

Systematic Review

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Environmental laws and politics, the relevance of implementing regulation of the presence of emerging pollutants in Mexico: a systematic review

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Abstract

Aim: To carry out a systematic review of the environmental regulation applicable to emerging pollutants at the international level, with a special interest in Mexico.

Methods: The search for articles and documents was carried out under the criteria of the PRISMA statement (Preferred Reporting Items for Systematic Reviews and Meta-Analysis), in databases such as Pub-Med, Scopus, Science Direct, Jane's, Dimensions, Google Scholar, as well as the Comprehensive System of Standards and Evaluation of the Ministry of the Interior of Mexico.

Results: 3089 documents were reviewed, and considering the inclusion, exclusion, and quality criteria, 2 tables were constructed, the first with 24 scientific articles and the second with 7 Mexican standards.

Conclusion: The regulation of emerging pollutants is a critical issue that must involve all sectors (for example, political, economic, social, and environmental). For this, it is necessary to coordinate the government, society and consider the experiences of other countries for its implementation. It was also identified that the issues of access to



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information and education programs have a significant impact on compliance with environmental regulations and that there is little scientific evidence on this matter.

Keywords: Emerging pollutants, environmental regulations, environmental legislation, environmental laws, environmental politics

INTRODUCTION

Mexico is a country in the American continent with a great diversity of ecosystems, flora, fauna, and valuable natural wealth^[1]. Nowadays, Mexico faces many challenges with monitoring a series of environmental problems, for which a suitable approach must be adopted to address, the direct and indirect, economic, social, health, and environmental implications of its decisions and activities^[2].

The most critical environmental problems afflicting the country are climate changes, and the loss of terrestrial, aquatic ecosystems and their corresponding biodiversity. At the same time, the scarcity and contamination of water resource, and air quality problems are other key issues. Thus, it is required to take urgent actions as these factors could negatively impact the environmental and economic spheres. Thus, they affect social aspects (e.g., health or food security), or even could endanger production and trade, as seen recently^[3]. Environmental issues are closely related to economic and social issues. Furthermore, The promotion of environmental education is essential for the development of sustainable lifestyles. Specifically, an integral, systematic, and collective approach is required to formulate strategies and government policies that harmoniously combine economic development and environmental conservation and recovery^[4].

Many laws have been issued to protect the environment. However, most of them are focused on regulating the presence of pollutants in the air, and few of them in the water. On the other hand, many of these have not been updated in 3 or 4 decades, and there are no real penalties for non-compliance. At the same time, they are focused only on regulating certain types of pollutants. Emerging pollutants, including pharmaceuticals, perfluorinated compounds, hormones, drugs of abuse, and personal care and hygiene products, are not covered by Mexican legislation. Additionally, nanomaterials, which have been recognized as contaminants of emerging concern in recent years, are not covered by these regulations.

The concern about emerging pollutants and their regulation has become a topic of great importance worldwide, even though many countries, mainly from the European Union, have taken on the task for some years of implementing regulations for these pollutants. The start of the pandemic showed the serious need to take immediate actions^[5].

The presence of emerging contaminants in aquatic environments (e.g., drinking water, groundwater, influent surface water, and effluent from wastewater treatment systems), atmosphere, aquatic organisms, and sediment remains a major challenge for both the environment and humans health^[5].

The need to legislate the presence of these compounds in the environment, lies in the fact that these micropollutants, generated by human activities, are generally released into the environment in small quantities. However, over time and due to their intensive and generalized use, they accumulate in the environment. The critical issue is that even at low concentrations, they can negatively affect living beings, especially in the long term.

The presence of emerging pollutants in wastewater is directly related to industrial activities, urban areas, and their surroundings. At the same time, the controlled or uncontrolled discharge and the persistence of emerging pollutants all pose a significant challenge to the government, from the following perspectives of policies and regulations generation, scientific research, and the development of technologies that allow the removal of these contaminants. In recent decades, Mexico has issued various documents (e.g., declarations, recommendations, non-legal agreements, and community agreements) aimed at environmental enforcement, without having any legally binding force, only of a recommendatory nature^[6-8].

Based on the previous points, in this work, a systematic review was carried out using the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) methodology of the international environmental regulations. Furthermore, we analyze the current situation of political laws and environmental education programs that have been implemented to regulate environmental problems in Mexico. Finally, we examine how this can help to regulate the presence of emerging contaminants.

Normative hierarchy in Mexico

Standardization is an indispensable instrument for the national economy and international trade. It is defined as the process by which the public and private sectors in the following areas of health, environment, and commercial information are regulated. On the other hand, standardization refers to the consolidation of knowledge gathered through consultations between experts in a branch or productive activity. In Mexico, it is reflected in the standards, which can be of three types, mainly NOM, NMX, and NRF^[9].

NOM is mandatory technical regulations that establish the characteristics that these processes or services must obey when they might cause risk or harm to human health. Additionally, it refers to terminology and its compliance and enforcement. They must be reviewed every five years from their entry into force and subsequently the modification, cancellation, or ratification. On the other hand, NMX provides the following for common and repeated use rules: specifications, attributes, test methods, guidelines, characteristics, or prescriptions applicable to a product, process, installation, system, activity, service, or method of production or operation. Furthermore, it included rules related to terminology, symbols, marked or labeled packaging. Noting that these standards are only mandatory if they are referred to as NOM. Finally, NRF standards are applicable to goods or services when Mexican or international standards do not cover their requirements, or when their specifications are obsolete or inapplicable^[9].

In Mexico, the Constitution is the supreme law that organizes the entire state. Furthermore, it emanates all normative order that is essentially secondary, whether at the federal or local levels. It consists of a dogmatic part in which the guarantees or individual rights are established and an organic part in which the structure, operation, and powers of the federal, and local powers are regulated. Based on the aforementioned points, it can be inferred that it is hierarchically superior to any other standard of the legal order, including international treaties, laws, regulations, and decrees in force in the country must be by what is mandated by the Constitution. Thus, the central axis of the legal life of the nation is in constant change according to the needs that arise from society^[10-15].

Environmental awareness and concern in Mexico began in the 1940s, motivated by increased industrialization, urbanization, growth, and demographic concentration, especially in the country's metropolitan areas. Basically, this situation was accentuated by the deterioration of air quality in large cities of the country, and the worldwide action in academic, intellectual, and governmental circles on atmospheric problems. It has been generating strategies that reduce pollution and the deterioration of natural resources^[16-19].

In 1988, the General Law of Ecological Balance and Environmental Protection was published, establishing the guidelines to achieve inter-institutional coordination, promoting sustainable development, and establishing the bases to guarantee the right for everyone to live in a healthy environment, health, welfare, and to continue being the leading law when it comes to the environment^[17-22].

In 1989, the National Water Commission itself was responsible for preserving national waters and their inherent public goods for their sustainable management and ensuring water security with responsibility for the orders of government and society. Starting in 1992, the National Institute of Ecology was created, to generate norms and define policies. Furthermore, the Federal Attorney for Environmental Protection was in charge of monitoring and overseeing compliance with regulations and laws. Later in 2000, the Ministry of the Environment and Natural Resources, which incorporates different areas of society and public functions, put forward criteria and instruments that ensure optimal protection, conservation and use of the country's natural resources, forming a comprehensive environmental policy^[17-19,21,23-26]. In [Table 1](#), the history of the regulation and management of water in Mexico can be seen. The first reports that go back to the nineteenth century clearly indicate that the management and control of the water oversaw municipalities and privately owned by the people, communities, and landowners, those who could appropriate them by any means. However, this lasted until the time of Porfiriato, a time in which the government granted itself the power to regulate the rights of the waters and their usage. Since that moment and as technology advances and the population increases, more significant support and larger budgets began to be allocated. Simultaneously, hydraulic works were carried out and the first laws dealt directly and specifically with water. Similarly, different agencies specialized and defined their functions in which both the use of water, its use for the generation of energy, and irrigation of agricultural properties were mainly vital^[27].

