National Implementation Plan of Brazil for the Stockholm Convention on Persistent Organic Pollutants

Updated/2023

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DEPARTAMENT OF ENVIRONMENTAL QUALITY L
Director
Thaianne Resende Henriques Fábio

GENERAL COORDINATION
Thaianne Resende Henriques Fábio

TECHNICAL COORDINATION
Camila Arruda Boechat

TECHNICAL TEAM (MMA)
Anísia Batista Oliveira de Abreu
Pollyane Rezende
Winston Durães

INTERNS (MMA)
Ester de Araújo Freire
Júlia Enéias Oliveira

AUTHOR / CONSULTANT
Yago Guida

IMPLEMENTING AGENCY AND FINANCIAL SUPPORT
United Nations Environment Programme (UNEP)
Global Environment Facility (GEF)

GRAPHIC DESIGN
Henrique Peirano

MINISTRY OF THE ENVIRONMENT AND CLIMATE CHANGE
NATIONAL SECRETARY OF URBAN ENVIRONMENT AND ENVIRONMENTAL QUALITY

NATIONAL IMPLEMENTATION PLAN OF BRAZIL FOR THE STOCKHOLM CONVENTION ON PERSISTENT ORGANIC POLLUTANTS

Updated/2023

Brasília, DF
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TECHNICAL INFORMATION

The present National Implementation Plan of Brazil for the Stockholm Convention on Persistent Organic Pollutants was developed based on the review and update of the POPs inventories developed until 2015 and the new inventories developed for the POPs listed between 2015 and 2019.

AUTHORS/CONSULTANTS

Yago Guida
Fábio Barbosa Machado Torres
Raquel Capella Gaspar Nepomuceno
Cláudio Eduardo de Azevedo e Silva
Gabriel Oliveira de Carvalho
Adan Santos Lino
Cláudio Ernesto Taveira Parente
Rodrigo Ornellas Meire
João Paulo Machado Torres

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Foreword

The Stockholm Convention on Persistent Organic Pollutants (POPs) commits governments to reducing, and where feasible, eliminating the production and environmental releases of POPs. The Convention entered into force on 17 May 2004.

Brazil ratified the Stockholm Convention in 2004 through the Legislative Decree No. 204 of 2004 June 16 and promulgated the Convention through the Executive Decree No. 5,472 on June 20, 2005. The Article 7 (seventh) of the Stockholm Convention establishes that Parties shall develop and disseminate a National Implementation Plan (NIP) setting out the strategies and measures planned to meet their country commitments.

The first Brazil's NIP was submitted to the Conference of the Parties in 2015. In addition to the initial 12 POPs, the Plan addressed the 11 POPs included until the sixth Conference of the Parties, in 2013.

After that, seven additional chemicals and related compounds were listed as POPs in the Stockholm Convention Annexes, in consequence of this it became necessary to review and update the NIP-Brazil-2015, as one of the commitments of the Brazilian State to the Stockholm Convention.

The NIP of the Stockholm Convention that we now present to the country is a guide for public and private action for the reduction and elimination of POPs. This document updates the NIP-Brazil-2015 as a result of the UNEP/GEF Project "Review and Update of the NIP for the Stockholm Convention on Persistent Organic Pollutants (POPs) in Brazil". The new NIP of the Stockholm Convention embodies an international commitment while representing an essential tool for the country to mobilize resources to eliminate POPs.

Brazil recognizes that NIP requires to be revised and updated from time to time according to relevant changes in the national priorities and changes in the status of a POP or listing new chemicals. Furthermore, the learning processes during each review and update of the NIPs are fully acknowledge as an extremely valuable tool for improving the national capacity of dealing with POPs over time.

