor operating conditions
Comondú	La Poza Grande	La Poza Grande	Stabilization Ponds	2.0	2.0	Soil Infiltration	
Comondú	Puerto Adolfo López Mateos	Adolfo López Mateos	Stabilization Ponds	10.0	3.0	Soil Infiltration	
Comondú	Puerto San Carlos	Puerto San Carlos	Stabilization Ponds	10.0	6.0	Soil Infiltration	

Municipality	Location	Plant name	Process	Installed capacity (l/s)	Treated Flow (l/s)	Receiving body or reuse	Remarks (Conagua, 2014)
Comondú	Villa Ignacio Zaragoza	Villa Ignacio Zaragoza	Stabilization Ponds	5.0	1.0	Meadow irrigation	It began operating in 2009 with the PROSSAPYS program
Comondú	Villa Morelos	Villa Morelos	Stabilization Ponds	5.0	1.0	Agricultural irrigation	It began operating in 2009 with the PROSSAPYS program
La Paz	El Pescadero	El Pescadero	Activated sludge	3.5	3.0	Agricultural Field	Rehabilitation required
La Paz	La Paz	La Paz	Activated sludge	450.0	450.0	Agricultural Field	Began operations in 1996. Exceeded capacity
La Paz	San Juan de los Planes	Los Planes	Activated sludge	3.5	1.7	Agricultural Field	
La Paz	Todos Santos	Cala de Ulloa	Activated sludge	15.0	13.0	Unnamed creek	Started operations in 2009, private initiative

Municipality	Location	Plant name	Process	Installed capacity (l/s)	Treated Flow (l/s)	Receiving body or reuse	Remarks (Conagua, 2014)
Loreto	Loreto	Loreto	Activated sludge	60.0	42.0	Golf courses and green areas	Expansion in 2006 from 30 to 60 l/s, Rehabilitated in 2013
Loreto	Nopoló	Loreto	Stabilization Ponds	60.0	10.0	Soil Infiltration	Installed capacity flow rate is modified from 20.0 lps to 60.0 lps and operating flow rate from 5.0 to 10.0 lps
Loreto	Nopoló	Nopoló	Activated sludge	30.0	8.0	Golf courses	Started operations in 2009
Los Cabos	Cabo San Lucas	El Arenal	Activated sludge	120.0	100.0	Golf courses and green areas	It is operated by the National Tourism Fund (FONATUR)
Los Cabos	Cabo San Lucas	Los Cangrejos	Activated sludge	75.0	25.0	Golf courses	Started operations in 2012

Municipality	Location	Plant name	Process	Installed capacity (l/s)	Treated Flow (l/s)	Receiving body or reuse	Remarks (Conagua, 2014)
Los Cabos	Cabo San Lucas	Mesa Colorada	Activated sludge	150.0	80.0	Golf courses and green areas	Started operations in 2009
Los Cabos	Cabo San Lucas	Miraflores	Aerobic	2.0	2.0	Irrigation of green areas	Rehabilitation required
Los Cabos	Cabo San Lucas	Miramar-Pueblo Bonito	Activated sludge	90.0	40.0	Golf courses and green areas	
Los Cabos	Cabo San Lucas	Sonrise	Activated sludge	50.0	50.0	Golf courses and green areas	Foul odors are occasionally generated
Los Cabos	La Ribera	La Ribera	Activated sludge	5.6	3.5	Green areas	Started operations in 2007, Rehabilitation required
Los Cabos	San José del Cabo	FONATUR	Activated sludge	250.0	250.0	Golf courses and green areas	

Municipality	Location	Plant name	Process	Installed capacity (l/s)	Treated Flow (l/s)	Receiving body or reuse	Remarks (Conagua, 2014)
Los Cabos	San José del Cabo	La Sonoreña	Activated sludge	150.0	80.0	Golf courses	Started operations in 2012 with tertiary treatment
Los Cabos	Santiago	Santiago	Activated sludge	1.7	1.7	Green areas	Started operating in 2007, Rehabilitation required
Mulegé	Guerrero Negro	Guerrero Negro	Stabilization Ponds	30.0	30.0	Soil Infiltration	Poor condition, new treatment plant required
Mulegé	Heroica Mulegé	Mulegé	Stabilization Ponds	20.0	5.0	Soil Infiltration	Poor operating conditions
Mulegé	Santa Rosalía	Santa Rosalía	Activated sludge	5.6	3.5	Green areas	Relocation of ponds is required
Total			29	1,766.9	1,312.4		

Source: Conagua (2016). Source of observations: Conagua (2014).

Non-municipal wastewater discharges are registered with Conagua, which publishes the volumes of wastewater discharges by water use in the state (Table 2).



Table 2. Discharge volume granted for water use in B.C.S., as of 2017.

Use	Title	Annex	Concession discharge volume m ³ /year
Agricultural	0	0	0
Agro-industrial	1	1	10 296
Domestic	8	8	186 838
Aquaculture	5	5	42 032 580
Services	155	547	24 783 778
Industrial	41	52	1 163 206 542
Livestock	0	0	0
Urban	5	6	2 734 405
Multiple	20	25	57 609 114
Power generation	0	0	0
Commerce	0	0	0
Ecological conservation	0	0	0
Total	235	644	1,290,563,552

Source: Conagua (2017b).

Methods

The objective of this paper is to evaluate the legal mechanisms that authorities have to achieve regulation compliance regarding wastewater discharges in B.C.S. Regulatory compliance requires a systemic approach that includes reliable data and better management, interpretation, and dissemination of information; and that also takes into account the relationship between the actors that influence water and the areas that are affected (Consejo Estatal de Ecología de Hidalgo, 2003).