As time passes, doubts about the impact of industrialization and pollution begin to change the main theme of water policy. It was changed to a water policy aimed at conserving and protecting water which also generates penalties for its misuse and contamination. Water has begun to be considered an essential element for development and human well-being. Furthermore, an attempt was made to reflect this thought in the regulations in the form of a National Water Law; however it did not come to fruition due to a drastic reduction in the budget^[27].

The regulations regarding water matters originated in 1996 when the Mexican Official Norms were decreed to establish the legal framework for controlling contamination in wastewater from different productive sectors, treatment, reuse, and final disposal^[17-19].

These policies and laws have been advancing over the years and have been extended to other areas to protect the integrity of water and soil resources. Over the years, environmental policies, laws, and regulations have increased in Mexico. In fact, since 2000, the government has made more efforts to increase the laws and regulations that protect the environment in the country^[16].

[Figure 1](#) shows the complete normative hierarchy from the Political Constitution of the United Mexican States. At the first level comes the supreme document of the country's legal system. The General and Federal Laws are at the second level, followed by the third level by which regulations, agreements, treaties, national Constitutions and state regulations derived, forming the fourth level. Finally, the Official Mexican Standards (NOM), Mexican Standards (NMX), Emerging Technical Standards (NTE), and Reference Technical Standards (NTR) come at the fifth level. Basically, international treaties are between the first and second hierarchical levels. Noting that, it applies as long as the treaty is signed by Mexico and has constitutional support. Because Article 133 of the Political Constitution of the United Mexican States, reflected that the

Table 1. Timeline on water regulations in Mexico^[27]

Year/Season	Event
1946	The General Law of Communication Roads emerged, by which the government granted itself the prerogatives to regulate water rights, their normalization, and the use of private or public sources
1902	The Law on the Regime and Classification of Federal Assets arose where the national property of the waters was given the inalienable and imprescriptible character
1910	The first specific law on water matters was issued, called the law on the Use of Waters of Federal Jurisdiction, which established a water classification, regulating its use and concessions for the first time
1917	Public decisions were made to put water at the country's service, and various regulatory laws were passed on water (Constitution)
1926	The Law on Irrigation with Federal Waters was promulgated, established the bases for the construction of irrigation works with waters of federal jurisdiction, declared the irrigation of private agricultural properties of public utility, and created the National Irrigation Commission (CNI), whose purpose was the promotion and construction of irrigation works
1927	The Law of Endowments and Restitution of Lands and Waters opened the way to private colonization; it indicated that the towns without lands or waters had the right to be endowed with them, establishing the procedure for the endowment of the same
1929	The National Property Water Law is issued, which regulated taxes on the use of federal waters
1934	There was a reform to the Water Law of 1929, continuous with the catalog of national waters, the regulation of the uses, the water concessions, and established monitoring criteria regarding the use of the waters they were assigned, including for the first time water user societies, the national water reserve for the generation of electricity and a chapter on trials, crimes, misdemeanors and penalties (they did not contemplate the previous laws), it is essential since for the first time it was considered a fault to throw polluting substances to the water
1936	The Regulation of the National Water Law is issued, which determined how the use of water could be obtained for the first time
1946	A Hydraulic Resources Secretariat (SRH) was established, which was recognized as having the power to decide on water use. (12% of the federal budget was assigned to it), the new National Property Water Law was published (which did not come into force until 1972). The Irrigation Law was repealed, and the Irrigation Law was issued whose objective was to promote and encourage the planning, construction, and operation of irrigation works, sanitation, and land protection, to ensure the maximum use of the country's water resources
1948	The Federal Law of Sanitary Engineering was published, which laid the foundations for the potable water supply and sewerage works and planning and zoning work in the towns nationwide. The use of groundwater is regulated
1956	The Law of Cooperation for the Provision of Drinking Water to the municipalities emerged
1960	The Federal Jurisdiction Water Law is approved, whose objective was to regulate the use and exploitation of federal jurisdiction waters and establish the bases for the better use of hydraulic resources and the defense against the destructive action of water (it did not enter into force until 1972)
1972	Publication of the Federal Water Law, which coordinated and unified the previous water regulations, was to regulate the use of water and take care of its conservation. The Environmental Protection Law includes a chapter on the prevention of water pollution
1988	General Law of Ecological Balance and Environmental Protection (LGEEPA), Ministry of Agriculture, Environment, Natural Resources and Fisheries (SEMARNAP), and the care of the environment began to position itself as a topic of national and international interest
1989	The National Water Commission (CONAGUA) was created as a decentralized body of SEMARNAP, and its functions were established; the objective was that through it, the state would carry out the administration of water (it is allocated only 1% of the federal budget)
1992	The National Water Law establishes that in addition to regulating the exploitation, use, and exploitation of water, its distribution and control were aimed at preserving its quantity and quality to achieve its integral sustainable development. For the first time environmental criteria were adopted in the water regulations, it had a chapter dedicated to preventing and controlling water pollution, regulating the authorization of pollutant discharges and their control
2004	A reform is carried out that gives way to the Integrated Management of Water Resources (IWRM), with which the basin organizations were created, under the principle of decentralization; however, although principles on water management were introduced, the regulatory framework (regulations and NOM) remained incomplete, causing limitations in its application. There was a genuine concern for conserving water resources, establishing measures to prevent or reverse pollution, overexploitation, and misuse
2006-2012	Several reform projects were reviewed in the Senate Water Resources Commission, and regulation of the law was proposed, but it was never adopted. CONAGUA continued to attend to the water problem even without the complete regulatory framework; it should be noted that it cannot apply sanctions even if there are episodes of contamination

2014-2018 In the National Water Program, legislative reform is considered necessary. Deputies, senators, social organizations, and academics have proposed initiatives to reform the LAN, seeking a radical reform that is difficult to implement in the country. However, it was not presented, and the term ended

normative documents, based on the laws, may be modified to be what is indicated in international treaties^[10-15].

The importance of knowing the hierarchical structure that governs Mexico, lies in identifying the levels of application of the regulations as well as focusing attention on those documents that may be subject to improvement proposals that are aligned with current international legislation.

METHOD

A systematic search of published articles and documents was carried out under the criteria of the PRISMA statement^[28].

Search strategy and identification of documents

To identify relevant articles and documents, a bibliographic search was carried out from the beginning until November 2021. Databases such as Pub-Med, Scopus, Science Direct, Jane's, Dimensions, Google Scholar, as well as the Integral System of Standards and Evaluation of the Mexican Ministry of the Interior were used in the search.

The search was performed using the PICO strategy using the terms: “environmental law”, “environmental protection”, and “emerging pollutants”. Using “OR”, “AND”, and “NOT”, the resultant search strategy becomes: “environmental law” OR “environmental legislation” AND “environmental policy” OR “environmental policies” AND “environmental protection” OR “environmental education” AND “emerging pollutants”. Noting that, some filters were applied during the search process such as published and English-language articles.

