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Inventory Of Persistent Organic Pollutants (Pops) In Products For Industrial Use In Ecuador.

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Abstract:
The result of the inventory of products with possible content of persistent organic pollutants POPs is presented. The inventory records that 1,218,906 tons of products with a possible content of perfluoroalkylated and polyfluoroalkylated and 134,756 tons of imported goods that could be composed of Dechlorane Plus entered Ecuador. As part of the inventory process, a documentary review process was carried out based on the Stockholm Convention guidelines for the preparation of POPs inventories and a phase for taking 121 samples of articles and their chemical analysis to detect perfluoroalkylated and polyfluoroalkylated substances, brominated compounds and short-chain chlorinated paraffins.
***Materials and Methods**: The POPs inventory is a compilation of information on the production and use of the compounds listed in the Stockholm Convention; this work has been carried out in depth in the Ecuadorian context so that the inventory is the result of the compilation of information on imports of goods that could contain the new POPs*
***Results**: In the period from January 2012 to June 2020, more than 1,200,000 tons of products were identified with possible content of PFAS and Dechlorane Plus. It should be considered that not all of these products contained POPs. One of the main reasons for this uncertainty is the type of information recorded by customs services, which has commercial rather than environmental management purposes.*
***Conclusion:** Ecuador managed to advance through the Convention's guidelines to an approximation to Level III of the inventory, based on the review of general information to identify products suspected of containing POPs and their imports during the period 2012-2020.*
***Keyword**: persistent organic pollutants, PFAS, Dechlorane, chlorinated paraffins, inventories.*

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I. Introduction

The "National Program for the Environmentally Sound Management and Life-Cycle Management of Chemical Substances" (PNGQ) works together with the Ministry of Environment, Water and Ecological Transition of Ecuador and other key stakeholders in the country's environmental management, to identify possible sources of persistent organic pollutants (POPs) emissions and to generate response strategies.

This paper summarizes the series of actions taken by Ecuador to build an inventory of new POPs, following the guidelines of the Stockholm Convention and local considerations. The project focused on presenting the main results of the inventories of POPs in products, carried out in 2019 and 2020, complemented with an analysis phase to determine POPs in samples of selected products for both industrial and household use.

The main objective of the inventories of POPs in products and the laboratory analyses was to present a general diagnosis of the entry of consumer products with new POPs in Ecuador, which can be used for the evaluation and formulation of sectorized environmental public policies, and can be a tool for replication and improvement in the Latin American and Caribbean region.

POPs have aroused the interest of the international community for several decades, and the Stockholm Convention is a clear example of the intention of the different States to reduce the toxic impacts that these molecules can have on human beings and nature. The latest efforts of the committee of experts advising the Stockholm Convention emphasize the analysis of several molecules that have replaced the original molecules that were restricted by the international instrument. Molecules such as perfluorooctane sulfonic acid (PFOS); perfluorooctanoic acid (PFOA); hexabromocyclododecane (HBCDD); polybrominated diphenyl ethers such as hexa, hepta, octa and decaBDE; have been listed since 2009, so that factories at the international level can replace them with less toxic alternatives (Stockholm Convention, 2019a). Despite the efforts of the chemical industry, some of these recently developed alternatives have failed to demonstrate that they break the continuum of toxicity, persistence or bioaccumulation; thus, by 2021, the effects of substitutes are still being discussed and investigated, among which chlorinated paraffins, Dechlorane plus and perfluorohexane-1-sulphonic acid (PFHxS) can be highlighted (Stockholm Convention, 2019).

The reality of the chemical industry is also reflected in Latin America and the Caribbean, where most countries are importers of chemicals and processed products, with the exceptions of Mexico and Brazil. For countries like Ecuador, without a strong local chemical industry, it is a question of access to the international market that provides the inputs and goods to develop national activities. One of the great challenges for buyer countries is to know the details of imports, at the chemical level, since there are several persistent organic pollutants that are added to consumer products to give them specific characteristics such as fire resistance, stain resistance or water and oil repellency.