The inductive method applied to legal studies was used in order to carry out such analysis, with the goal of proposing solutions to likely deficiencies derived from wastewater regulation and/or management. The proposed method is based on a formal analysis of the Mexican legal framework and its hierarchization, as well as the characterization of the type of legal system in the country (Carmona-Lara, 2010). Although this is a case study, to the extent that so are the applied concepts and methodology, its results may be comparable to other analysis. Departing from a general panorama regarding wastewater discharges in Mexico, the study area and the situation of wastewater discharges in B.C.S. were identified by compiling official data published by different government agencies.

Subsequently, 27 legal sources applicable to wastewater were systematized and ranked at the federal, state, and municipal levels. Once this was achieved, a database of the distribution of authorities' faculties related to the control and regulation of wastewater was elaborated. To this end, a documentary research was carried out based on the bibliographic review of academic articles and books, as well as databases, official statistics and information obtained from the webpages of government institutions, namely: Congress of the Union, Congress of the State of Baja California Sur, National Institute of Statistics and Geography (INEGI), Secretariat of Environment and Natural Resources (Semarnat), National Water Commission (Conagua), Mexican Institute of Water Technology (IMTA), Federal Environmental Protection Agency (Profepa), State Water Commission (CEA) and Municipal Operating Organizations of the Potable Water, Sewerage and Sanitation System of the five municipalities in the B.C.S.

After the legal framework was characterized, the legal mechanisms available to the competent authority to apply the legislation on wastewater were determined, taking into account what was proposed in the studies and government programs referred to in the background section. Once the control mechanisms were selected (inspection and surveillance, sanctions and precautionary measures, criminal complaints, popular complaint and environmental audits), they were organized in a 10-year period (2009-2018) to determine the trend of application of control mechanisms regarding wastewater in B.C.S. A format with

questions and schematic tables was developed to make requests for information, through the mechanisms of transparency and access to information using the INFOMEX platform (www.plataformadetransparencia.org.mx), addressed to Profepa, Conagua, the CEA and the Operator of Potable Water Organism, Sewage and Sanitation System in each one of the five municipalities of the state. With the information provided by the authorities, the databases were prepared for each of the legal mechanisms, which are shown in the results.

Results

Legal framework of water discharge in Mexico

The Political Constitution of the United Mexican States (CPEUM) (DOF, 2019), states the right to safe and clean drinking water and sanitation as a human right (paragraph sixth of article 4); as well as the rights to health



and a healthy environment. Constitutional articles 16, 27, 73, 115 and 124 establish Mexico's national water regime, including the regulation of wastewater, and indicate that the State has the obligation to guarantee a sustainable use and conservation of water resources, the achievement of sustainable development in the country, and the improvement of the population's living conditions. This constitutional framework defines the primary distribution of powers regarding water, faculties that will allow the government to safeguard the rights established in article 4 of the Constitution.

The legislation enacted to support these constitutional dispositions in matters of wastewater management is extensive and establishes various rights and obligations for both individuals and authorities. Therefore, a schematic analysis was performed, according to Table 3.

Table 3. Legal regulations on wastewater.

LEVEL	LAW	RELEVANCE
FEDERAL	Constitución Política de los Estados Unidos Mexicanos DOF 5-02-1917 Last amendment DOF 28-05-2021	Establishes the human right to access, provision and sanitation of sufficient, safe, acceptable, and affordable water for personal and domestic consumption, and the consequent obligation of the State to guarantee this right. It establishes the water property regime and the distribution of competencies regarding wastewater management
	Ley General del Equilibrio Ecológico y la Protección al Ambiente	Establishes the criteria for the prevention and control of water pollution and aquatic ecosystems through the

LEVEL	LAW	RELEVANCE
	DOF 28-01-1988 Last amendment DOF 21-10-2021	regulation of wastewater discharges Establishes the precautionary measures and penalties for water pollution and establishes the distribution of powers of the federation, states, and municipalities
	Ley de Aguas Nacionales DOF 1-12-1992 Last amendment DOF 6-01-2020	Regulates the quality of wastewater, the prevention and control of pollution, the recirculation and reuse of such water, as well as the construction and operation of works for the prevention, control and mitigation of water pollution, including wastewater treatment plants. It establishes the distribution of powers of the competent authorities
	Ley General de Bienes Nacionales DOFL20-05-2004	Lists the assets subject to the public domain regime of the Federation, which is important since the wastewater discharged into these national assets will be under federal jurisdiction
	Ley Federal de Derechos DOF 31-12-1981 Last amendment DOF 12-11-2021	Establishes the obligation to pay the fee for the use or exploitation of public property of the Nation as receiving bodies of wastewater discharges
	Código Penal Federal DOF 14-08-1931 Last amendment DOF 12-11-2021	Establishes the assumptions of the crime of wastewater discharges
	Ley Orgánica de la Administración Pública Federal DOF 10-10-2021	Establishes the bases for the organization of the Federal Public Administration, both centralized and parastatal.

