

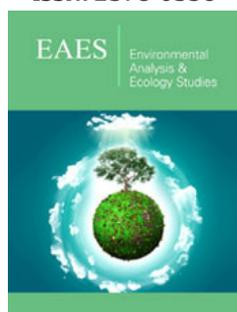
Soil Pollution by Persistent Organic Pollutants in Mexico

González Márquez J¹ and Ivett Montelongo B^{2*}

¹Professor, Department of Law, Metropolitan Autonomous University, México

²Professor, Department of Energy, Metropolitan Autonomous University, México

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***Corresponding author:** Ivett Montelongo B, Professor, Department of Energy, Metropolitan Autonomous University, México

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Abstract

This paper analyses how the Mexican government deals with soil pollution from Persistent Organic Pollutants (POPs). To achieve this objective, the analysis is divided into seven parts. The first explains the relevance of soil for environmental equilibrium and the necessity of controlling soil pollution. The second discusses on soil as subject of legal protection. The third explains what persistent organic pollutants and their adverse effects on the environment are. The fourth part explains what soil pollution by POPs consists of. The fifth analyses the legal framework of soil pollution by POPs, including the international and local regimes. Section six discusses the legal regime of restoration of sites polluted by POPs. Finally, a few conclusions are pointed out in light of the conducted analysis.

Keywords: Soil; Persistent organic pollutants; Restoration; Liability; Pesticides; Pollution

The Soil

Scientific studies consider the soil as the biologically active superficial part of the earth's crust, resulting from the physical or chemical disintegration or alteration of rocks and the residues of the activities of living beings that settle on it [1]. Soil comprises minerals, organic matter, tiny plant and animal organisms, air and water. It is a thin layer that has formed very slowly, over the centuries, with the disintegration of surface rocks by the action of water, temperature changes and wind. Plants and animals that grow and die in and on the soil are decomposed by microorganisms, transformed into organic matter and mixed with the soil [2].

Soil is a non-renewable resource since its degradation is more significant than its capacity for renewal. The food chain begins and ends with its preservation. If the chain base is cut, the ecosystem is drastically altered. One of its main threats is erosion, which affects the production of up to 95 per cent of our food [3]. Soil is one of the world's foremost biodiversity reservoirs, hosting more than 25% of the planet's biological diversity. In addition, more than 40% of living organisms in terrestrial ecosystems are associated with soil during their life cycle.

According to a report published by the Food and Agriculture Organization of the United Nations, soil organisms are essential in boosting food production, improving nutritious diets, preserving human health, restoring contaminated sites and combating climate change. Still, their contribution must be recognized more [4]. Therefore, control of soil pollution is fundamental for any government. This explains why the legal systems have established mechanisms to avoid soil degradation and pollution. Particularly, controlling soil pollution from persistent organic pollutants has become a universal concern due to several catastrophic accidents involving such substances.

Soil as a Subject of Legal Protection

Although the soil is subject to legal Regulation from different perspectives in all jurisdictions, there is no legal definition of this natural element. For instance, article 27 of Mexican Federal Political Constitution does not refer to soils but the lands in a double sense. First, as a subject of property. Second, as a subject of nation's power to impose modalities on private property. However, soil's legal nature is not a concern for the constitutional provisions.

The Federal Civil Code rules the property of things including the property of soil but it does not refer expressly to this natural element. The only legal body that defines soil from a legal

perspective is the General Law of Sustainable Forest Development. This law defines forest soil as a “Natural body that occurs on the surface of the earth’s crust, composed of mineral and organic material, liquids and gases, presenting horizons or layers and that it is capable of supporting life; that have evolved under a forest cover and that present characteristic that the forest vegetation that has grown there developed”. The lack of a legal definition of soil results in a serious obstacle to protect and restore soils polluted by POPs.