The POPs included in the scope of work were:

PFAS (in inventory and laboratory)

Per- and polyfluoroalkyl PFAS (including PFOS, PFOA, PFHxS and 27 related molecules) have been widely used in coating formulations and surface protection agents due to their surfactant properties; with applications in protective coatings for paper and paperboard packaging products, carpets, leather and textile products, and as foaming agents for firefighting products (ATSDR, 2021).

Dechlorane plus (in inventory)

The "Dechlorane Plus" mixture is a polychlorinated flame retardant used, since the 1960s, as an additive in coatings for electrical wires and cables, plastic roofing materials, connectors in televisions and computer monitors, and as a non-plasticizing flame retardant in polymeric systems, such as nylon and polypropylene plastic (Stockholm Convention, 2019c).

SCCP and MCCP (in laboratory)

Short-chain chlorinated paraffins (SCCP), between 9 and 13 carbons, are mainly used in metalworking applications and in polyvinyl chloride (PVC) processing, they are also used as plasticizers and flame retardants in various applications, such as in paints, adhesives and sealants, leather fatty liquors, plastics, rubber, textiles and polymeric materials (UNEP, 2019). Medium-chain chlorinated paraffins (MCCP), on the other hand, are alternative molecules, between 14 and 17 carbons, which are used as substitutes for the short-chain ones, given their restriction due to their harmful environmental effects (US EPA, 2009).

PBDE and HBCDD (in laboratory)

Polybrominated diphenyl ethers (PBDE) are brominated chemicals that were added to a variety of consumer products (among electrical appliances, electronics and office furniture) giving them some fire resistance (ATSDR, 2015). The entire PBDE family consists of 209 possible substances called congeners; the work included: pentabromodiphenyl ether (pentaBDE), octabromodiphenyl ether (octaBDE) and decabromodiphenyl ether (decaBDE).

HBCDD is used as a flame-retardant additive to reduce ignition of flammable polymers and textiles in buildings, vehicles or electrical and electronic equipment; its main uses globally are in expanded and extruded polystyrene foam insulation, while use in textile applications and electrical and electronic appliances has declined (Stockholm Convention, 2017).