LEVEL	LAW	RELEVANCE
	Norma Oficial Mexicana NOM-001-Semarnat-1996 NOM-001-ECOL-1996 DOF 6-01- 1997	Establishes the maximum permissible limits of pollutants in wastewater discharges into national waters and property
	Norma Oficial Mexicana NOM-002-Semarnat-1996 DOF 3-06-1998	Establishes the maximum permissible limits of pollutants in wastewater discharges to urban or municipal sewage systems
	Norma Oficial Mexicana NOM-003-Semarnat-1997 NOM-003-ECOL-1997 DOF 21-09-1998	Establishes the maximum permissible limits of pollutants for treated wastewater reused in services to the public
STATE	Constitución Política del Estado de Baja California Sur BOGE 15-01-1975 Last amendment BOGE 27-12-de 2021	Establishes the right to access, availability and sanitation of water for personal and domestic consumption in a sufficient, safe, acceptable, and affordable manner. The State shall guarantee this right. Establishes the powers and obligations of the municipalities, among them the functions and public services in drinking water, drainage, sewage, treatment and disposal of wastewater
	Ley de Equilibrio Ecológico y Protección del Ambiente del Estado de Baja California Sur BOGE 30-11-1991 Last amendment BOGE 1-12-2018	Establishes the powers of the State, including preventing and controlling the pollution of waters under its jurisdiction; promoting the treatment and reuse of wastewater; verifying compliance with technical ecological standards for the discharge of wastewater into drainage and sewerage systems; and authorizing the discharge of wastewater into drainage and sewerage systems

LEVEL	LAW	RELEVANCE
	Ley de Aguas de Baja California Sur BOGE 31-07-2001 Last amendment BOGE 20-12-2019	Regulates the public drinking water, sewage and sanitation services; the organization, operation and attributions of the Municipal and Intermunicipal Operating Organizations; the participation of the social and private sectors in the provision of public drinking water, sewage and sanitation services; and the recovery of expenses and costs of investment, operation, conservation, connection fees and maintenance of drinking water systems, water desalination systems, sewage and sanitation
	Ley de Derechos y Productos del Estado de Baja California Sur BOGE 31-12-2015 Last amendment BOGE 27-12-2021	A fee of 1,084.00 Mexican pesos will be charged and paid for the services rendered by the Ministry of Tourism, Economy and Sustainability, under the Environment and Ecology category for the registration of wastewater discharges
MUNICIPAL COMONDÚ	Ley de Hacienda para el Municipio de Comondú del Estado de Baja California Sur BOGE 05-11-2001 Last amendment BOGE 31-12-2012	Establishes the fees for the supply of drinking water, sewage and sanitation services
	Reglamento de Agua Potable, Alcantarillado y Saneamiento para el Municipio de Comondú BOGE 30-11-2002	Regulates the provision of drinking water, sewage, and sanitation services. It establishes that the Municipality will be responsible for the treatment of wastewater generated by the systems under its responsibility, prior to its discharge into national property receiving bodies
MUNICIPAL MULEGÉ	Ley de Hacienda para el Municipio de Mulegé, Baja California Sur BOGE 05-011-2001 Last amendment BOGE 31-12-2012	Establishes the rights for potable water services, drainage, sewage, treatment, and disposal of wastewater. It establishes the penalty for discharges of wastewater to public streets outside the limits established by law

LEVEL	LAW	RELEVANCE
MUNICIPAL LA PAZ	Ley de Hacienda para el Municipio de La Paz, Baja California Sur BOGE 31-03-2001 Last amendment BOGE 10-12-2017	Establishes the fees for potable water, drainage, sewage treatment, sanitation, and wastewater disposal services
	Reglamento de Protección al Medio Ambiente BOGE 10-10-1995	Regulates the prevention and control of water pollution, establishing regulations regarding wastewater discharges
	Reglamento de uso de la red de alcantarillado sanitario del O.O.M.S.A.P.A.S. La Paz BOGE 20 de febrero de 2007	Regulates the discharge of wastewater other than for domestic use, as well as the particular conditions of discharge in accordance with the maximum permissible limits of pollutants established in NOM-002-Semarnat-1996. It states that the Municipal Water, Sewage and Sanitation System of La Paz, which oversees providing water, sewage, and sanitation services, is responsible for the application of the regulation
MUNICIPAL LOS CABOS	Ley de Hacienda para el Municipio de Los Cabos, Baja California Sur BOGE de 31-12-2002 Last amendment BOGE 31-10-2016	It establishes the revenues obtained by the City Council from the fees for drinking water, drainage, sewage, treatment, and disposal of wastewater
	Reglamento Municipal del Equilibrio Ecológico y Protección al Ambiente BOGE 20-05-2008 Last amendment BOGE 3-02-2017	Establishes the authority of the City Council to monitor and enforce compliance with applicable regulations regarding the discharge of wastewater into the sanitary sewer system. Title Two, Chapter Six, provides for the prevention and control of water pollution from industrial and service activities

LEVEL	LAW	RELEVANCE
	Reglamento del Uso de la Red de Alcantarillado del Municipio de los Cabos, Baja California Sur	Regulates wastewater discharges to the municipal sewage system and discharge conditions in accordance with the maximum permissible limits of pollutants discharged into the sewage system, as established in NOM-002-Semarnat-1996, to guarantee the proper treatment of municipal wastewater, prevent water and soil contamination by. It also regulates the treatment, handling, reuse, and final disposal of wastewater processed by the treatment plants operating in the Municipality of Los Cabos, in accordance with NOM -001-Semarnat-1996 and NOM-003-Semarnat-1997
	Reglamento del Organismo Descentralizado Operador del Sistema de Agua Potable y Alcantarillado del Municipio de los Cabos 10-10-1996	Establishes the responsibilities and faculties, including the supply, management and monitoring of drinking water and sewerage services. It may conduct home inspections to verify the correct operation of the drinking water systems and, if necessary, certify and impose administrative penalties for violations of the regulations
MUNICIPAL LORETO	Ley de Hacienda para el Municipio de Loreto, Baja California Sur BOGE 05-11-del 2001 Ultima reforma BOGE 20-12-2017	Establishes the obligation of the owners or the possessors of the properties, to pay cooperation duties for the treatment and disposal of wastewater
	Reglamento para la Protección al Ambiente y la Preservación Ecológica para el Municipio de Loreto, Baja California Sur BOGE 31-122000	Regulates the protection and rational use of water, and establishes the power of the City Council to monitor and control water pollution generated by municipal public services, to require those who discharge or intend to discharge wastewater into the drainage and sewage systems not to exceed the maximum permitted levels and to verify that they have installed a treatment system