The general process for identifying relevant documents can be described with the following points: (1) literature search in selected databases; (2) export results to a reference management software (Mendeley) and removal of duplicates; (3) selection of abstracts considering the inclusion, exclusion criteria, and the research question through the PICO strategy. Noting that it was performed by two members of the research group using Rayyan software; (4) conflict review by a third member of the group and selection of relevant articles from a full text by reading the papers by two members of the study group; and (5) identification of any additional relevant papers using the snowball technique^[29].

Eligibility criteria

Papers were considered eligible for inclusion in the review if they satisfy the following criteria: (1) original research articles published in a peer-reviewed journal, as well as Mexican laws, standards, agreements, and policies; (2) being published in English, for articles and in English and Spanish for normative documents; (3) being focused on water legislation; (4) addressing implications of the presence of emerging contaminants in aquatic organisms and on human

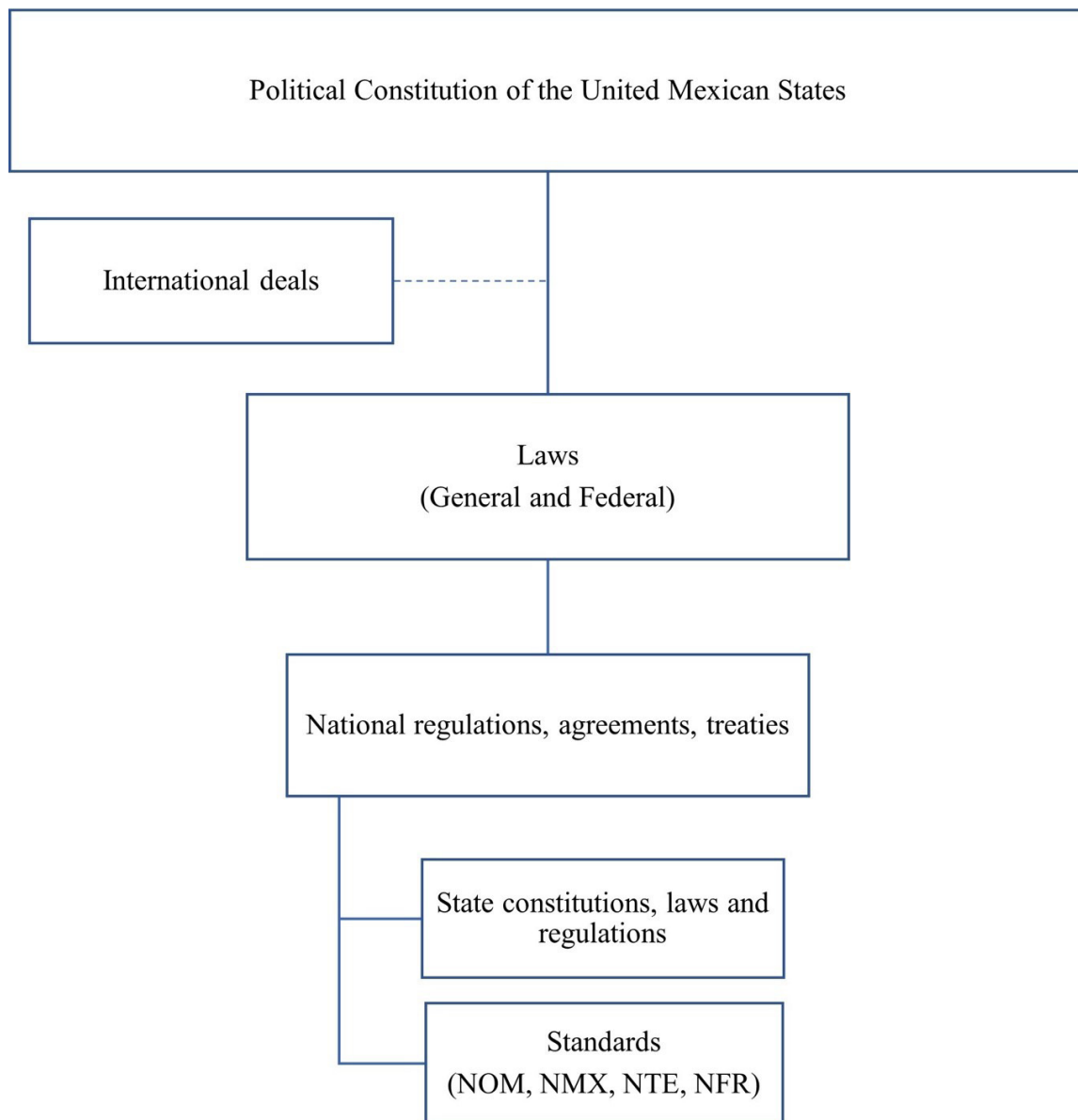


Figure 1. Normative Hierarchy in México^[10-15].

health; (5) including issues identified by the presence of contaminants in water bodies; and (6) including the study of emerging contaminants: occurrence and toxicity.

Articles were excluded if they involved the following: (1) Mexican laws, standards, agreements, or policies on soil, air, and sediment; (2) focusing on aspects of bioremediation, water treatment, and legislation not in force.

Data extraction

Data were extracted from eligible papers by two reviewers, using a standardized format based on the PRISMA statement. Various information was collected, and a third member of the group resolved disagreements.

The research articles identified the following: author, date of publication, country or state where the research was conducted, objective, methodology, results, and conclusions. In the normative documents, the following aspects such as code, date of publication, title, and type of contaminant, were identified, too.

Evaluation of methodological quality

The quality of the articles was evaluated by the first author and then verified by the remaining authors. The articles were evaluated using the Joanna Briggs Institute (JBI) Critical Appraisal Checklist for Qualitative Research^[30]. At the same time, this procedure was used to evaluate the methodological quality by analyzing the following elements in the form of questions (Q):

- Q1: Is there congruity between the stated philosophical perspective and the research methodology?
- Q2: Is there a consistency between the research methodology and the research question or objectives?
- Q3: Is there congruity between the research methodology and the methods used to collect data?
- Q4: Is there a consistency between the research methodology, the representation, and the analysis of data?
- Q5: Is there congruity between the research methodology and the interpretation of results?
- Q6: Is there a statement locating the researcher culturally or theoretically?
- Q7: Is the researcher's influence on the research, and vice-versa, addressed?
- Q8: Are participants, and their voices, adequately represented?
- Q9: Is the research ethical according to current criteria or, for recent studies, evidence of ethical approval by an appropriate body?
- Q10: Do the conclusions drawn in the research report flow from the analysis or interpretation of the data?

All those articles with a positive score of 80% of the items were included.

Data synthesis

The data synthesis was done separately for the research articles and the normative documents. For the review and selection of articles that, according to the final table, meet the quality criteria above, if it was not met, the articles will be discarded. Basically, for the review and selection of standards, those that mention concentrations of pollutants or that serve as a reference for their control are included. On the other hand, the rest of the norms were excluded.

The selected articles and standards will permit identifying the relationship between Mexican regulations and international regulations focused on regulating the presence of emerging contaminants.

RESULTS

Overview of publications

Figure 2 demonstrates the procedure followed for the selection of articles that make up the systematic review. Initially, the search for information in the databases resulted in a total of 3062 documents at the international level and normative documents for Mexico; in addition to this, it identified 27 articles from other sources, for a total of 3089 documents. Then, using the Mendeley software, 178 duplicate records were eliminated, leaving a total of 2911 documents. Later, these were entered into Rayyan for reviewing title and abstract, leaving 78 articles reviewed in full text. After reading the 78 articles, 47 of them were excluded, leading to 31 final articles. Using these selected documents, we proceeded with the construction of the summary table of the final articles.