II. Material And Methods

Construction of the product inventory with new POPs

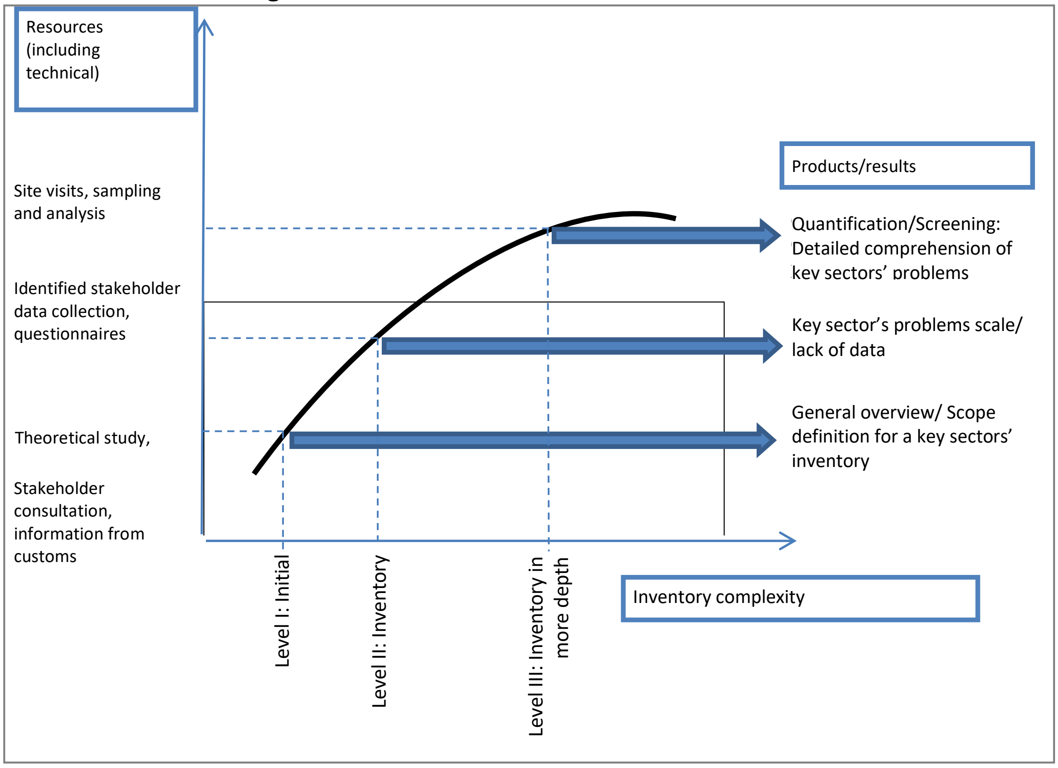
The POPs inventory is a compilation of information on the production and use of the compounds listed in the Stockholm Convention; this work has been carried out in depth in the Ecuadorian context so that the inventory is the result of the compilation of information on imports of goods that could contain the new POPs. Some of the guidelines proposed by the Stockholm Convention were followed for its preparation. Furthermore, the work of the "National Program for the Environmentally Sound Management and Life-Cycle Management of Chemical Substances" -PNGQ-, carried out in 2019 with the involved stakeholders to review whether there was local production of products with new POPs in Ecuador, was taken into account. As a result of the first approaches to the Ecuadorian industry (petroleum, mining, firefighting, electroplating, leather and tannery, aviation), it was established that, in general, with the exception of the polymer and plastics industry, POP additives were not being used. Given this background, it was necessary to include goods brought in from abroad in the Inventory.

Figure 1 shows the Convention guidelines for developing POPs inventories. In the case being presented, a Level II was used as a starting point to subsequently identify samples of the sectors in which the use or presence of POPs was presumed.

The inventory of products with new POPs consisted of a theoretical study (Level I), in which the possible quantities of PFOA, PFHxS and Dechlorane Plus that would be introduced into Ecuador were established.

The methodology used to prepare the inventory was based on the review of imports related to products with possible new POPs content, over a time frame of 8.5 years, from January 2012 to June 2020. To identify products of interest, risk profiles and risk management evaluations available on the Stockholm Convention website and scientific articles were reviewed.

Fig.1. Guide for the construction of POPs inventories



Considering that Ecuador does not have a significant manufacturing industry, imports were considered as the focus of analysis for the inventory. For this purpose, the "Arancel del Ecuador" (Ecuador Tariff) was used, which is a local adaptation of the tariff classification created by the World Customs Organization. The most important information the country has is the import and export database of the National Customs Service of Ecuador, which compiles information on each lot of goods entering and leaving the country. According to international guidelines for foreign trade, imported and exported goods must be classified under the international nomenclature established by the World Customs Organization, which establishes numerical codes for the different types of goods (called tariff headings). Thus, the tariff headings of the products suspected of containing POPs were selected.

As a next step in the construction of the inventory of products with new POPs, some criteria were applied for the analysis of the database, including the country of origin and the description of the products (since the local tariff classification is very general for certain products, for example, the tariff heading for carpets includes several types of synthetic and natural carpets).

Guidelines from the Stockholm Convention and agencies such as the U.S. Environmental Protection Agency and the European Chemicals Agency for the identification of products of concern are summarized in Table 1:

Table no 1. Products with possible PFAS content.