Persistent Organic Pollutants

Persistent Organic Pollutants (POPs) are chemical substances or mixtures synthesized to control disease-transmitting insects, improve agricultural production and make some industrial processes more efficient [5]. The main characteristics of POPs are their persistence in the environment and their volatile nature. Persistence means that they resist photolytic, chemical and biological degradation processes. Volatility means that they evaporate at a relatively slow rate. Persistent substances with this property tend to enter the air, travel long distances carried by currents, and then return to the ground. The colder the climate, the lower the tendency of POPs to evaporate, accumulating in regions such as the Arctic, thousands of kilometers from their sources. In addition to the above, POPs have low water solubility and are fat soluble.

POPs can affect people’s health and are currently found in the environment, wildlife and humans. Some POPs, at low concentrations, can alter normal biological functions, including

the physical activity of hormones and other chemical messengers, and trigger several potentially harmful effects. The production of synthetic organic compounds has increased dramatically since the beginning of the 20th century due to the industry’s growth in producing new materials that have radically made our lives more comfortable. However, this positive aspect of progress has had negative aspects. The increase in the production and use of synthetic organic compounds (such as pesticides, lubricants, solvents, gasoline, etc.) has multiplied the number of incidents in which these organic substances have reached the atmosphere, hydrosphere, soils and sediments, causing polluting episodes. One of the most famous accidents is the 1986 dioxin spill in the Rhine River, attributable to the chemical company Sandoz.

In Mexico, examples of major accidents involving POPs are the underground explosions in Guadalajara, Jalisco, in 1992² and the ammonium leak in Oaxaca in 2013³.

The Stockholm Convention, in its annexe A, initially recognized 12 chemicals as POPs; currently, there are 30 substances considered as such, which can be classified into three categories:

- a) Pesticides.
- b) Industrial chemicals.
- c) By-products

The following table lists the total number of POPs in Annexes A, B and C of the Stockholm Convention [6] (Table 1).

Table 1

	Chemical Substance	Acron YM	Category	Anne XE
1	Aldrin		Pesticides	A
2	Alpha-hexachlorocyclohexane	α-HCH	Pesticides	A
3	Beta-hexachlorocyclohexane	β-HCH	Pesticides	A
4	Chlordane		Pesticides	A
5	Chlordecone		Pesticides	A
6	Decabromodiphenyl ether	Deca-BDE	Industrial chemicals	A
7	Dicofol		Pesticides	A
8	Dichlorodiphenyltrichloroethane	DDT	Pesticides	A
9	Dieldrin		Pesticides	B
10	Endosulfan		Pesticides	A
11	Endrin		Pesticides	A
12	Gammahexachlorocyclohexane	γ-HCH	Pesticides	A
13	Heptachlor		Pesticides	A
14	Hexabromobiphenyl	HBB	Pesticides	B

¹In that year, due to an incident at the chemical company Sandoz, tons of pesticides were spilt into the Rhine River, causing one of the most severe accidents in Europe.

²In 1992, historical hydrocarbon seepage into the subsoil in the so-called Reforma Sector of the city of Guadalajara mixed with sewage gases, causing a tremendous explosion that killed 12 people and injured 1,800 others.

³In 2013, workers of the Cuadro Rojo company accidentally damaged a pipeline of the state oil company Petroleos Mexicanos (Pemex) producing a toxic gas leak that caused 9 deaths, 40 intoxicated and the evacuation of 1,200 people.

15	Hexabromocyclododecane	HBCD	Industrial chemicals	A
16	Hexabromodiphenyl ether and heptabromodiphenyl ether	PBDE	Pesticides	A
17	Hexachlorobenzene	HCB	Pesticides, Industrial chemicals, By-products.	A
18	Hexachlorobutadiene	HCBD	Industrial chemicals, By-products.	A y C
19	Mirex		Pesticides	A y C
20	Pentachlorobenzene	PeCB	Pesticides, Industrial chemicals By-products	A
21	Pentachlorophenol, its salts and esters	PCP	Pesticides	A y C
22	Perfluorooctanesulfonic acid	PFOS	Pesticides, Industrial chemicals	A
23	Perfluorooctanoic acid	PFOA	Industrial chemicals	B
24	Polychlorinated biphenyls	PCB	Industrial chemicals, By-products.	A
25	Polychlorinated dibenzo-para-dioxins	PCDD	By-products.	A y C
26	Polychlorinated dibenzofurans	PCDF	By-products.	C
27	Polychlorinated naphthalenes	PCN	Industrial chemicals, By-products.	C
28	Short-chain chlorinated kerosenes	SCCPs	Industrial chemicals	A y C
29	Tetrabromodiphenyl ether and pentabromodiphenyl ether	PBDE	Pesticides	A
30	Toxaphene		Pesticides	A