LEVEL	LAW	RELEVANCE
	Reglamento Interno del Organismo Operador del Sistema de Agua Potable, Drenaje, Alcantarillado, Tratamiento y Disposición de Aguas Residuales del Municipio de Loreto, Baja California Sur BOGE 20-03-2000	Establishes the faculties and attributions

Source: Prepared by the authors with information on the applicable regulations and reference to Valdivia, Gámez, Beltrán and Ortega-Rubio (2020).

Administrative structure of the sector in charge of wastewater control

The administrative structure of the sector in charge of wastewater control in Mexico is made up of various government entities at the federal, state, and municipal levels, which have diverse and sometimes concurrent powers, based on the legal framework referred to in Table 3. To determine the specific competence of each of these authorities in terms of wastewater control, the content of the applicable laws was outlined in a



way that would allow their coherence and problems to be analyzed. Table 4 shows each of the public entities and their competence.

Table 4. Administrative structure for wastewater control.

Authority	Entitiy	Faculty
Federal level		
Congreso de la Unión		- It issues the laws on the use and exploitation of waters under federal jurisdiction - Establishes taxes on the use and exploitation of water resources Establishes the jurisdiction of the federal, state and municipal governments in matters of environmental protection and the preservation and restoration of the ecological balance
Semarnat. Secretaría de Medio Ambiente y Recursos Naturales	Conagua. Comisión Nacional del Agua	- Issue discharge permits - Keeps the Public Registry of Water Rights - Studies, with the assistance of the Basin Councils and Basin Organizations, the amounts for the collection of wastewater discharge fees to be submitted to the consideration of the corresponding Authorities under the terms of the Law - Establishes and monitors compliance with the particular discharge conditions that must be met by wastewater from different uses and users, which are generated in: a) property and areas under federal jurisdiction; b) national waters and property; c) any land when they may contaminate the subsoil or aquifers; d) other cases provided for in the Law - Inspects and verifies compliance with the provisions of the applicable NOMs, for the prevention and conservation of the quality of national waters and assets indicated in the Law

Authority	Entitiy	Faculty
		- Authorizes the discharge of wastewater into the sea, and in coordination with the Secretary of the Navy when they come from mobile sources or fixed platforms. Exercises the functions entrusted to the federal government in the prevention and control of water pollution and its control and sanction, in terms of law a) Systematic monitoring of water quality and keeping the Water Quality Information System updated at the national level. b) The national inventory of wastewater treatment plants. c) The national inventory of wastewater discharges
	Organismos de Cuenca	Issues discharge permits
	Profepa. Procuraduría Federal de Protección al Ambiente	- Prevents and controls pollution - Oversees inspection and surveillance, applying sanctions, imposing technical corrective and safety measures, formulating complaints, promoting the repair or compensation of environmental damage, and requesting the cancellation of wastewater discharge permits
Fiscalía General de la República		Hears all complaints that may constitute crimes in accordance with the provisions of the applicable legislation
Secretaría de Hacienda y Crédito Público	SAT. Servicio de Administración Tributaria	Is responsible for the collection of federal taxes



Authority	Entity	Faculty
State level		
Secretaría de Desarrollo Económico, Medio Ambiente y Recursos Naturales	Subsecretaría de Medio Ambiente y Recursos Naturales	- Regulates the control of contamination of waters under state jurisdiction and federal waters assigned to it - Oversees compliance with Mexican Official Standards
CEA. Comisión Estatal del Agua		Is empowered to execute hydraulic infrastructure works; promote water potabilization and wastewater treatment, reuse of wastewater and sludge management; sanction service providers and contractors for non-compliance with the Law; promote the use of wastewater for irrigation of green areas, agriculture, and other uses, subject to compliance with official standards
Municipal level		
OOMSAPA. Organismo Operador Municipal del Sistema de Agua Potable, Alcantarillado y Saneamiento		- Prevents and controls water pollution discharged into the drainage and sewage systems of population centers and assigned national waters - Oversees compliance with regulations in this area of competence and imposes sanctions - Determines the amount of fees for wastewater treatment and registration of discharges to drainage and sewerage systems

Source: Prepared by the authors with information on the applicable regulations and reference to Gilabert-Alarcón, Salgado-Méndez, Walter-Daesslé, Mendoza-Espinosa and Villada-Canela (2018).