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LIST OF ABBREVIATIONS

ABDI	Brazilian Agency for Industrial Development
ABIPLAST	Brazilian Plastic Industry Association
ABIQUIM	Brazilian Chemical Industry Association
ACPO	Association for Combating Pollutants
ANA	National Water and Sanitation Agency
ANEEL	Brazilian Electricity Regulatory Agency
ANFAVEA	National Association of Motor Vehicle Manufacturers
ANP	Brazilian National Agency for Petroleum, Natural Gas and Biofuels
ANVISA	National Agency of Health Surveillance
APROMAQ	Association for the Protection of the Environment of Cianorte
ATESQ	Association of Workers Exposed to Chemicals
ATSDR	Agency for Toxic Substances and Disease Registry
AVCB	Fire Department Inspection Certificate
BAT	Best Available Techniques
BDE	Bromodiphenyl ether
BEP	Best Environmental Practices
BSEF	Bromine Science and Environmental Forum
CAR	Rural Environmental Register
CDT	Cyclododecatriene
CEEE	State Power Company
CEMA	Business Council for the Environment
CETESB	Sao Paulo State Environmental Company
CHESF	Sao Francisco Hydroelectric Power Company
CNPq	National Council for Scientific and Technological Development
CONAMA	National Environmental Council
CONASQ	National Commission for Chemical Safety
COP	Conference of the Parties
COPAM	State Council of Environmental Policy
COPEL	Paranaense Power Company
CP	Chlorinated paraffins
CRT	Cathode ray tube
CTF	Federal Technical Registry
DDD	Dichlorodiphenyldichloroethane
DDE	Dichlorodiphenyltrichloroethylene
DDT	Dichlorodiphenyltrichloroethane
decaBDE	Decabromodiphenyl ether
EaD	Distance learning
EC	European Commission
EDC	Dichloroethylene
EEE	Electrical and electronic equipment
EMBRAPA	Brazilian Agricultural Research Corporation
EPE	Energy Research Company
EPS	Expanded polystyrene
EtFOSA	Sulfluramid
EU	European Union
FAO	Food and Agriculture Organization
FINEP	Financier of Studies and Projects
FIOCRUZ	Oswaldo Cruz Foundation

FSP	Full size project
FUNAI	National Indigenous Foundation
FUNASA	National Health Foundation
FUNDACENTRO	Jorge Duprat Figueiredo Foundation for Occupational Safety and Medicine
GDP	Gross domestic product
GEF	Global Environment Facility
GHS	Globally Harmonized System of Classification and Labeling of Chemicals
GMP	Global Monitoring Plan
GRULAC	Global Monitoring Plan in Latin America and the Caribbean
HBB	Hexabromobiphenyl
HBCD	Hexabromocyclododecane
HC	Harmonized codes
HCB	Hexachlorobenzene
HCBD	Hexachlorobutadiene
HCH	Hexachlorocyclohexane
HDI	Human Development Index
HS	Harmonized system
IARC	International Agency for Research on Cancer
IBAMA	Brazilian Institute for the Environment and Renewable Natural Resources
IBGE	Brazilian Institute of Geography and Statistics
ICMBio	Chico Mendes Institute for Biodiversity Conservation
IEA	International Energy Agency
IMF	International Monetary Fund
INMETRO	National Institute of Metrology, Standardization and Industrial Quality
IPAM	Amazon Environmental Research Institute
ISO	International Organization for Standardization
JICA	Japan International Cooperation Agency
LCCP	Long-chain chlorinated paraffins
LCM	Life cycle management
LTDA	Limited
MAPA	Ministry of Agriculture and Livestock
MCCP	Medium-chain chlorinated paraffins
MCTI	Ministry of Science, Technology and Innovation
MDIC	Ministry of Development, Industry, Trade and Services
MDR	Ministry of Integration and Regional Development
ME	Ministry of Economy
MERCOSUR	South American Trading Bloc
MIN	Ministry of National Integration
MJSP	Ministry of Justice and Public Security
MMA	Ministry of the Environment and Climate Change
MME	Ministry of Mines and Energy
MRE	Ministry of External Relations
MS	Ministry of Health
MT	Ministry of Transport
MTE	Ministry of Labor and Employment
MTUR	Ministry of Tourism
NAFTA	North American Free Trade Agreement
NBM	Brazilian Nomenclature of goods
NCM	Mercosur Common Nomenclature
NGOs	Non-Governmental Organizations