Soil Pollution by POPs

Soil pollution is the degradation process due to physical or chemical causes that lead to the total or partial loss of its productivity, generating harmful effects for living organisms or people [7,8]. One of the most worrying causes of soil pollution is the improper use and management of POPs. Therefore, most of the contamination processes by organic compounds are generally a consequence of the inadequate control of these substances. Soil

organic pollutants are very variable (phytosanitary products, oils, petroleum, gasoline, etc.), and their presence in soils is due to a wide range of human activities (agriculture, industry, transport, etc.). One of the most frequent causes of soil pollution is associated with the use of phytosanitary substances. In Mexico, there are 1046 sites polluted by chemical substances, of which six are attributable to pesticides. The following table lists these last sites (Secretaría de Medio Ambiente y Recursos Naturales, 2022) (Table 2).

Table 2

Year of Identification of the Site as Polluted	Responsible for the Contamination (Individual or Legal Entity)	State	Municipality	Contaminating Product	Has an Approved Remediation Program
2008	Swiss North American Properties of México, S.A. de C.V.	Mexico City	Azcapotzalco	Hydrocarbons, thallium, Polychlorinated biphenyls	Yes
2008	Bridgestone Firestone de México, S.A. de C.V., Planta México.	Mexico City	Miguel Hidalgo	Polychlorinated biphenyls	Yes
2008	Guanajuato, Government (Ex-Industrial Unit Fertimex-Tekchem)	Guanajuato	Salamanca	Organochlorine pesticides	No
2016	Ministry of Urban Development and Ecology of the Government of the State of Chihuahua (Ávalos)	Chihuahua	Chihuahua	Lead, arsenic, cadmium, vanadium, Medium fraction hydrocarbons, Heavy fraction hydrocarbons, Polychlorinated biphenyls	Yes
2016	Almexa Aluminio, S.A. de C.V.	Mexico City	Tlalnepantla de Baz	Heavy fraction hydrocarbons, Medium fraction hydrocarbons, Polychlorinated biphenyls	Yes
2019	Ferrocarriles Nacionales de Mexico in Liquidation (The Board)	Chihuahua	Guerrero	Creosote and Polychlorinated biphenyls	Yes

These are products used in agriculture to combat parasites and plant diseases, to protect crops from harmful agents, even if they are not parasites (weeds, algae, etc.) and to improve production qualitatively and quantitatively. Phytosanitary substances include pesticides, herbicides and fertilizers. These products mainly

include halogenated derivatives, organophosphorus compounds, carbamates, urea and thiourea derivatives, and heterocyclic compounds. Soil pollution by POPs also poses a severe risk to human health by direct contact (dermal exposure, inhalation of contaminated soil particles or consumption of contaminated

water); or indirectly, by consumption of plants or animals that have accumulated large quantities of soil contaminants. Preventing and controlling soil pollution by POPs is fundamental for food security and a sustainable future since soil plays an essential role in food production, climate change mitigation and adaptation, water filtration, and resilience to floods and droughts, among other problems. All these factors illustrate the need to regulate the use and disposal of such substances.

The Legal Framework of Soil Pollution by POPs

Although Mexico has signed several treaties that specifically refer to soil pollution by POPs, it does not have a national legal regime that comprehensively regulates the subject matter. In the following sections, we will discuss the international and national legal frameworks of soil pollution by POPs.

International legal framework

In the Mexican legal system, treaties signed by the Executive Branch and ratified by the Senate are part of the national legal order and are hierarchically placed above federal laws. Moreover, when it comes to international conventions that protect human rights, such as the human right to a healthy environment, they are placed at the same level as the Constitution and complement it. In this case, treaties that refer to POPs that can potentially harm human health and the environment are in such a circumstance.