USES	PFOS	PFOA	PFHxS
Carpets	X	X	X
Firefighting foams	X	X	X
Semiconductor industry	X	X	X
Uses in tannery (leather treatment)	X	X	X

Surfactants or fluorinated polymers for various products	X		X
Fluoropolymer processing	X	X	
Food packaging		X	X
Aviation fluids	X		X
Photography liquids	X	X	
Paper and packaging	X	X	
Paints, enamels and coatings	X	X	
Pesticides	X		X
Substances for electroplating	X		X
Upholstery	X		X
Uses in the textile industry and dyeing process with sulfur dyes	X	X	
Surfactants for industrial and domestic use	X		X
Floor waxes and sealers for stone and wood, tapes and thread sealants, and glues		X	
Popcorn bag paper		X	
Polishes, cleaning and washing agents			X
Coatings, impregnation / waterproofing.			X
Sports Clothing			X
Semiconductors used in the photolithography process			X

As for Dechlorane Plus, it can be found in epoxy resins, polyurethane foams, silicone rubbers and neoprene fibers, especially for industrial uses, although it has also been reported in consumer products such as in the plastic of electronic device connectors (Stockholm Convention, 2020b; Weil & Levchik, 2016, p. 15). Due to international restrictions on the use of Octa-BDE and Deca-BDE, Dechlorane Plus is also used as a flame retardant in the plastic of electrical and electronic appliances (Cai et al., 2022).

Sample selection

The analytical component was used as an exploratory strategy (Level III of the POPs Inventory Guidelines) to contrast the results of the review of imports of products that may have PFAS. A number of samples of products with possible content of brominated compounds and chlorinated paraffins were also included, in order to continue with the follow-up of the information previously collected suggesting the entry of this type of POPs into the country, based on the results of the inventory prepared in 2019.

Within the analytical component, criteria sampling, a non-probability sampling technique, was conducted, where the work team selected the units to be sampled based on their knowledge, professional experience and judgment, and considering the results of the inventories (2019 and 2021) (Guo & Kannan, 2015). This type of sampling is useful for detecting small-scale problems with small budgets and a limited timeframe, in order to assess whether further investigation is warranted, considering the limitations that persist in the analysis of new POPs in complex matrices.

The nature of the substances to be analyzed contrasts with most standardized methods for environmental POP measurements, i.e. the objective of the analysis is not to quantify traces in air, water, soil or sediments but to determine constituent quantities in the products, therefore, a combination of pre-existing analytical methods and other ad hoc experimental methods under international recommendations was needed to guarantee the quality of the results.

Product sampling included the main industrial facilities in Ecuador, such as refineries, airports, and plastics and polymer industries, and visits to small leather and textile establishments, in order to develop the actions proposed in Level II of the POPs Inventory Guidelines. Also included were mass consumer products purchased from the shelves of the country's main supermarket chains and hardware stores. A total of 121 product samples were analyzed for PFAS, brominated compounds (PBDE and HBCDD) and chlorinated paraffins (SCCP and MCCP).

Samples were obtained from the following products:

- 64 samples for PFAS analysis: 2 from electroplating liquids; 6 from degreasers; 2 from photographic developing liquids; 3 from leather greasing agents; 3 from aviation hydraulic fluids; 3 from detergents and cleaning products; 3 industrial liquids, 6 from paints, oils and waxes; 2 of insecticides for ants; 5 of plastic products; 5 of carpets; 2 of treated leathers; 1 of degreasing wipes; 2 of electrical cables; 4 of fabrics and textiles; 8 of papers, cartons and packaging; and 7 of firefighting foams.
- 29 for analysis of brominated compounds: 3 from polystyrene samples, 2 from textiles, 3 from sponges, 4 from plastic from iron and air conditioner casings, 9 from waste electrical and electronic equipment, 2 from toner plastic, 4 from upholstery, and 2 from automobile panels.
- 28 for analysis of chlorinated paraffins: 3 samples of PVC, 3 of oils and lubricants, 3 of leather and grease, 3 of electrical cables, 2 of adhesives, 3 of baby toys, 3 of mattresses, 6 of rubber products, 2 of food processing oil.