During the construction of the table, seven articles were identified, they were excluded for not meeting the quality criteria established for this review, which is why the table was constructed considering 24 final articles. Afterwards, the quality of each article was assessed. Table 2 shows the analysis results of the quality criteria for the included documents.

Characterization of included studies

After the analysis, 24 research articles were used, as demonstrated in Table 3. As we can see, seven articles were identified that were carried out in China, four articles in the United States, and two articles in India. In parallel to that, five articles involved more than three countries, and one article was for the countries of Ethiopia, Russia, Bangladesh, and Mexico. Finally, two articles were written in a general way, without including any specific country. Of the total of 24 articles, 11 were carried out under a conceptual methodology^[6,31,33-36,42,43,47,48], one in a mixed way^[52], and the rest with a qualitative methodology^[32,37,39-41,44-46,49-51,53].

Concerns about environmental management have globally increased, leading to a particular interest in actions, environmental responsibilities, the establishment and verification of sanctions. This can be observed in five of the included articles^[6,35,47,51,52].

In seven more articles, the participation of the government internally and the external support of environmental organizations for the application of the legislation is evidenced, considering the economic aspects and their variation when applying environmental regulations and culture. Because it is identified that the population has shown disinterest in participating in these issues^[37,39-41,45,46,53].

Article^[38] mentions resilience in socio-economic systems. However, it highlights the importance of carrying out reforms in the short term since, as indicated in the article^[31], there may be an excess of laws, but if there is no coordination between government sectors, it will be difficult for non-governmental organizations to meet the objectives set^[43].

This agrees with article^[42] that emphasizes sustainable development objectives and congruences with Mexican regulations. Complementing what is referenced in the article^[42], Figure 3 presents a diagram of sustainable development objective number 6 and the goals that can be derived from it.

A total of eight articles referred to issues related to emerging pollutants, which represents third of the total articles. Three articles mentioned the problem of microplastics, addressing strategies to control these compounds due to the toxic effects they cause. They seriously affect organisms and human health^[7,10]. The state of California intends to establish a collaborative model to address the impacts of microplastics in

Table 2. Results of the critical analysis of the articles included in the study with the tool “JBI-Qualitative Critical Appraisal Checklist”

No.	Autor	Quality criteria										T
		Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	
1	Anisimov <i>et al.</i> ^[6] 2019	U	Y	Y	Y	Y	U	Y	Y	Y	Y	8
2	Bahauddin ^[31] 2014	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	10
3	Bali <i>et al.</i> ^[32] 2020	Y	Y	Y	Y	Y	Y	U	Y	Y	Y	9
4	Coffin <i>et al.</i> ^[33] 2021	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	10
5	Conti <i>et al.</i> ^[34] 2021	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	10
6	Dasgupta ^[35] 2000	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	10
7	Deme <i>et al.</i> ^[36] 2022	Y	Y	Y	Y	Y	Y	U	Y	Y	Y	9
8	Francesch-Huidobro <i>et al.</i> ^[37] 2012	Y	Y	Y	Y	Y	Y	U	Y	Y	Y	9
9	Garmestani <i>et al.</i> ^[38] 2019	U	Y	Y	Y	Y	U	Y	Y	Y	Y	8
10	Guo <i>et al.</i> ^[39] 2020	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	9
11	Kauffman and Martin ^[40] 2018	N	Y	Y	Y	Y	Y	Y	N	Y	Y	8
12	King ^[41] 2003	Y	Y	Y	Y	Y	Y	Y	Y	U	Y	9
13	Koff ^[42] 2021	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	10
14	Krasnova and Vlasenko ^[43] 2020	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	10
15	Lau <i>et al.</i> ^[44] 2012	Y	Y	Y	Y	Y	Y	U	Y	Y	Y	9
16	Li <i>et al.</i> ^[45] 2019	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	10
17	Wu <i>et al.</i> ^[46] 2020	Y	Y	Y	Y	Y	U	Y	Y	Y	Y	9
18	Montforts and de Knecht ^[47] 2022	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	10
19	Naidu <i>et al.</i> ^[48] 2016	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	10
20	Núñez-Rocha and Martínez-Zarzoso ^[49] 2019	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	10
21	Sharma <i>et al.</i> ^[50] 2014	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	10
22	Wang <i>et al.</i> ^[51] 2016	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	10
23	Zinabu <i>et al.</i> ^[52] 2018	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	10
24	Zhu and Ru ^[53] 2008	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	10

T: Total value; Y: yes; N: no; U: unclear; N/A: not applicable.

various sectors^[33]. Three articles considered that the application of the laws depends on the type of pollutant and the investigations carried out on them to establish links that allow adequate environmental management^[32,44,50]. Finally, the two remaining articles referred to international conventions and global regulations aimed at dangerous substances, considering emerging pollutants. They also addressed how their application and reforms to legislation could reduce their presence and impacts on the environment and human health.

The current environmental regulations date from 1996 to 2005, as shown in [Table 4](#). These regulations are issued by different secretaries, in this case, the Ministry of Health (SSA) and the Ministry of the Environment, Resources Natural and Fishing (SEMARNAT).

The first three standards^[55-57] refer to the maximum permissible limits for pollutants in wastewater, mainly metals, substances, chemicals, and organic matter. In standard^[58], it referred to forestry use. However, standard^[59] pointed out the issue of hydrocarbons.

The two remaining standards considered water quality for human use and consumption, establishing the permissible limits for pollutants^[59]. Unlike the first standards, in this one, there are a more significant number of contaminants. At the same time, standard^[60] mentioned the responsibilities regarding monitoring and evaluating water quality, taking as a reference the permissible limits indicated in the standard^[61].

As we can see, both tables refer to the issues that must be considered in the management of pollutants. Basically, we have the political sector, which corresponds to the decisions established by the government; Additionally, we have the economic sector, which regulates capital investment. Furthermore, we have the social sector, which marks the participation and monitoring of the population.

DISCUSSION

This systematic review enabled the selection of articles that represent the world panorama and its evolution over the years. We can also know, in a concrete way, how various countries develop environmental policies, how do they apply them, the problems they have faced, the pollutants of the most significant concern, and the implications in various sectors.

One of the main objectives of national and international legislation is to guarantee the right of every person to live in a healthy and balanced environment. Based on this, there is an international approach to the management of environmental policies that guarantee this right^[6].

Considering the results obtained in [Table 2](#), we can highlight some important points of the environmental legislation of some countries, which show a general panorama of the environmental situation in the world. For example, Brazilian environmental legislation is considered one of the most modern. It establishes that every person has the right to live in a balanced environment, which must be provided by the state and civil society. In the case of China, the regulatory framework focuses on protecting the environment; however, they do not consider environmental rights; In Russia, the development of effective legal measures for compensation and protection of damages, focusing on damage to the health of citizens, stands out. On the other hand, in South Africa, as well as in Brazil, the right to a favorable environment is guaranteed by the state. In contrast, India does not have any regulations that directly regulate this right, but citizen participation has forced a more active application of the regulations through a system of sanctions. Mention is also made of the absence of specialized instances that monitor offenders and there are also no