Legal mechanisms to achieve compliance with wastewater legislation

Inspection and surveillance

Article 16 of the Mexican Constitution empowers administrative authorities to carry out on site visits to verify compliance with the law (CEPEUM, art. 16) (DOF, 2019). These visits are regulated by the LGEEPA in Chapter II on “Inspection and Surveillance”, where Semarnat is empowered to carry them out (LGEEPA, 1988. art.161) (DOF, 2018a). Semarnat exercises these powers through Profepa, which is responsible for monitoring compliance with legal provisions related to the prevention and control of environmental pollution, natural resources, and wastewater discharges to national water bodies, among others (RISemarnat, 2012. Art 45) (DOF, 2012). Conagua, in accordance with the provisions of the National Water Law, also has the power to inspect or monitor wastewater discharges in order to verify compliance with the law (LAN, 1992. art. 95)

(DOF, 2020). As a result of the inspection or verification visits, the competent water or environmental authority may impose the respective penalties or enforcement and security measures according to the applicable law.

State governments also have power regarding inspection and surveillance for the prevention and control of pollution of the waters under state jurisdiction, as well as the national waters assigned to them (LGEEPA, 1988. art. 7 section VIII) (DOF, 2018a). For their part, the municipalities will have the power to monitor compliance with the legal provisions on the prevention and control of water pollution that is discharged into the drainage and sewage systems of population centers, as well as the national waters assigned to them (LGEEPA, 1988. art. 8, section VII) (DOF, 2018a). In this sense, the B.C.S. State Water Law establishes that the City Councils by themselves or through the Operating Agency may carry out inspection visits to verify the connections of the discharges that the discharges comply with the provisions of the law, and general compliance with the law.

In order to identify the number of control acts carried out by the authorities in terms of wastewater discharge in the selected period, the authorities of the three areas of competence were asked for information through the instruments of access to public information. Only Profepa and Conagua responded. The State Water Commission, the Municipal Operators of the Potable Water, Sewerage and Sanitation System of Mulegé, Los Cabos and La Paz replied that they did not have the requested

information (Table 5 and Table 6). Only the H. XVI Municipality of Comondú reported that, in 2018, six inspection visits of residual discharges were made to members of the cheese industry in the municipality, to verify the existence of traps for fats and solids in their discharges (H. Ayuntamiento de Comondú XVI, 2019).

Table 5. Control acts regarding wastewater discharges carried out by Profepa in B.C.S., 2009-2018.

Concept	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Inspection visits made to wastewater discharge points	0	0	0	0	0	20	4	3	12	5
Temporary total closures	0	0	0	0	0	0	0	2	2	1
Temporary partial closures	0	0	0	0	0	0	0	0	0	0
Verification of compliance with corrective action	0	0	0	0	0	2	1	1	1	1
Sanctions	0	0	0	0	0	8	2	1	3	1

Source: Profepa, Transparency Unit, Official Letter

PFPA/1.7/12C.6/00003019.18, Response to request 1613100003019

(Profepa, 2019).



Table 6. Control acts regarding wastewater discharges carried out by Conagua in B.C.S., 2009-2018.

Concept	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Inspection visits made to industries and companies that discharge wastewater	3	3	2	6	13	1	6	9	10	16
Inspection visits carried out only in the industrial sector	0	0	1	0	0	1	1	3	2	1
Sanctions imposed for wastewater discharges in the State for the visits made in the years shown below	1	2	2	2	5	0	0	6	6	-

Source: Conagua, official letter 160629, response to SISI request 1610100011519 (Conagua, 2019b).

Sanctions and precautionary measures

Governmental authorities, whether federal, state, or municipal, have the faculties to verify compliance with regulations and may impose sanctions or preventive measures. LAN establishes in its article 118 BIS 2 (DOF,



2020) that, in case of imminent risk, damage, deterioration to health, national waters, national assets, biodiversity or ecosystems linked to water, Conagua or the Profepa, within the scope of their respective powers, may immediately carry out one or more of the established measures. Once the authority unburdens the corresponding administrative procedure and determines that there is a violation of the law it may, in accordance with article 119 of the LAN (DOF, 2020), sanction offenses related to wastewater discharges, and they will be sanctioned by Conagua, as established by the Article 120 of the LAN (DOF, 2020), with fines, regardless of the sanctions stipulated in the LGEEPA, LAN, the Law of National Assets and the Federal Law of Metrology and Standardization and its regulations, the Official Mexican Standards, the Federal Penal Code and other applicable provisions in the matter (Table 7).

Table 7. Sanctions regarding wastewater discharges regulated by the National Water Law.

Sanctioned action	REGULATED PENALTIES
Conagua	
I. Permanently, intermittently, or accidentally discharging wastewater in contravention of the provisions of the Law into receiving bodies that are national property, including marine waters, as well as when they infiltrate land that is	• Temporary closure of the use of national waters. • Suspension of the activities that give rise to the process that generates wastewater discharges.

Sanctioned action	REGULATED PENALTIES
national property or other land when they may contaminate the subsoil or aquifer. X. Impede or obstruct visits, inspections, surveys, verifications, and inspections carried out by Conagua. XI. Failure to deliver the data required by Conagua or Profepa, as the case may be, to verify compliance with the provisions contained in the Law and in the concession, assignment or discharge permit titles, as well as in other legal ordinances. XII. Use volumes of water greater than those generated by wastewater discharges to dilute and thus try to comply with the Mexican Official Standards on ecological matters or the particular conditions of discharge. XV. Failure to comply with the obligations set forth in the titles of concession, assignment, or discharge permit. XXI. Failure to inform Conagua of any change in its processes when this causes modifications in the characteristics or volumes of the wastewater used to issue the corresponding discharge permit. (LAN, 1992. art. 119) (DOF, 2020)	- Promote before the civil protection and public safety authorities of the Federal, state, and municipal governments, the adoption of urgent measures including the securing of property, removal or demolition of infrastructure, in order to protect the life and property of people. (LAN, art. 118 BIS 2) (DOF, 2020) Fines related to discharges: - From 260 to 1 950 Units of Measurement and Actualization, in the case of violation of fractions X, XI, XXI. - From 1 560 to 6 500 Units of Measurement and Actualization, in the case of violations to fractions I, XII. - From 1 950 to 26 000 Units of Measurement and Actualization, in the case of violation of section XV. (LAN, 1992. art. 120) (DOF, 2020)