Analytical component

In the product sampling phase, other POPs that had been under investigation in Ecuador were included. Thus, PFAS (PFOS, PFOA, PFHxS, and other molecules), HCBDD and PBDE, and short- and medium-chain paraffins were part of the laboratory analysis. The samples obtained were sent to two laboratories for analysis and quantification of POPs, PFAS were analyzed at the MTM Research Centre of Örebro University (Sweden), while HCBDD, PBDE and chlorinated paraffins were analyzed at the Environment and Health laboratory of Vrije University (The Netherlands).

The MTM laboratory analyzed 31 substances. PFAS analysis was performed using an ultra performance liquid chromatograph (UPLC) system coupled to a tandem mass spectrometer (Acquity XEVO TQ-S or XEVO TQ-S micro, Waters Corporation, Milford, U.S.). Separation was performed on a C18 column (1.7 µm, 2.1 mm x 100 mm) (Acquity BEH (ethylene bridge hybrid), Waters Corporation, Milford, U.S.). The injection volume was 10 µl. The mobile phases used were methanol: water 70:30 (v/v) (A) and methanol (B) with 2 mM ammonium acetate in both phases. The flow rate was 0.3 ml.min-1. The LC gradient started with 100% A, held for 0.5 min, then increased to 100% B in 13 min, held until 14 min, then decreased to 0% B in 14.2 min and equilibrated until 17 min. The instrumental settings of the mass spectrometer were electrospray ionization (ESI) operated in negative mode with a source temperature at 150 C, desolvation temperature at 400 C, desolvation gas flow at 800 l/h, cone gas flow at 150 l/ h. The column temperature was 50 C.

Samples of products with suspected brominated compounds (PBDE and HBCDD) were initially subjected to a screening process, this process used a direct probe - atmospheric pressure chemical ionization - time of flight (DP-APCI-TOF) (Bruker Daltonics microTOF II mass spectrometer). No sample preparation was required for detection. A few micrograms of the sample were inserted into a glass probe, the glass probe was inserted into the direct probe. 5 µl of calibration solution was added to the probe to correct for mass deviations. After adding the APCI tuning mixture, the probe was introduced into the APCI source. The following exact masses were used during the selection: Penta-BDE, Octa-BDE, Deca-BDE and HBCD. After screening, the sample with the positive result for Deca-BDE was subjected to a specific quantification process by Agilent Gas Chromatography - Negative Chemical Ionization - Mass Spectrometer (GC-NCI-MS, 5975) with an Agilent DB-5HT column (dimensions 15 m, 0.25 mm, 0.1 µm), ultra inert coating and 10 µl syringe.

For the quantification of short- and medium-chain chlorinated paraffins, gas chromatography (GC) coupled to low-resolution negative chemical ionization mass spectrometry (GC-ECNI-LRMS) was used on an Agilent GC 6890 instrument (Santa Clara, CA, U.S.). with an Agilent Model 7683 autosampler and an Agilent Model 5975C inert MSD. The injection was pulsed without splitting at 275 C. The column used was a DB-1, 50 m long, 0.25 mm inner diameter and 0.25 µm film thickness. The temperature program was as follows: 90 °C for 2 min, from 30 °C / min to 290 °C, from 15 °C / min to 325 °C and 7 min at 325 °C. The helium gas flow rate (constant) was 1.0 ml/min. Detection was performed using a mass selective detector (MSD).

III. Results and Discussion

Inventory of products with potential new POPs content

After reviewing information on imports to Ecuador between January 2012 and June 2020, thousands of tons of goods suspected of containing new POPs were detected. The results for each group of molecules are presented below:

The products most frequently imported into Ecuador, among which PFHxS are expected to be found, are carpets and polishes (see Table 2). In smaller quantities, food boxes, industrial detergents, aqueous film forming foam (AFFF), and food wrapping have been imported.