Mexico has signed three international treaties that apply to soil pollution generated by POPs. These treaties are the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (1989) [9], the Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade (1998) [10], and the Stockholm Convention on the Reduction and Elimination of Persistent Organic Pollutants (2001) [11]. The following sections briefly analyse the content of the mentioned international instruments.

Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal: The Basel Convention was adopted in 1989 and entered into force in 1992. Its general objective is to protect human health and the environment against the adverse effects of the generation, transboundary movement and management of hazardous wastes. Although this Convention does not expressly refer to POPs, it applies when considered hazardous wastes.

The Basel Convention aims to establish a global regime to control the transboundary movements of hazardous wastes and

other wastes and their disposal to establish rules for their trade rather than prohibit them. The Treaty establishes the basis for member states to pass laws on these matters at the national level. Concerning the environmental Regulation of hazardous waste international trade, Article 4 of the Basel Convention establishes general obligations to minimize the generation of wastes and their transboundary movements and to ensure their environmentally sound management. Thus, the principal obligation imposed by the Basel Convention on signatory parties is to manage transboundary movements of wastes in an environmentally sound manner.

Parties to this Convention should not allow the export of hazardous wastes to other parties that have prohibited the import of such wastes or where they have reason to believe that the wastes would not be managed in an environmentally sound manner and are obliged to cooperate to improve and achieve environmentally sound management of such wastes. The Convention is based on a system of "prior informed consent". In cases where Parties have prohibited the import of hazardous wastes, the import shall not proceed. However, if the prohibition is absent in the state of import, export to that state is permitted only when the state of export obtains the written consent of the state of import. Failure to obtain the state's consent for the import and trafficking of wastes will be considered criminal conduct. The exporting state must provide complete information on the wastes and their transboundary movements to obtain this consent. The Basel Convention's provisions in Mexico have been included in the Environmental and Waste Laws.

The Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade: The Rotterdam Convention⁴ has the double objective of a) promoting shared responsibility and cooperative efforts among the signatory parties in the international trade of certain hazardous chemicals to protect human health and the environment from potential harm and b) contributing to their environmentally sound use; by facilitating information exchange about their characteristics, by providing for a national decision-making process on their import and export, and by disseminating these decisions across the Parties.

Adopting this Convention was influenced by many factors, including the concern about the massive growth in chemicals production and trade, the potential risks associated with these hazardous chemicals, and the lack of mandatory controls.

According to section I of its second article, the Rotterdam Convention applies to⁵:

- A. Banned or severely restricted chemicals; and

⁴Adopted by the Conference of the Plenipotentiaries in Rotterdam, 10 September 1998. The text was subsequently amended September 2004, October 2008, June 2011, May 2013 and May 2015. The Convention has 160 parties. It came into force in 2004

⁵On the other hand, according to section II of the same provision, the Convention does not apply to: narcotic drugs and psychotropic substances; radioactive materials; wastes; chemical weapons; pharmaceutical products, including human and veterinary drugs; chemicals used as food additives; food; chemicals in quantities unlikely to affect human health or the environment, provided they are imported; for research or analysis; or by an individual for his personal use in quantities reasonable.

B. Severely hazardous pesticide formulations.

The Convention is based on two fundamental pillars:

a) Banning or severely restriction chemicals listed in Annex III may be exported only with the importing Party's Prior Informed Consent (PIC). A procedure has been established to obtain and disseminate a formal decision from importing countries as to whether or not they are willing to receive future shipments of a particular chemical and to ensure that exporting countries abide by these decisions. There are currently 52 chemicals in Annex III: 35 pesticides (including three severely hazardous pesticide formulations) and 16 industrial chemicals, and one chemical listed in both the pesticide and industrial categories.

b) Exchanging information between Parties. Thus, countries planning to export a chemical whose use is banned or severely restricted in their territory must inform the importing country that such export is to take place before the first shipment and annually after that through the procedure known as Export Notification.