Sanctioned action	REGULATED PENALTIES
Municipalities	
Failure to comply with the respective payment in accordance with the provisions of the Law (LA BCS, 2019: art. 137)	Prevent, obstruct, or close the possibility of discharging wastewater to drainage and sewage networks (LA BCS, 2019:art. 137)
Municipalities in coordination with the environmental authority	
Discharge in non-compliance with the particular conditions of discharges, the maximum permissible limits of pollutants indicated in the NOM, as well as with the provisions of the legislation of ecological balance and environmental protection and other applicable to the matter (LA BCS, 2019:art. 137)	Prevent, obstruct, or close the possibility of discharging wastewater to drainage and sewage networks (LA BCS, 2019: art. 137)

Source: self-made.

At the state level, the B.C.S. Water Law empowers municipal governments to carry out acts to “prevent, obstruct or close the possibility of discharging wastewater to the drainage and sewage networks, when the user fails to pay the respective payment in accordance to the law, or in collaboration with the ecological authorities, when the discharge does not comply with the particular discharge conditions, the maximum permissible limits or with the provisions of any other applicable environmental law” (LA BCS, 2019: art. 137).



Criminal complaints

As established in article 182 of the LGEEPA (DOF, 2018a), in cases in which Semarnat is aware of acts or omissions that could constitute crimes in accordance with the provisions of the applicable legislation, it through Profepa, will file the corresponding complaint with the Federal Public Ministry (MPF). Article 123 Bis 1 of the LAN (DOF, 2020) also empowers Conagua to file complaints with the MPF in cases where the existence of a crime is presumed. Likewise, any person may directly file criminal complaints corresponding to environmental crimes provided for in the applicable legislation (LGEEPA, 1988. art. 182) (DOF, 2018a).

Crime in terms of wastewater discharges is regulated in article 416 of the Federal Penal Code, which establishes that:

“A penalty of one to nine years in prison and a three hundred to three thousand day fine will be imposed on anyone who illegally discharges, deposits, or infiltrates, authorizes or orders, wastewater, chemical or biochemical liquids, waste or contaminants in the soil, subsoil, marine waters, rivers, basins, vessels or other deposits or currents

of water under federal jurisdiction, which causes a risk of harm or damage to natural resources, flora, fauna, water quality, ecosystems or the environment. In the case of water that is deposited, flows in or towards a protected natural area, the prison term will be increased to three more years and the economic penalty up to a thousand days fine" (CPF, 1931. art. 416) (DOF, 2018b).

Criminal complaints are one of the instruments to generate compliance in environmental matters that most influences individuals, which is why it is considered important to analyze the number of complaints that have been filed by Profepa. It should be noted that Conagua has no record of any criminal complaint related to wastewater discharges in the period under study (Conagua, 2019a; Conagua, 2019b) (**Table 8**).

Table 8. Criminal complaints filed by Profepa regarding crimes related to wastewater discharges in B.C.S., 2009-2018.

Municipal government complaints to PGR	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Comondú	0	0	0	0	0	0	0	0	0	0
La Paz	0	0	0	0	0	0	0	0	0	1
Loreto	0	0	0	0	0	0	0	0	0	0
Los Cabos	0	0	0	0	0	0	0	0	0	0
Mulegé	0	0	0	0	0	1	0	0	1	0
Total	0	0	0	0	0	1	0	0	1	1

Source: Profepa, Transparency Unit, Official Letter

PFPA/1.7/12C.6/00003019.18, Response to request 1613100003019
(Profepa, 2019).

Citizen complaints

The citizen complaint is an instrument of environmental policy that offers the possibility to any person, social groups, non-governmental organizations, associations and societies, to denounce before Profepa or



before other authorities a fact, act or omission that produces or may produce ecological imbalance, or damage to the environment or natural resources, or contravenes the provisions of the law and other ordinances that regulate matters related to the protection of the environment and the preservation and restoration of the ecological balance (LGEEPA, 1988. art. 189) (DOF, 2018a). These complaints provide the legitimacy for society to go to the authority and report any wastewater discharge that may affect both health and the environment. From the complaint, the authority has the obligation to initiate an inspection procedure to verify the breach of any law and proceed accordingly (Table 9 and Table 10).

Table 9. Complaints filed with Profepa regarding wastewater discharges in B.C.S., 2009-2018.

Municipal governments complaints to Profepa	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Comondú	0	0	0	0	0	0	0	0	0	0
La Paz	0	0	0	0	1	4	2	1	0	3
Loreto	0	0	0	0	1	0	0	0	0	0
Los Cabos	2	3	1	2	3	2	2	2	2	1
Mulegé	0	0	0	2	0	1	1	0	1	0
Total	2	3	1	4	5	7	4	3	3	4

Source: Profepa, Transparency Unit, Official Letter

PFPA/1.7/12C.6/00003019.18, Response to request 1613100003019
(Profepa, 2019).



Table 10. Complaints filed with Conagua regarding wastewater discharges in B.C.S., 2009-2018.

Complaints	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
	2	1	0	0	4	0	0	1	2	2

Source: Conagua, official letter 160629, response to SISI request 1610100011519 (Conagua, 2019b).