Table no 2. Products with possible PFOA and PFHxS content.

Product	Weight of products in tons
Carpets	13,773.60
Brighteners	5,242.40
Food boxes	5,140.70
Industrial detergents	4,051.70
Firefighting foams AFFF	1,220.70
Food packaging	804.90

As part of the construction of the PFAS inventory, perfluoroalkylated acids (PFAA), some of the most basic and non-degradable molecules, were also considered (ITRC, 2017); for this group of substances the main imported products (see Table 3) that could contain them were surfactants and semiconductors, components of electronic devices (such as televisions, laptops or desktop computers, among others).

Table no 3. Products with possible PFAA content.

Product	Weight of products in tons
Surfactants	172,464.50
Semiconductors (televisions)	53,912.50
Semiconductors (laptops)	9,344.00
Semiconductors (PC parts)	3,363.70
Semiconductors (cellular)	2,914.20
Semiconductors (monitors)	2,497.10
Semiconductors (mainboards)	770.10

The PFOA-related products (see Table 4) with the highest imports were high-voltage electrical cables, industrial sealants and textiles, which accounted for 79% of the imports of goods with possible POPs content.

Table no 4. Products with possible PFOA content.

Product	Weight of products in tons
High voltage electric cable	77,735.20
Industrial sealants	48,215.10
Oleophobic and water-repellent textiles	31,780.30
Teflon utensil	13,496.20
PPEs and similar	8,016.80
Fluorinated polymers	5,549.20
Membranes for filtration	3,721.20
Bitumen for leather	2,752.60
Microwaveable popcorn bag	1,773.50
Floor and wood waxes	1,733.80
Photographic coatings	1,458.80
Sports clothing, gloves, girdles	643.40
Lithography	625.20
Diving suits	27.50
Teflon PTFE	21.80
Invasive and implantable medical devices	6.80

In the case of products with possible PFHxS content (see Table 5), the greatest amount belonged to industrial lubricants and surfactants. Paper products, electrical appliances and some surface treatment products, among others, were found in smaller proportions.

Table no 5. Products with possible PFHxS content.

Product	Weight of products in tons
Industrial lubricants	319,687.00
Industrial surfactants	193,409.30
Coated paper	35,033.70
Carbonless paper	30,118.40
Fans	16,169.90
Tanning liquids	10,287.80
Irons	4,591.40
Hydraulic fluids	1,230.50
Textile liquids	457.60
Chassis, housings, panels	90.60
Electroplating fluids	14.20
Wallpaper	2.00

In the PFAS group, the main imported products were industrial lubricants, surfactants, electrical cables and televisions. Although these products include packaging, carcasses and other transport elements, the quantification of imported goods is a first step to take into account the magnitude of the problem. A total of

1,281,707.30 tons of goods with possible PFAS content were registered in the 8.5 years of the study period, i.e. reaching an import rate of 150,789.09 tons per year.

Among the products that could contain Dechlorane Plus (see Table 6), the polymers are in first place, contributing 50% of imports. According to reports from the Stockholm Convention, concentrations of Dechlorane Plus in products vary between 5% and 35%; although in recent studies they have been found in the range of 1.16% to 62% (Cai et al., 2022; Hansen et al., 2020). The uncertainty in defining whether products imported into Ecuador actually contain Dechlorane Plus is high and a laboratory analysis phase should be included in the near future.

Table no 6. Products with possible Dechlorane plus content.

Product	Weight of products in tons
Polymers	67,580.10
Rubber and similar	19,226.30
High voltage electrical cables	12,481.10
Epoxy resins	12,032.60
Electrical cables	10,280.40
Resins	7,735.00
Plastic coatings	3,288.70
Polyurethanes	2,001.70
PC connectors	102.10
Flame retardant textiles	27.90

Considering that, up to this point, it has been possible to work within Level II for the inventory, it should be noted that it is very difficult to determine which products contain POPs and their respective concentrations. However, the results allow us to establish priorities for environmental policies that are proposed as strategies to manage POPs. Likewise, the use of POPs and their alternatives (some of which are under review by the Stockholm Convention for presenting harmful characteristics) are often not declared on product data sheets. The challenge will be twofold to establish regulations on imports of products, on the one hand, the lack of identification and on the other hand, the scarce reports on the net content of POPs in the different goods.