Based on the Rotterdam Convention, the Mexican government has banned⁶ the following substances: 2,4,5-T; aldrin, dieldrin, dinoseb, toxaphene; and restricted⁷: alachlor, aldicarb, chlordane, lindane, methamidophos, and pentachlorophenol.

Stockholm Convention on the Reduction and Elimination of Persistent Organic Pollutants: The Stockholm Convention was adopted in 2001 and entered into force in 2004. It was adopted from Persistent Organic Pollutants to protect human health and the environment. It called for global action on increasing POPs. According to Article 1, The Stockholm Convention aims to protect human health and the environment from persistent organic pollutants. Article 6 of the Stockholm Convention states that each Party shall endeavor to develop appropriate strategies to identify sites polluted with chemicals listed in Annex A, B or C. If remediation of these sites is undertaken, it should be done in an environmentally sound manner.

The Stockholm Convention establishes the following obligations for signatory parties:

A. Eliminate the production and use of the chemicals in Annex A following the provisions.

B. To restrict the production and use of the chemicals in Annex B following the same provisions.

C. Eliminate or restrict imports and exports of the chemicals listed in Annexes A and B, except for environmentally sound

disposal, purposes or uses allowed by the Convention, or by complying with specific requirements and considering existing international prior informed consent instruments.

D. Reduce and, where feasible, permanently eliminate releases from unintentional anthropogenic sources of the chemicals in Annex C. The Stockholm Convention requires minimizing such releases through the Best Available Techniques and Best Environmental Practices (BAT/BEP).

E. Determine stockpiles and wastes containing POPs to manage them safely, efficiently and environmentally soundly, eliminating their POP content as far as possible. Identification and environmental remediation of contaminated sites are also envisaged.

F. Encourage, with the support of research, the substitution of hazardous chemicals with POPs characteristics for alternatives that are not or less hazardous.

G. Allow the inclusion of new POPs. In addition to the 12 POPs initially contemplated in the Convention, new substances have been incorporated, according to the available scientific and technical information presented by the POPs Review Committee.

H. Create the Regional and Subregional Centers for capacity building and technology transfer concerning the Convention. Promote the exchange of information, awareness and education to make citizens aware of the danger posed by POPs. It is worth highlighting the work of the Regional Activity Center for Sustainable Consumption and Production (SCP/RAC) in Barcelona, designated in 2009 as the Regional Center for Capacity Building and Technology Transfer at the Stockholm Convention. Since that year, POPs have been included as a priority in many of the SCP/RAC activities. It is considered one of the most active regional centres of the Convention for its work in capacity building and technology transfer.

At the Conference of the Parties to the Stockholm Convention (CoP 9) held in May 2019, jointly with the Basel and Rotterdam Conventions, important decisions were made. The main decisions adopted were listing dicofol in Annex A with no exemptions, perfluorooctanoic acid (PFOA), its salts and PFOA-related compounds in Annex A with two exemptions, the reduction of the scope of the exemptions for Perfluoro Octane Sulfonates (PFOS), its salts and PFOSF. In compliance with Stockholm Convention, México has identified a list of sites polluted by POPs, has prohibited the import of several substances in Annex A, and has passed numerous legal provisions to rule the polluted sites restoration.

⁶Mexico has also banned: phenyl mercury propionate, cyanophos, chloranil, DBCP, dialiafor, endrin, erbon, formothion, sodium fluoroacetate, fumisel, kepone/chlordecone, mirex, monuron, nitrogen, schradan triamiphos, BHC, EPN, ethyl parathion, thallium sulfate, thallium sulfate

⁷Mexico has also restricted: 1, 3-dichloropropene, methyl bromide, chloropicrin, chlorothalonil, dicofol, phorate, aluinium phosphide, methyl isothiocyanate, metam sodium, methoxychlor, mecinphos, paraquat, quintozone, methyl isothiocyanate, methoxychlor, mecinphos, paraquat, quintozone