Table 3. Summary of the included studies

No.	Author(s)/publication year	Country	Objective of study	Methodology	Main results and conclusions
1	Anisimov <i>et al.</i> ^[6] 2019	Brazil, Russia, India, China, and South Africa (BRICS)	To compare the experience of BRICS in the field of regulation of liability for environmental crimes to recommend improvements of the Russian environmental legislation	Conceptual	The environmental legislation of the BRIC countries was evaluated, considering aspects such as the regulatory consolidation of the rights and obligations of citizens in the field of environmental protection, types of legal liability, and applicable sanctions for violations of environmental norms provided by the national legislation of all BRICS countries; finding that if some of the provisions in the Russian legislation were applied, they would allow improving their system of legal liability for environmental crimes and making it more modern and efficient
2	Bahauddin ^[31] 2014	Bangladesh	To investigate environmental laws, rules, regulations, and projects of Bangladesh, as well as the current status, mechanism, and decision making of the environment in the context of environmental governance, analyzing the issues and also exploring the challenges of environmental management in Bangladesh and the associated problems and risks of the system	Conceptual	It was found that there is an excess of laws, rules, and regulations, and institutions to manage and govern the environmental sector. Bangladesh's legal regime is quite comprehensive, but the institutions still lack coordination between the various ministries and agencies in the governmental and non-governmental sectors. Although attempts have been made to involve the people in formulating action plans, people are rarely considered and consulted when these plans are implemented. One of the consequences of this situation is the lack of public interest in government-sponsored environmental protection programs
3	Bali <i>et al.</i> ^[32] 2020	58 countries	Understand the effect of the informal sector and the quality of governance on a range of pollutants in environmental quality, corruption control, political stability, voice and accountability, and government effectiveness	Qualitative	The impact of governance depended on the type of measure, the level of economic development, and the type of pollutant. Control of corruption emerges as the most critical factor for improving environmental quality, especially in non-OECD countries. Furthermore, the effectiveness of an environmental policy for a country with a large informal sector will be low if policy measures do not address governance, the informal sector's size, and the environmental policy's objectives. Finally, it was identified that non-OECD countries lack strong environmental controls and incentive-based environmental policy enforcement, especially in their informal sector
4	Coffin <i>et al.</i> ^[33] 2021	California	Address microplastics' environmental and health impacts to discuss the development of regulations and health protection policies related to their use	Conceptual	It was identified that in the state of California, two pioneering laws were enacted to address the impacts of microplastics in drinking water and the marine environment in response to growing public concern; considering that state as a case study to identify actions that policymakers and researchers can take to advance the field and develop effective pollution intervention strategies. California's pioneering efforts to address microplastics in drinking water and aquatic ecosystems can serve as a model for developing open collaborations among diverse sectors
5	Conti <i>et al.</i> ^[34] 2021	---	Describe current policies on plastics to limit their use to combat environmental pollution by plastics, analyzing the characteristics of the toxic and polluting components of plastics, which can spread with different concentrations in the environment, reaching different levels of biota up to humans	Conceptual	Although additives and environmental pollutants are already regulated, new legislation is urgently needed to manage the plastic problem. The reduction can prevent environmental pollution, thus avoiding plastic toxicity in organisms because of inhalation and ingestion. Although plastic additives and contaminants alone on human health are well studied, the acute and long-term toxicities of plastics and plastic/additives and plastic/additives/contaminants complexes are not fully elucidated. Further studies will be needed to assess the incorporation, accumulation, and toxicity of plastics and related contaminants in humans, which may help to implement plastics policies that will ensure a common legislative strategy at the global level and lead to both a reduction of plastic pollution and its toxic effect on living organisms, including humans
6	Dasgupta ^[35] 2000	India	Review the implementation of environmental regulations in India	Conceptual	This study showed that current policies in India have limitations, are counterproductive to long-term environmental management, and are anti-poor. It was suggested that a solution to these problems might be a participatory and interactive approach to enforcement, backed by a package of incentives and sanctions, which requires a combination of sanction and compliance-based strategies

7	Deme <i>et al.</i> ^[36] 2022	Africa	Review policies, legislation, and regulations enacted to control microplastic pollution in Africa to develop a sustainable and harmonized framework for the coordinated reduction of plastic waste generation in Africa	Conceptual	It was found that most African countries employed a traditional approach to banning plastic use, production and import levies, and consumer taxes. However, the continuous increase in microplastic waste generation suggests that traditional perspective approaches may not be effective in Africa. Therefore, a hybrid bottom-up regulatory approach was proposed to develop and adopt proven regulations and frameworks
8	Francesch-Huidobro <i>et al.</i> ^[37] 2012	China	Analyze the pro-environmental orientation, institutional capacity, and external political support for environmental units in eleven jurisdictions in Guangzhou Municipality	Qualitative	The results show that after several decades of environmental protection regulations, the pro-environmental orientation of Guangzhou environmental officials has been strengthened. Although often strengthened in real terms, the institutional capacity of environmental agencies remains inadequate due to the increased expectations of state and social actors. The external political support that environmental agencies receive determines the success or failure of environmental protection implementation. Often, the strength or weakness of political support is embedded in the policy design and implementation structure and is associated with the political orientation of political leaders
9	Garmestani <i>et al.</i> ^[38] 2019	United States	Describe the current approach to environmental law in the United States and the European Union to justify the need for changes to respond comprehensively and forcefully to new and accelerating environmental criticisms	Conceptual	In the case of the United States and the European Union, it was found that they have yet to modify existing laws to foster resilience in social-ecological systems. It was shown that governments and other governance actors could make substantial progress in addressing environmental change in the short term, without major legal reform, by exploiting these untapped capacities and by offering principles and strategies to guide such initiatives
10	Guo <i>et al.</i> ^[39] 2020	China	To examine how the Chinese stock market reacts to polluting companies due to the announcement of new environmental policies during 2014-2017	Qualitative	The results indicate that the stock market reacts negatively to stricter environmental regulation, with negative abnormal returns for high polluting firms. The market response varies under different types of environmental policies, i.e., laws versus regulations, due to variation in the strength of policy enforcement. More influential environmental laws generated more negative market responses than relatively less effective regulations. A post-event analysis shows that cumulative average abnormal returns remain negative for at least six weeks
11	Kauffman and Martin ^[40] 2018	Ecuador, the United States, and New Zealand	They compared the law of nature laws in Ecuador, the United States, and New Zealand by analyzing two conceptual axes (scope and strength). The article then shows how these differences resulted from each law's unique conditions and contested processes	Qualitative	The study revealed the importance of three internal factors in right-to-nature laws: the openness of national political opportunity structures (influencing the type of legal provision adopted), the types of organizations and socio-political alliance structures driving the process (influencing the interests pursued), and the cultural context (influencing the frameworks used to mobilize support). Together, these factors shaped the strength of the laws and the way they were framed, contested, and expressed institutionally
12	King ^[41] 2003	Asia	Explain how education and science planning at the subnational level can be improved to assume a crucial role in the planning hierarchy and thus contribute to sustainable development in Asia	Qualitative	It was identified that integrated economic-environmental (E-environmental) planning should be a link within sustainable development plans in Asia, just as subnational planning for education and culture is necessary by committing the necessary human and financial resources to carry it out. It is concluded that an enhanced approach to integrated E-c-E planning at the subnational level can play a pivotal role in the planning hierarchy and thus help lead Asian nations towards sustainable development and offers some ideas for further application and research
13	Koff ^[42] 2021	Mexico	Identify whether the Environmental Impact Assessment (EIA) in Mexico is consistent with the spirit and objectives of the Sustainable Development Goals (SDGs)	Conceptual	Although the EIA could contribute significantly to the implementation of the SDGs because it is a globally accepted policy tool, it does not proactively encourage sectoral change, which leads to stagnation of political systems as is the case in Mexico; given that the 2030 Agenda aims to transform the way of understanding and to practice development, national states must implement it with tools that correspond to this new mandate. Otherwise, the SDGs may represent an opportunity that does not materialize
14	Krasnova and Vlasenko ^[43] 2020	Russia	Review strategic and policy documents addressed environmental protection,	Conceptual	It was found that Russian environmental law has a comprehensive approach to social, economic, and ecological relations on the enactment of policy strategy documents, in which environmental