Environmental audits

To protect the environment and human health, the environmental authority has established various programs to encourage voluntary compliance with environmental regulations. The main one is environmental audits, which seek that those responsible for the operation of a company, on a voluntary basis, methodologically examine their operations in terms of pollution and the risk they generate, as well as general compliance with environmental legislation, international regulations and practices. The objective is to establish the preventive and corrective measures that are necessary to take care of the environment (LGEEPA, 1988. art. 38 BIS) (DOF, 2018a).

Profepa is the competent authority to carry out the environmental audit program, which agrees with the individual to carry out the audit. With this agreement, the individual is obliged to abide by the results and the Action Plan that is prepared at the end of the audit, and in which the preventive and corrective programs are set, as well as the time to implement them (CCA, 1999). Once the audit is completed, and if the company satisfactorily complies with the technical specifications established in the Action Plan, Profepa grants the Clean Industry Certificate. This Certificate represents an attractive incentive for the industry, reflecting the high environmental and social responsibility of the company in question. There are thirty-three companies with a valid clean industry certificate in B.C.S. for the 2019-2021 period, including automotive companies, airports, cement companies, the Federal Electricity Commission, hotels, and two wastewater treatment plants: FONATUR Infraestructura, SA de CV (Loreto/ Nopoló Wastewater Treatment Plant) and FONATUR Maintenance Turístico, SA de CV (Wastewater Treatment Plant) (Profepa, 2020).

Discussion

Situation in B.C.S.

Availability and quality of water are vital for the development of B.C.S. One of the key factors in the problem related to water is the poor management of wastewater and, even when there is a broad federal, state, and municipal legal framework that regulates them, there are deficiencies to achieve compliance.

From Table 1 it was observed that, according to the 2014 Conagua report, of the 29 wastewater treatment plants reported in B.C.S., 44 % operate in poor conditions or require rehabilitation or have some other operational problem, 24 % do not indicate the operating conditions, and 32 % started operations or had recent modifications, but the working conditions are not mentioned. These reports show that almost half of the reported municipal treatment plants are working in poor conditions. Therefore, the authority should verify their operation to determine if they are complying with the legal provisions, with the goal of protecting the ecosystems and the health of the population. We can also observe that

after the 2014 report, Conagua's observations regarding the operation of the plants were not made public again, at least in that informative format.

Now, wastewater is reused from these 29 municipal plants for fodder irrigation (two plants), agricultural irrigation (five plants), meadow irrigation (one plant), green areas (four plants), golf course irrigation and green areas (nine plant), infiltration into the ground (seven plant) or discharge to a stream (one plant). Of the 13 plants reported working in poor conditions, nine plants allocate residual water for irrigation, whether for fodder, agriculture, meadows, or green areas; three plants infiltrate them to the ground; and one is dedicated to the irrigation of golf courses. Of the remaining eight that have comments, it is observed that six started more recent operations or had modifications or rehabilitation and allocate the residual water to irrigate golf courses, one to irrigate meadows and one for agricultural irrigation. From Table 2 we observe that the uses with the highest volume of concession discharge are industrial, multiple uses, aquaculture, and services; however, there is no online public information available on their quality or reuse.

If we consider that municipal, industrial, and agricultural water discharges without prior treatment and the low efficiency of treatment plants are among the main sources of water pollution in B.C.S. (Tejas-Álvarez, 2013), the information in the tables is transcendent. These show that residual water in B.C.S. is being reused even without treatment plants operating in optimal conditions, putting health and ecosystems at risk. Given this, the obligation of the authority to carry out its inspection

and verification functions to demand compliance with regulations and, in case of non-compliance, exercise its powers to impose the corresponding sanctions, takes on special relevance.

Institutional competence and coordination

Wastewater is regulated, first, by federal legislation (Table 3). The Mexican Constitution, being the supreme law, establishes the human rights to water and sanitation and lays the foundations for the distribution of competence among the three levels of government (Table 4). The main federal laws that regulate the constitutional articles related to water discharges are the LGEEPA and the LAN. The LGEEPA, as the framework law on environmental matters, establishes the criteria for the prevention and control of pollution of water and ecosystems through the regulation of wastewater discharges, empowering Profepa as the executing authority in charge of verifying compliance of the law and sanction non-compliance. LAN regulates the quality of wastewater, pollution prevention and control, recirculation, and reuse, empowering Conagua as the competent authority to verify compliance and impose sanctions and precautionary measures. This competition is centered on the premise that the waters

are the property of the nation and, therefore, fall under federal jurisdiction.

The states, in this case B.C.S., have jurisdiction to regulate the control of contamination of waters under state jurisdiction and the federal ones that are assigned to them and oversee compliance with the NOM. The municipalities have powers over the administration and surveillance of the public services of potable water, drainage, sewage, treatment, and disposal of wastewater (Table 4). This primary distribution of competence between the federation, states and municipalities seems clear; however, depending on the content of discharges and pollution control provisions, jurisdiction may be federal or state-level. For example, in the case of fuel discharges, regardless of whether they are discharged into the municipal sewer network, Profepa continues to have the power to sanction. Likewise, depending on the source of the wastewater, the competence of the authority may also vary, or it may be determined by the place of discharge. For example, the federal authority (Profepa/Conagua) will oversee controlling the discharge of water from municipal treatment plants discharged to a receiving body classified as a national asset.