The national legal framework for soil contamination by POPs

As mentioned, Mexico has no specific legal regime on POPs soil pollution. In the absence of such a particular regime, the general soil contamination regime provided by: the General Law for the Prevention and Integral Management of Wastes (Waste Law) of 2003 [12], together with its Regulations, the General Law on Ecological Balance and Environmental Protection (Environmental Law) [13], the Federal Law on Environmental Responsibility (Environmental Responsibility Law) [14], the Health Law [15] and its Regulations on Pesticides, the issued on the subject is applicable. Some of the regulations established by the aforementioned international treaties are included in various precepts of these laws, but none of them comprehensively regulates the subject matter. For example, both the Waste Law and the Environmental Law refer to POPs as hazardous materials and wastes whose improper disposal can contaminate soils and cause damage to the environment or health and are therefore applicable to soil contamination from POPs. In contrast, the Health Law regulates only those POPs that fall under the pesticide category but do not address soil pollution [16].

The Environmental Law contains a chapter called 'Prevention and control of soil pollution', composed of Articles 134–144. Almost all these legal provisions are programmatic, and only Article 137 states that it is subject to the authorization by municipalities or by the Federal District (the government of Mexico City), the operation of the collection, storage, transportation, accommodation, reuse, treatment and final disposal of municipal solid waste systems. Similarly, Article 142 prohibits the import of waste for its spillage, deposit, confinement, storage, incineration, or any treatment for its destruction in the national territory or the areas where the nation exercises sovereignty or jurisdiction. However, these two provisions only refer to soil pollution indirectly. Finally, according to Article 141 of the Environmental Law, the Ministry of Environment, in coordination with the Ministries of Economy and Health, shall issue the Official Mexican Standards for the manufacture and use of containers and packages for all kinds of products whose materials make possible the reduction of solid waste generation. The rest of the provisions of this chapter are much more programmatic and refer to the criteria for the prevention and control of soil pollution, the issuance of Official Mexican Standards in this area, and the process of getting into coordination agreements with the states and the municipalities.

By contrast, in a different chapter, Article 152bis of the Environmental Law refers explicitly to soil pollution and establishes a parameter of polluted soil remediation, stating:

When the generation, management, or final disposal of hazardous materials and waste produces soil pollution, those

responsible for these operations must carry out the necessary actions to recover and restore the conditions of the soil so that it can be destined for any of the activities foreseen in the urban development program or of ecological ordinance plan that results applicable for the specific site or area. The Waste Law also contains a chapter on soil pollution called 'liability for pollution and remediation of sites', which includes Articles 68–79.

The chapter governs fundamentally five issues:

- a) The obligation to repair the damages caused by soil pollution.
- b) The authorization for the transfer of contaminated sites.
- c) The abandonment of contaminated sites.
- d) The identification, inventory, registration, and
- e) The categorization of sites contaminated with hazardous wastes and remediation declarations.

According to Article 69 of Waste Law, "The persons responsible for activities related to the generation and handling of hazardous materials and wastes that have caused the pollution of sites with these are obliged to carry out remediation actions by the provisions of this Law and other applicable provisions."

The liability referred to in Article 69 extends to owners or possessors of private lands and holders of concessioned areas whose soils are contaminated; according to Article 70, the latter are jointly and severally liable for soil pollution, even if they do not carry out activities related to the generation and handling of hazardous materials and wastes. In principle, transferring property of polluted sites is banned by Article 71 of the Waste Law. However, this prohibition can be lifted using the authorization granted by the Ministry of Environment⁸. Article 72 refers to soil pollution due to unforeseeable or force majeure events. This precept states, "In the case of contamination of sites with hazardous materials or waste, due to an unforeseeable event or force majeure, the competent authorities shall impose the necessary emergency measures to deal with the contingency to avoid endangering the health or the environment". In the case of sites contaminated by hazardous waste that are abandoned, Article 73 of the Waste Law provides that the Ministry of Environment, in coordination with state and municipal governments, may formulate and execute the related remediation programmes and make effective the guarantees provided by those who abandoned the site in question. Article 74 of the Waste Law states that the Remediation Declarations may establish modalities for property right. Still, the Law does not indicate to whom it corresponds to issue such declarations.