NIP	National Implementation Plan
OCPs	Organochlorine pesticides
OEMAs	State Environmental Agencies
PARA	Pesticide Residue in Food Analysis Program
PBDE	Polybrominated diphenyl ethers
PCB	Polychlorinated biphenyl
PCDD	Polychlorinated dibenzo-p-dioxins
PCDF	Polychlorinated dibenzofurans
PCNs	Polychlorinated naphthalenes
PCP	Pentachlorophenol
PeCB	Pentachlorobenzene
PF	Formulated products
PFAS	Per-or-Polyfluoroalkyl Substances
PFN	Polifluorinated naphthalenes
PFOA	Perfluorooctanoic acid
PFOS	Perfluorooctane sulfonic acid
PFOSF	Perfluorooctane sulfonyl fluoride
PIA	Active age population
PIC	Prior Informed Consent of The Rotterdam Convention
PM	Pre-mixes
PNAD	Continuous National Survey by Household Sample
PNMA	National Environmental Policy
POP	Persistent Organic Pollutants
POPRC	Persistent Organic Pollutants Review Committee
PRTR	Pollutant Release and Transfer Register
PT	Technical Products
PTFE	Polytetrafluoroethylene
PVC	Polyvinyl chloride
RAPAL	Action Network on Pesticides and Their Alternatives in Latin America
RET	Special temporary authorizations for research and experimentation
RoHS	Restriction of Hazardous Substances Directive
SAICM	Strategic Approach to International Chemicals Management
SCCPs	Short-chain chlorinated paraffins
SCRC	Stockholm Convention Regional Centre
SDG	Sustainable Development Goals
SINIR	National Information System on Solid Waste Management
SISNAMA	National Environmental System
SUS	Unified Health System
Toxisphera	Environmental Health Association
UN	United Nations
UNDP	United Nations Development Programme
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environment Programme
USEPA	United States Environmental Protection Agency
VCM	Vinyl chloride monomer
VECAP	Voluntary Emission Control Action Program
WEEE	Waste Electrical and Electronic Equipment
WHO	World Health Organization
XPS	Extruded polystyrene

Executive Summary

Brazil signed the Stockholm Convention treaty at its creation date in May 2001 and ratified its text in June 2004, being a Party of this global commitment. The Brazilian State acknowledges its obligation to: I) develop a National Implementation Plan (NIP), indicating how it will meet the provisions established under the Convention, defining priorities and strategies to implement it; and II) review and update the NIP periodically, in order to help the government to identify the necessary measures for the control of Persistent Organic Pollutants (POPs) in the country — according to article 7 (seventh) of the Stockholm Convention and the Brazilian internal legal system, established through Decree N°. 5472 of 20 June 2005.

The first Brazilian NIP was transmitted to the Conference of the Parties at the Stockholm Convention in 2015 (NIP-Brazil-2015). The NIP-Brazil-2015 covered the 23 POPs listed by Stockholm Convention, presenting the findings of an initial investigation on the state of implementation of the Stockholm Convention on POPs in Brazil, the occurrence and uses of those POPs in the country, the management of their wastes and stocks, the contaminated areas, as well as the national installed capacity for POP analysis. The NIP-Brazil-2015 also identified the legislative and administrative measures already underway to protect human health and the environment from the effects of POPs and pointed out the gaps that needed to be filled. Moreover, a list of action plans was set so Brazil can address the provisions of the Stockholm Convention.

Since 2015, seven additional chemicals and related compounds were listed as POPs in the Stockholm Convention during the 7th, 8th, and 9th COPs — Hexachlorobutadiene (HCBD); Pentachlorophenol (PCP); Polychlorinated Naphthalenes (PCNs); Decabromodiphenyl Ether (decaBDE); Short-chain Chlorinated Paraffins (SCCPs); Perfluorooctanoic Acid (PFOA); and Dicofol. Therefore, five years after the first Brazilian NIP was transmitted to the Secretariat of the Stockholm Convention and considering the listing of new POPs, it became necessary to review and update the NIP-Brazil-2015, as one of the commitments of Brazil to the Stockholm Convention.