			environmental safety, and the use of Russia's nature		problems are not addressed in isolation, but in the context of the interconnectedness of socio-economic development goals points to the need to find its place within the system of legal acts related to the environment to build a clear hierarchy in the system, increase the effectiveness of laws and create a functional mechanism of implementation. The authors suggest two options: adopt a separate legislative act on the national environmental policy, introduce a separate chapter in the Federal Law on Environmental Protection, or codify the adopted strategic instruments
15	Lau <i>et al.</i> ^[44] 2012	China	Review the policy and legal framework for monitoring and managing chemical contaminants in China, referencing relevant experience in other jurisdictions	Qualitative	Although there has been significant progress in the last decade in the control, policy, and legislation of persistent organic pollutants in China, there is a need to establish effective mechanisms to enforce existing laws and regulations. To this end, China needs an effort in nationwide monitoring of priority chemical pollutants in different environmental compartments, including humans, and harmonization of sampling and measurement protocols, effective regulation on the use and disposal of toxic chemicals and new chemicals, strict enforcement of related environmental laws, and active promotion of environmental awareness
16	Li <i>et al.</i> ^[45] 2019	China	Analyze the impact of Chinese central government rules, regulations, and reward/penalty mechanisms on policy implementation by local governments	Qualitative	The results indicate that local governments selectively apply environmental policies mainly due to environmental authoritarianism and the target-based accountability system imposed by the central government. Local governments focus their attention on the central government's attitude toward that policy because the extent of its reward/penalty system provides a signaling effect for different policies The Communist Party emphasized the "rule of law with Chinese characteristics". Although the Chinese government tries to solve the environmental problem through laws or policies derived from the law, it is paramount to incentivize local governments to work for such laws and policies
17	Wu <i>et al.</i> ^[46] 2020	China	To analyze the impact mechanism of governmental environmental governance, public participation, and its combined effect on improving regional environmental quality as a global indicator measured by the emission of waste gases, wastewater, and residual solids	Qualitative	The results show that environmental quality in China has been increasingly deteriorating; government environmental investment, legislation, and law enforcement on improving environmental quality are significantly positive, and public participation also helps to stimulate environmental quality The Chinese government should promote people's environmental awareness, expand, and improve the channels of public participation in environmental governance, and induce the public to correctly express their interests and demands to improve the environmental governance system, which is suitable for improving regional environmental quality
18	Montforts and de Knecht ^[47] 2022	United States	Investigate the limitations that environmental legislation imposes on the use of medicines and how an environmental assessment within the registration process can help meet environmental quality standards	Conceptual	The great efforts made recently by regulators and scientists must be based on clear political decisions and integrated into a uniform and transparent decision-making procedure. It should not take much effort to postulate community decision criteria and their levels of acceptability. These will provide a sound basis for applying existing risk assessment methodologies and help clarify (mandatory) data requirements and (realistic) risk mitigation measures. These five elements (e.g., criteria, standards, methodology, data requirements, and mitigation measures) will then provide a reference for deciding on environmental acceptability for both producers and decision-makers
19	Naidu <i>et al.</i> ^[48] 2016	Minnesota, United States	Analyze the environmental legal framework designed for emerging contaminants in the Minnesota Department of Health (MDH)	Conceptual	It was identified that there are a small number of regulatory regimes and guidance globally. Therefore, best practices in regulating contaminants of emerging concern must involve the integration of science and policy, be defensible and accepted by various stakeholders. Critical elements of environmental legal frameworks should include identifying and prioritizing emerging contaminants, assessing health and environmental impacts of crucial matrices such as soil, groundwater, surface water, and sediment, and evaluating available data, methods, and technologies
20	Núñez-Rocha and Martínez-Zarzoso ^[49] 2019	---	Review the effectiveness of international environmental policies such as the Rotterdam and Stockholm Conventions on exporting hazardous substances to	Qualitative	The effectiveness of the international environmental agreement was demonstrated; ratification of the Rotterdam Convention (RC) and the Stockholm Convention (SC) implies a reduction in trade of hazardous substances from OECD to non-OECD countries. It was found that when the exporter ratified the RC, there was a reduction in the import of hazardous chemicals of about 7%. In the

			developing countries		case of the EC, the results showed significant reductions of about 16% in commercial shipments of persistent organic pollutants. This reduction is more than double the effect found for the RC due to a more restricted obligation imposed by the EC convention
21	Sharma <i>et al.</i> ^[50] 2014	India	To review India's legal and non-regulatory policies and schemes to manage the chemical risk of persistent organic pollutants and compare them with those of developed countries	Qualitative	Although India has environmental laws, an integrated perspective approach to chemical regulation and pollution management of chemicals is lacking. Retrospective approaches to pollution management need to be replaced by risk-based approaches. Scientific knowledge must underlie the formulation of these policies. To narrow the gap with developed countries, there is a need to improve scientific research capacity and pollution and environmental impact monitoring programs
22	Wang <i>et al.</i> ^[51] 2016	China	Analyze the limitations of China's water quality management system to formulate environmental water standards based on the current water quality criteria	Qualitative	It was found that China is not yet ready for a complete shift from national-level environmental water standards to a system based on local standards. Therefore, a framework for transforming water quality criteria to environmental water standards was proposed. The framework consists of three parts: responsibilities, processes, and policies. Responsibilities include research authorization, guideline development, and information gathering at the national and local levels; processes include four steps and an impact factor system for setting water quality standards, and policies include seven specific proposals
23	Zinabu <i>et al.</i> ^[52] 2018	Ethiopia	To assess compliance with industry water quality guidelines and identify gaps in pollution control to recommend policy options based on quantification of dissolved metals in effluents from five industries in Kombolcha, Ethiopia	Mixed	Average metal concentrations above USEPA emission guidelines were found in the effluents. Comparison with emission guidelines indicates poor environmental management by industries and regulatory institutions. Despite appropriate legislation, no clear measures have been taken to control industrial discharges, with an apparent mismatch between environmental law enforcement and investment policies
24	Zhu and Ru ^[53] 2008	China	To analyze the implementation of strategic environmental assessment at the national level in China until 2005	Qualitative	It was found that bureaucratic politics between environmental and non-environmental ministries have limited the legislation and application of strategic environmental assessment to environmental assessment for a set of government plans defined in the Environmental Impact Assessment Act of 2003; thus, limiting the planning role of environmental assessment as a participatory decision-making tool. In addition, little public participation was found

environmental courts that establish the necessary activities for compliance with environmental legislation^[6,16,19,20].

Considering the previous points, we can state that in Mexico, the key normative document establishes the right to an environment that allows it to develop and maintain its well-being. However, compliance with this point is not guaranteed despite the existence of organizations dedicated to monitoring compliance with environmental regulations, which have the power to apply sanctions to those who are outside the regulations. At the same time, political, social, and economic factors have a direct impact on the functions of the environmental agencies as they depend entirely on the government, largely excluding the non-governmental sector and having minimal participation from society, a constant weakness also found at the international level, as in the specific case of Bangladesh^[6,16].