Likewise, under Article 75 of the Waste Law, the Ministry of the Environment and local governments must carry out actions of

⁸Article 126 of the regulation states in this regard: Those who transfer to third parties real estate that hazardous materials have contaminated must inform those who transfer ownership or possession of such property, in the terms provided in the second paragraph of Article 71 of the Law; such report shall be recorded in the instrument in which the transfer is formalized

identification, inventory, registration, and categorization of sites contaminated with hazardous waste, to proceed to its remediation. In this regard, Article 78 empowers the Ministry of the Environment and the Ministry of Health to issue standards for characterizing polluted sites. Finally, Article 76 states, "Local authorities must register polluted sites within their jurisdiction in the corresponding Public Registry of Property." Regarding the remediation of contaminated soils, Articles 77, 78 and 79 of the Waste Law, 152 of the Environmental Law, and the provisions of Chapter II of the Environmental Responsibility Law are applicable. According to the Stockholm Convention, several pesticides are considered POPs. The Regulation of pesticides in Mexico is addressed in the Environmental Law, Waste Law, General Health Law, General Plant Health Law and General Animal Health Law. The General Health Law states that the formulation, manufacture, commercialization, import and export of pesticides and the establishments dedicated to it are subject to obtaining a sanitary authorization, either a sanitary license or a notice of the operation. In Article 120 Section IV, the Environmental Law establishes some provisions regarding these substances. Firstly, it considers them substances subject to federal Regulation for being potential water pollutants when applied. Article 135 Section IV considers them substances that can pollute the soil, so this aspect must be considered when granting authorizations for the manufacture, importation, use and performance of related activities.

Since these substances can become hazardous waste during handling, the Waste Law, in its articles 3 and 28, establishes that producers, importers, exporters and distributors of pesticides must have a management plan since these are products that become hazardous waste when used, expire, are withdrawn from commerce or are discarded. In addition, Article 67 Section IX prohibits the incineration of persistent, bio accumulative and organochlorine organic compounds. Articles 5, 7, 30 and 42 of the Federal Plant Health Law and Articles 10 and 95 of the Federal Animal Health Law provide that the Ministry of Agriculture and Rural Development has the authority to establish and monitor the maximum permissible limits of toxic residues, including pesticide residues in animals, soil and food, to issue opinions on the biological effects of these products and to participate in the procedure for the registration of these substances.

All the abovementioned laws were integrated into the Regulation on Registration, Import and Export Authorizations and Export Certificates of Pesticides, Plant Nutrients and Toxic or Hazardous Substances and Materials, 2004 and reformed almost entirely in 2014. This Regulation in its Article 1° establishes as its purpose to regulate the requirements and procedures according to which the Federal Commission for the Protection against Sanitary Risks, the Ministry of Environment and the Ministry of Agriculture and Rural Development will grant, within the scope of their attributions according to the laws mentioned above, sanitary registrations, permits and authorizations for the import and export of pesticides. It also contains the procedures for obtaining permits and authorizations. It clarifies the collaboration of the

three governmental agencies so that the formulation, manufacture, commercialization, importation, exportation and even application of these pesticides are adequate and respects the right to health and the environment.

In addition to these general provisions, several Official Mexican Standards have been issued to guarantee the sanitary, environmental and agricultural safety of pesticides formulated, marketed and used in Mexico. These include the following:

- A. NOM-232-SSA1-2009 establishes the requirements for the container, packaging and labelling of technical-grade pesticide products and agricultural, forestry, livestock, gardening, urban, industrial and domestic use.
- B. NOM-082-SAG-FITO/SSA1-2017, where maximum residue limits are determined. Technical guidelines and authorization and review procedure.
- C. NOM-256-SSA1-2012 establishes the sanitary conditions that establishments and personnel dedicated to urban pest control services using pesticides must comply with.