Laboratory results

The study proposed to analyze the POP content in product samples as an exploratory action. In particular, further details were sought on the content of PFAS, brominated substances and chlorinated paraffins. It should be noted that the quantity and type of products, their locations and manufacturing methods, play a very important role. As the Stockholm Convention guidelines point out, there are developed countries where the production of POPs (e.g., PFOA and PFHxS) is still regulated, and in the case of medium-chain chlorinated paraffins, restrictions have not yet been established. The intention of sampling the products was to obtain preliminary data on their POP content, while recognizing that in order to achieve a Level III in the inventory it is necessary to implement systematic actions to be able to perform representative analyses of the products of interest (Stockholm Convention, 2020a).

In the group of samples selected for PFAS analysis (see Table 7), these were detected in 20 samples (31% of the total). The highest concentration of PFAS was detected in the ant insecticide, in addition PFAS were detected in 6 of 7 firefighting foams, in 1 sample of mainboard plastic fiber, in 2 of 5 carpet samples, in the 2 leather samples and 1 wipe degreaser, and in 3 of 8 fabric and textile samples. According to the laboratory reports, in the remaining 44 samples no PFAS were detected, above the detection limits of the instruments used.

Table no 7. PFAS content result report.

Group	Total	Detected	ΣPFOS	PFOA	PFHxS	NEtFOSA	Other ΣPFAS
Electroplating fluids	2	n.d.					
Degreasers	6	n.d.					
Photography liquids	2	n.d.					
Leather greasing agents	3	n.d.					
Aviation hydraulic fluids	3	n.d.					
Cleaners, detergents	3	n.d.					
Industrial liquids	3	n.d.					
Paints, oils, waxes	6	n.d.					
Insecticides (for ants)	2	1				150,000 µg/L*	

Plastic products	5	1	2.02 ng/g*				216 ng/g*
Carpets	5	2	1.35 ng/g	1.36 ng/g*			
Leathers and degreasing wipe	3	3	1.46 ng/g	1.67 ng/g*			1.65 ng/g
Electrical cables	2	n.d.					
Textiles and fabrics	4	3	1.87 ng/g*	3.20 ng/g			4.82 ng/g*
Papers, cartons and packaging	8	4	0.46 ng/g	20.90 ng/g			53.09 ng/g*
Firefighting foams	7	6					5,761.7 ng/g

Average values unless * is indicated, in which case the value corresponds to the result of an individual sample.
n.d. = Not detected.

The highest PFAS concentration was reported in the insecticide sample (ant bait), which had Sulfluramid (NEtFOSA, a precursor substance of PFOS) as its active ingredient. This product in South America is manufactured in Brazil and its main function is to combat leaf-cutting ants in the Amazon, according to information attached to the Stockholm Convention, until now there is no better alternative. Pesticide management is a challenge in the region.

Regarding aqueous film-forming foam (AFFF) firefighting agents, Herzke et al. (2012) and Favreau et al. (2017) had already detected the use of new PFAS, different from PFOS, PFOA and PFHxS. Laboratory results show higher concentrations than those reported in those studies and while these new PFASs have not yet been restricted, they are currently under investigation and have raised concerns in the scientific community.

The screening (for PBDE and HBCDD) performed for the 29 samples (see Table 8), from the group of brominated compounds, detected one sample with Deca-BDE-c content. Subsequent analysis of the sample quantified the Deca-BDE-c content.

Table no 8. Brominated compounds content result report.