As mentioned in this article regarding Mexico, even though the sustainable development goals are worldwide, it is necessary to make modifications in the legislation of each country in order to comply with the established goals; otherwise, there would only be one proposal of improvement that would not reflect any benefit, as mentioned in the introduction, an adequate control regarding legislation would not be instituted. In parallel to that, having clear goals and

Table 4. Summary of Official Mexican Standards

No. Code	Publication date	Qualification	Pollutant type
1 NOM-001-SEMARNAT-1996 ^[55]	January 06 1997 In force	That establishes the maximum permissible limits of pollutants in wastewater discharges into national waters and goods	Fats and oils, floating matter, sedimentable solids, suspended solids, biochemical oxygen demand, nitrogen, phosphorus, arsenic, cadmium, cyanide, copper, chromium mercury, nickel, lead, and zinc
2 NOM-002-SEMARNAT-1996 ^[56]	June 03 1998 In force	That establishes the maximum permissible limits for pollutants in wastewater discharges to sewage systems	Fats and oils, arsenic, cadmium, cyanide, copper, chromium, mercury, nickel, lead, zinc
3 NOM-003-SEMARNAT-1997 ^[57]	September 21 1998 In force	That establishes the maximum permissible limits of pollutants for treated wastewater that is reused in public services	Fecal coliforms, helminth eggs, fats and oils, biochemical oxygen demand, suspended solids
4 NOM-060-SEMARNAT-1994 ^[58]	May 13 1994 In force	That establishes the specifications to mitigate the adverse effects caused on soils and bodies of water by forest use	Solid and liquid waste
5 NOM-127-SSA1-1994 ^[59]	January 18 1996 In force	Environmental health, water for human use, and consumption-Permissible quality limits and treatments to which water must be subjected for its purification	Total coliform organisms, fecal coliform organisms, aluminum, arsenic, barium, cadmium, cyanides, free residual chlorine, chlorides, copper, chromium, total hardness, phenols, iron, fluorides, manganese, mercury, nitrates, nitrites, nitrogen, pesticides, chlordane, DDT, gamma-HCH, hexachlorobenzene, heptachlor, and heptachlor epoxide, methoxychlor, 2, 4 D, lead, sodium, total dissolved solids, sulfates active substances to methylene blue, zinc trihalomethane, global high radioactivity global beta radioactivity
6 NOM-143-SEMARNAT-2003 ^[60]	March 03 2005 In force	That establishes the environmental specifications for managing congenital water associated with hydrocarbons	Hydrocarbons, total dissolved solids
7 NOM-179-SSA1-1998 ^[61]	September 24 2001 In force	Monitoring and evaluation of the quality control of water for human use and consumption, distributed by public supply systems	Residual chlorine Physicochemical and microbiological analysis Water quality analysis program

objectives but without making the appropriate modifications to the legislation will nullify any effect or opportunity to achieve it successfully.

More than 60% of the articles included in this systematic review refer to the description and review of the political, legal, and economic framework related to environmental issues. They analyze the impact of the application of sanctions and mitigation measures. Mainly, at the national level, intergovernmental organizations were created to administer national resources, coordinating efforts to achieve the well-being of society, and reduce damage to the environment. Additionally, the historical background guides the evolution and the aspects that these organizations must maintain as a priority. Basically, they are divided into three stages; the first refers to the relationship between environmental pollution and the population's health conditions, the second is oriented towards prevention, and the third oversees comprehensively considering an environmental economic policy^[18,19,22,26,62].

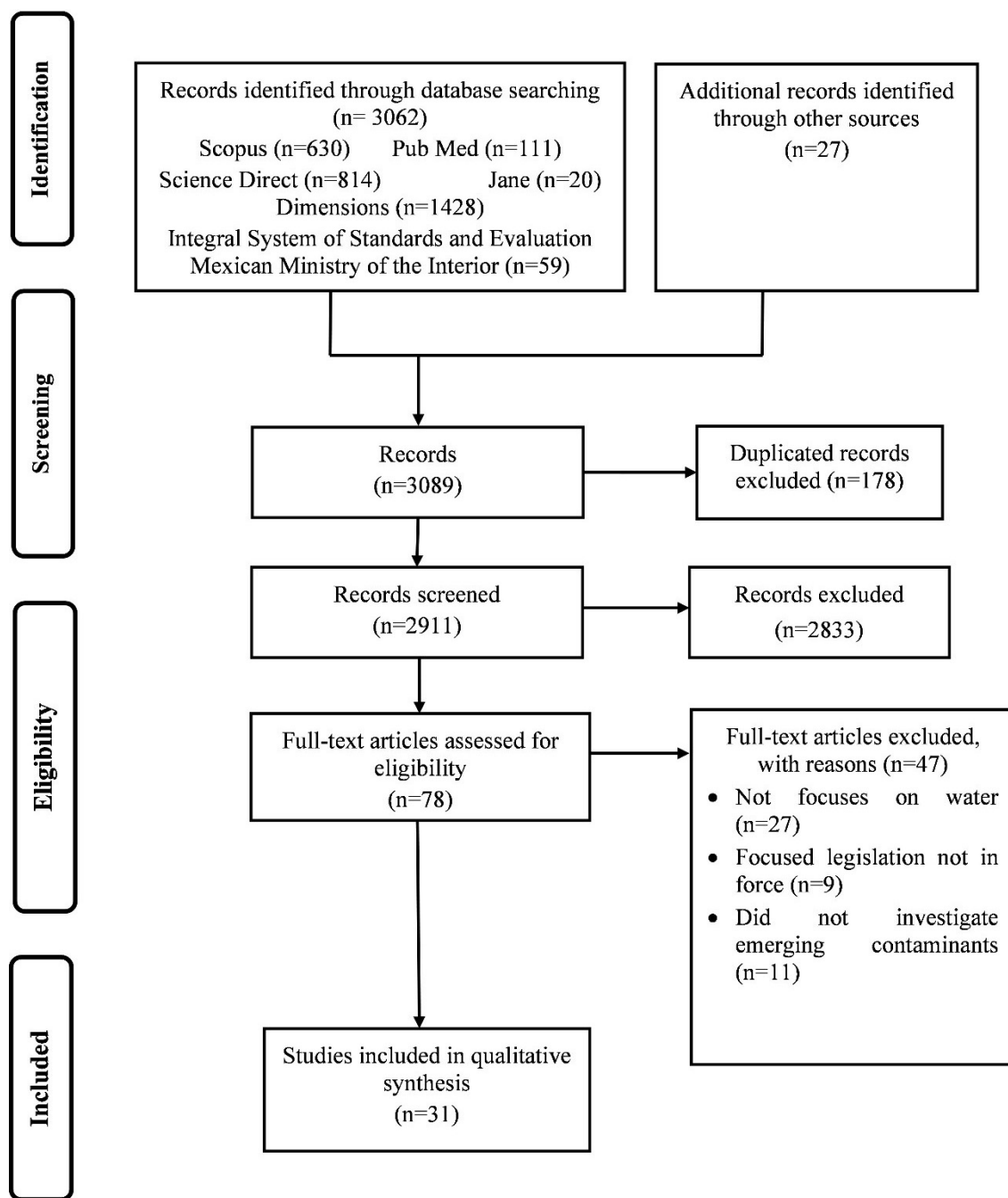


Figure 2. PRISMA flow diagram, based on Moher et al.^[28] (2009). PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analysis.