Restoration of Sites With POPs Pollution

One of the main problems facing Mexican legislation in this area is the lack of clarity regarding the ideal remediation standard for a site previously polluted by POPs to be considered clean of contamination. The Environmental Law and the Waste Law, as well as the Environmental Responsibility Law, establish different parameters in this regard. The Regulation of soil remediation contaminated by POPs is scattered in the Waste Law, Environmental Law and Environmental Responsibility Law. All three laws refer to the remediation parameter, but the procedure to achieve this is a matter of the Waste Law Regulations. In this sense, Article 152BIS of the Environmental Law states that "When the generation, handling or final disposal of hazardous materials or wastes produces soil pollution, those responsible for such operations must carry out the necessary actions to recover and re-establish the conditions of the soil, so that it can be used for any of the activities outlined in the applicable urban development or ecological management program for the respective property or zone."

On the other hand, according to Article 78 of the Waste Law, the remediation parameter is a matter for the authority to determine; the article states: "The Ministry of the Environment, in coordination with the Ministry of Health, will issue the official Mexican standards for the Characterisation of contaminated sites and will evaluate the environmental and health risks arising from there, to determine, based on the risk, the appropriate remediation actions".

Based on this provision, the Ministries of Environment and Health have issued two official Official Mexican Standards establishing remediation parameters for polluted soils. These standards can be applied to soil pollution by POPs. The standards are:

- a) Mexican Official Standard NOM-147-SEMARNAT/SSA1-2004 establishes criteria for determining remediation

concentrations of soil contaminated by arsenic, barium, beryllium, cadmium, hexavalent chromium, mercury, nickel, silver, lead, selenium, thallium and/or vanadium.

b) Mexican Official Standard NOM-138-SEMARNAT/SSA1-2012, Maximum permissible limits of hydrocarbons in soils and guidelines for sampling in the Characterisation and specifications for remediation.

In addition to the above, the Ministry of Environment issued the standard: NOM-133- SEMARNAT-2015, Environmental Protection-Polychlorinated Biphenyls (PCBs)-Management Specifications; within this standard.

The Environmental Responsibility Law does not refer to the remediation of contaminated soil but, more generally, to the remediation of damage caused to the environment, which may include soil pollution by POPs. Article 13 of this Law states: The reparation of damages caused to the environment shall consist of restoring to their Base State the habitats, ecosystems, natural elements and resources, their chemical, physical or biological conditions and the interaction relationships that exist between them, as well as the environmental services they provide, through the restoration, re-establishment, treatment, recovery or remediation.

The second problem we found in the Mexican legislation is the absence of a transparent process according to which remediation of POPs polluted sites should be carried out. None of the three laws mentioned above address the issue. The Waste Law Regulations contain a Sixth Title of Articles 126 to 152, which contains many provisions relating to the problems usually encountered in the cleanup of contaminated sites but does not regulate a remediation procedure. Thus, the Regulation mentioned above contains rules relating to the transfer to third parties of previously contaminated sites (articles 126-128); contamination by spills, seepage, discharges or accidental spills (articles 129-131); remediation programs (articles 132-136); the person in charge of the remediation (article 137); Characterisation studies and environmental risk evaluation studies (articles 138-142); and remediation proposals (article 143-146). However, although this Regulation has a specific chapter (articles 148-152), this chapter does not refer to the procedure. However, it establishes a series of measures applicable to emergencies derived from the spill of hazardous materials or wastes.

Despite the vagueness of the Regulation, it can be noted that when a site has been declared contaminated by POPs, a remediation program must be prepared by the responsible party. This program should contain a Characterisation study, environmental impact assessment, and remediation proposal. However, the Regulation does not clarify who is responsible for declaring the contamination and who is responsible for saying that the site has been remediated.

Conclusion

Although Mexico has signed the main international agreements that deal with soil pollution by POPs, and even though official data

show that there are several contaminated sites in the national territory, it still does not have specific and complete national legislation that regulates this problem. Despite the lack of specific legislation, it is feasible to identify dispersed provisions in different national legal systems related to the described problem. However, several contradictions between these legislations make their application impossible. For example, there is no standard of homogeneous reparation in the three legislations, which differ in this respect. Similarly, there is no regulation governing the procedure to be followed in the remediation of sites and identifying the obligations of the polluter and the powers of the environmental authority in this respect. It can be said that there is no legal framework to control soil pollution from POPs.

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