Group	Total	Detected	Deca-BDE-c
Polystyrene samples	3	n.d.	
Textiles	2	n.d.	
Sponges	3	n.d.	
Irons and air conditioning	4	n.d.	
Waste from Electrical and Electronic Equipment (WEEE)	9	n.d.	
Toner plastic	2	1	3.3 mg/g
Tapestries and coverings	4	n.d.	
Car panel	2	n.d.	

n.d. = Not detected.

According to some independent reports, some generic toners have been found to contain elevated levels of Deca-BDE-c (ETIRA, 2018; Xerox, 2020). In the case of the sample in which the persistent organic compounds were detected, it was a new generic toner manufactured in China. This type of product is brought into Ecuador by the thousands, so it may be necessary to consider a monitoring or certification strategy ("POPs-free" style). If massive entry of Deca-BDE-c through these products is proven, their environmental management should include mechanisms to prevent their waste from entering the common waste stream.

Of the 28 samples selected for analysis of short- and medium-chain chlorinated paraffins, concentrations above the detection limit were reported in 3 of them (see Table 9).

Table no 9. Chlorinated paraffin content result report.

Group	Total	Detected	SCCP	MCCP
PVC samples	3	1	0.07% w/w	3.2% w/w
Oils and Lubricants	3	n.d.		
Leather and greasing agents	3	n.d.		
Cables	3	1	0.05% w/w	3.1% w/w
Adhesives	2	n.d.		
Baby toys	3	n.d.		
Mats	3	n.d.		
Rubber/plastic products	6	1	0.36% w/w	0.51% w/w
Food processor oil	2	n.d.		

n.d. = Not detected.

In the study by Xu et al (2019), which analyzed 30 samples of rubber products and adhesives the reported concentrations ranged from 0.0235 ug/g to 12,800 ug/g for SCCP and from 0.0202 ug/g to 160,000 ug/g of MCCP. In the analysis of selected products in the Ecuadorian market, between 500 ug/g to 3,600 ug/g of SCCP and between 5,100 ug/g and 32,000 ug/g of MCCP were found (Xu et al., 2019). The use of SCCP as plasticizers and flame retardants in some applications, even though their use is restricted, is reflected in the products produced with results above the detection limit; the products were PVC resin, electrical cable wrap and pieces of a rubber ball. It should be kept in mind that MCCP were mass-produced to replace SCCP when SCCP began to be restricted in some countries (Wang et al., 2019).

IV. Conclusion

The construction of national POP inventories, whether new or already listed in the Stockholm Convention, responds to the need to have information for the development of environmental public policies. In the case of Ecuador, it was possible to advance through the Convention's guidelines to an approximation to Level III of the inventory, based on the review of general information to identify products suspected of containing POPs and their imports during the period 2012-2020. Although more than 1,200,000 tons of products with possible PFAS and Dechlorane Plus content were identified for the period January 2012 to June 2020, it must be considered that not all of these products contained POPs. One of the main reasons for this uncertainty is the type of information recorded by customs services, which is for commercial rather than environmental management purposes. After establishing a base of imported products of interest, as they may contain POPs, the customs information does make it possible to establish the contacts of the companies that import them; approaching company representatives is useful and helps to define whether the products contain POPs.

POPs inventories require approaches to local stakeholders (especially industry) to corroborate the use of the substances in their production or commercial processes. The analytical component allows for refining the results of the inventories, although its cost may be high for developing countries' economies.

The lack of economic and analytical capacity in the region is a real obstacle. The authors believe that one strategy to overcome the challenges is to share the costs of monitoring between the public and private sectors, within institutional strengthening plans that generate analysis capacities at the local level.

Although many studies have dealt with the environmental monitoring of POPs, this study monitored the pollutant sources (products) in their different matrices (oils, dusts, fabrics, resins, plastics, sponges, leather, etc.) in the hope of providing an approach to the growing problem of POPs and their alternatives.

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