On the other hand, the worsening of environmental problems in Mexico has persisted. One of the fundamental factors that prevent community participation in the management of water resources is limited access to information. One of the proposals consists of broadcasting through radio, including broadcasts in various indigenous languages, verifying that the levels federal, state and municipal have the necessary resources. Another central factor is the allocated budget, which may be insufficient to carry out the established environmental proposals. A clear example is the construction of water treatment plants, research, and the generation of new technology to remove pollutants. Moreover, a third factor that

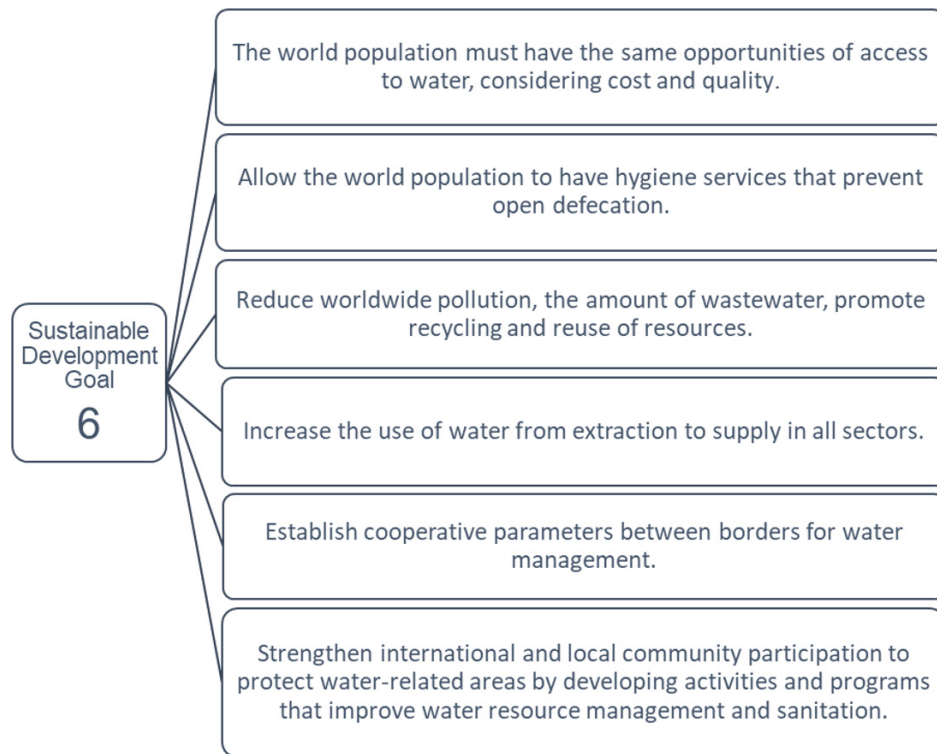


Figure 3. Sustainable development goals^[54].

especially impacts water management is the lack of coordination between the governments, secretariats, and competent offices of the different organizational levels responsible for addressing environmental problems^[22,62-64].

In many cases, progress in environmental matters is only formal, at the regulatory and discursive level, but not in the concrete field of problems, the detention, prevention, or remediation of environmental damage^[16]

Water resources management must be managed from different areas subject to technical, political, economic, and social issues. This has implied one of the significant problems faced by environmental legislation because a large part of the concept of water is seen as an economic good. At the same time, understanding that the ownership of water should preferably be private and managed as a market instrument would allow the allocation and protection of the resource to be made more efficient. Furthermore, it has been found that environmental modifications have a negative effect on the economy (i.e., because primary activities increase), the consumption of resources. It also increases, as expected, the most affected economic levels which are medium and low. Hence, the importance of establishing responsibilities such as the aforementioned polluter pays, to avoid the population having to assume obligations that do not correspond to them. On the other hand, it focuses on the fact that water should be conceived as a social good. Consequently, as a human right, it would be the duty of the state and society to equally provide population with access to the resource in an organized and cooperative way^[22,65,66].

Although the current legislation aims to unite both views, there have been problems regarding allocating control of the resource, its usage efficiency, and even its distribution in society. At the same time, environmental legislation does not exclude water resources as an economic component, but gives superior

importance to justice, equity, and sustainability^[65,67].

In the case of water resources, there is a concept called water stress in which two aspects are observed, when the water demand is higher than the quantity available during a given period or when its use is restricted by its low quality. Moreover, it has been observed that it exists in regions with accelerated economic development. Thus, it is understood that the regions may increase the productive sectors, increasing the water demand, causing the availability is not enough to satisfy the production and population needs^[62].

Another fundamental issue is social participation. It has been shown that in many countries, participation by the population is not attained. This is the case due to lack of interest, because they do not have the information, they do not have an incentive like large industries, or because they solely focus on obtaining benefits from resources without considering the environmental implications. A clear example is found in pollutants and especially emerging pollutants, which are recently being integrated into global regulation and which, thanks to the efforts of many researchers, have been demonstrated adverse effects on both the environment and human health. Thus, it provides guidelines to accelerate the implementation of strategies that regulate their presence. Two groups participated in water management. In the first group, there are people in government positions, and the second group is made up of interest groups, political parties, the media, academic researchers, consultants, and other people without a government position^[68,69].

The ideal objective would be for governments to commit to reforming environmental legislation by integrating new knowledge derived from scientific research, adapting, and transforming policies considering environmental changes, disseminating information to society, and involving communities for generation, development, compliance, and improvements of applicable laws. However, the fundamental limitation that Mexico has, as well as the United States and the European Union, is the hierarchical structure means that higher-level documents consider general actions that can hardly change. For this reason, the normative documents that can be focused on primary care at the national level are the aforementioned NOM^[2,23,25].

In the table made up of the Mexican standards, we can see that the standards date back several years, and the most relevant thing is that the number of regulated pollutants is extremely low compared to the compounds regulated worldwide. The detailed analysis of these documents reveals the legal gap in the regulation of emerging pollutants.

Based on the national and international scientific research, there is a broader knowledge of the aquatic environment and the probability of finding emerging contaminants, which allows for measuring its concentration and determining the potentially harmful effects on the ecosystem and human health. Basically, at the national level, these studies could serve as a basis for the generation of norms that regulate these substances and the implementation of technologies that allow their removal.

Another better relevant approach is to focus the attention on environmental education programs. It should be noted that no information was found on this item in the systematic review. Therefore, this topic is recommended to be considered as a perspective for future work or as part of a follow-up to this review.

There is a significant number of standards worldwide; however, adjusting them to each country is a crucial issue. Because each government has well-defined interests and objectives, implementation, compliance and verification are problematic for most countries.

It has been shown that coordination between sectors is essential for the success of environmental management, and the results of this systematic review allow us to identify red flags to increase this attention when developing environmental policies aimed at complying with the most developed international standards.

In the last few years, specialized groups in Mexico have focused on the investigation of pollutants, but mainly on the group of so-called emerging pollutants, highlighting the adverse effects on the environment and human health. In that sense, the next step is to create that link between research and regulations to well-establish the necessary regulatory parameters and mitigate these effects.

Knowledge of world regulations allows Mexico to evaluate its normative documents and, following the experience of other countries, integrate the government and society in decision-making from an economic-environmental balanced approach. Thus, increasing the chances of success.

The generation of NOMs, to regulate emerging pollutants would represent the first step toward a comprehensive management of emerging pollutants, taking special care with the relevant aspects addressed and discussed in the scope of this systematic review.

Considering that specialized non-governmental groups, such as researchers, have made considerable progress in recent years regarding environmental issues, especially in the effects caused and the evaluation of environmental legislation. Thus, it is urgent to work on issues with little information but great application, such as environmental education programs and proposals for reforms to existing Mexican regulations.

If these two aspects are added to all the existing information to date, a solid base could be considered, in which regulatory gaps are minimized, and better control of environmental contamination can be realized.

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All authors declared that there are no conflicts of interest.

Ethical approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

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