This network of faculties dispersed in federal, state, and municipal laws (Table 3 and 4) generates a fragmentation of both the regulation of wastewater and the control of pollution, a situation that favors the inactivity or administrative paralysis to manage the wastewater. This problem becomes more serious, since the authority in charge of wastewater at the three levels of government must supervise an

enormous number of obligations (Cory & Rahman, 2009), which requires a solid institutional structure for the management and control of wastewater.

Ineffectiveness of the legal mechanisms to achieve compliance

In Mexico there is an extensive legal framework that regulates wastewater discharges and that imposes a maximum permitted limit of pollutants in water discharges. However, wastewater continues to be a risk factor that endangers water supply and the health of the population. In this context, the power of the authorities to carry out the inspections is one of the most important control mechanisms, since it will be able to verify compliance with regulations in a coercive manner, sanctioning non-compliance, ordering, if appropriate, the repair of the environmental damage caused (Semarnat & Profepa, 2014).

There is little literature regarding the effects of the effectiveness of legislation for the proper management of wastewater. This paper presents the results of analyzing the mechanisms available to authorities to enforce legislation on wastewater in B.C.S. Although these mechanisms are



sufficient to achieve compliance and to sanction non-compliance, we observed that such tools are not executed as frequently as needed, and that there is a systematic non-compliance by individuals. Therefore, better and more surveillance is needed to comply with regulations regarding wastewater with or without treatment, especially NOM and particular discharge conditions.

The number and results of the visits to verify compliance carried out by Profepa and Conagua allow us to know the magnitude of the activity of the authority in the matter. However, the number of visits does not determine the degree of pollution control or the environmental compliance of the persons or entities. From Table 5, it can be deduced that Profepa does not carry out representative visits to wastewater discharge points to national water bodies, but it reported a total of 29 municipal treatment plants (Table 1) and 235 discharge titles (Table 2). The sanctions imposed by Profepa also do not show a representative penalty that promotes compliance with the regulations in wastewater issues. The Conagua report (Table 6) shows that a greater number of inspection visits was carried out, which increased until 2018, when 16 of those visits were carried out, although this represents little execution by the authority in charge of verifying compliance with regulations regarding wastewater discharge in B.C.S.

Criminal complaints, which could be the instrument that generates the greatest awareness of compliance, have not been used, except for two complaints made by Profepa in 2017 and 2018, in a period of ten

years starting from 2009 (Table 8). Establishing a public policy that encourages criminal complaints, both by Profepa and Conagua, as well as by citizens, would favor compliance. To achieve this, there should be better channels of access and generation of information, awareness, and institutional improvement, which should include the Office of the Attorney General of the Republic, which is the authority in charge of the criminal sanctions. On the other hand, the figure of citizen complaint has been more effective in dealing with the problem of wastewater discharges, Profepa being the authority that has received the most complaints at the federal level by citizens (Tables 9 and 10). Therefore, the incorporation of society in surveillance tasks should be encouraged and recognized as a necessary mechanism in the verification system of compliance with regulations, thus increasing the institutional capacities of Profepa and Conagua.

Environmental auditing as an instrument to promote compliance with environmental regulations has had good results in general terms to ensure that companies voluntarily comply with environmental regulations. In B.C.S., of 33 certified companies, two of them are wastewater treatment plants. Companies obtaining the Clean Industry Certificate are considered to be up to date in complying with regulations on water matters and there is a risk that they will not be verified by both federal and municipal authorities, since they only have the obligation to request the two-year renewal. Hence, information must be updated accordingly

to maintain compliance with national environmental legislation, in the case under study, regarding the quality of wastewater discharges.

Another relevant deficiency in terms of control is the lack of real mechanisms for municipalities to be regulated and sanctioned. It must be considered that municipal governments, which provide the drinking water supply service and wastewater management, also are responsible for the treatment of this wastewater before being discharged to a receiving national waterbody or land. The federal government, through Profepa and Conagua, should ensure that water discharged or provided for reuse by the municipalities meets the parameters established by the regulations and that, in the event of non-compliance, the corresponding parties are sanctioned. This will be the way to put an end to years of poor operation of municipal treatment plants, which are currently the most important source of water pollution in B.C.S.

Conclusions

Legal mechanisms to achieve compliance with the legislation on wastewater discharge are suitable instruments for the authority to verify and enforce environmental regulations. Yet, the effectiveness of the law



depends on its execution by the authorities and compliance by individuals and entities. Without the application of legislation related to wastewater discharges, it will not be possible to achieve the objectives of the 2030 Agenda for Sustainable Development, aimed at reducing water pollution and the percentage of untreated wastewater, and promoting safely reuse and wastewater recycling.

Inadequate enforcement of legislation regarding wastewater discharge encourages poor management of wastewater in B.C.S. More research on inter/institutional coordination is needed, but authorities must enforce administrative and institutional regulations regarding the application of regulations related to wastewater discharge, which should be complemented with adequate public policy. Authorities in the three spheres of government ought to evaluate their strategies and orient them towards local, national, and international objectives.

Also, carrying out periodic studies to determine the levels of compliance of regulations related to wastewater discharges should be a priority, as well as making information available to develop analysis in the light of the prevailing environmental conditions. This would allow us to assess the effectiveness of the legislation in reversing or preventing specific environmental problems, which in the case under study are both the pollution and scarcity of water in B.C.S. Public information on compliance of wastewater discharge regulations will make possible to determine whether, by increasing efforts to enforce laws and regulations, the dumping of wastewater discharges without prior treatment or,

alternatively, the total wastewater discharged into national water bodies are reduced. Then a paradigm shift might be reached to acknowledge wastewater as a valuable alternative source of water.

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