The NIP update aimed to:

1) Track progress from the first NIP;
2) Include POPs listed after the first NIP development;
3) Identify and apply synergistic actions with related national plans;
4) Raise public awareness and educate the public about POPs and related international treaties;
5) Contribute to improve chemical management in Brazil;
6) Raise awareness on the population about the POP issue;
7) Meet the obligations under the Stockholm Convention; and
8) Reduce risks caused by POPs to the environment and human health.

Brazil has followed the provisions of the Stockholm Convention, in terms of not producing any of the listed POPs and only using them for their acceptable purposes and specific exceptions, within the period in which these were granted. Measures planned to strengthen and expand the national legal framework and institutional capacity to manage POPs include: eliminating releases of POPs to the environment from the production and use of POPs; reducing unintentional releases of POPs to the environment; expanding the capacity for monitoring and management of POPs; and establishing the environmentally sound adequate management for POPs waste and products containing POPs.

Although Brazil has participated in several rounds of the Stockholm Convention's Global Monitoring Plan, there is still no centralized monitoring program that covers the entire country. The existing monitoring are usually carried out through studies conducted by public universities, within their graduate programs, and financed by the Federal Government through its agencies that promote education and research. Other monitoring is carried out by governmental institutions, such as Sao Paulo State Environmental Protection Company (CETESB), Brazilian Agricultural Research Corporation (EMBRAPA), and Oswaldo Cruz Foundation (FIOCRUZ). However, Brazil is endeavoring to build a national human biomonitoring program to assess the exposure of the national population to hazardous chemicals, including POPs. This program is being developed by the Ministry of Health.

Brazil has endeavored to expand the level of information and participation of the population regarding the Stockholm Convention and the listed POPs, as well as to improve and expand the number of professionals trained on the subject. These activities have been carried out both by the Ministry of Environment and Climate Change (MMA) and by CETESB as the Regional Center of the Convention for technical assistance and technology transfer.

The update of the Brazilian NIP focused on the revision of the inventories of the chemicals of industrial origin (HBCD, POP-PBDE and PFOS and PFOSF) taken as priority and the development of new inventories for the compounds listed after 2015 (decaBDE, dicofol, HCBD, PCNs, PCP, PFOA, SCCPs). However, all other POPs have been adequately addressed in the updated NIP.

POP-agrochemicals listed before 2015 were extensively addressed in the NIP-2015. The follow-up of their action plans highlights that no remaining stocks were found in Brazil, so these compounds are no longer a priority issue for the implementation of the Convention in the country.

In 2015, the Stockholm Convention decided to include Pentachlorophenol - **PCP**, its salts and esters with specific exceptions. In Brazil, PCP and its related products have been used as pesticides, for agricultural, domestic and industrial use (as a wood preservative). However, due to the toxic potential of these compounds, the application of PCP as an agrochemical was banned in Brazil in 1985. In 1998, Brazil banned the use of PCP in public health campaigns and in household applications. The last permitted use of PCP, as a wood preservative, ended in 2006. Although there is no current record of PCP production in Brazil and the few institutions that responded to the questionnaires sent out limited themselves to reporting that they have already substituted Na-PCP as an active ingredient in their wood preservative products without providing any production history, two reports were received on areas potentially contaminated with PCP in the state of São Paulo. For this reason, the main action plan for the control of PCP will be to monitor potentially contaminated areas to assess whether further measures are needed.

Dicofol is an agrochemical used mainly as an acaricide. In Brazil, dicofol has been used as an acaricide for cotton, citrus and apple crops. Due to its toxic, persistent, bioaccumulative and environmentally widely dispersible properties, the Secretariat of the Stockholm Convention decided in 2019 to list dicofol as a POP and, its production and use should be banned without specific exceptions. The production of dicofol in Brazil ceased in 2012, however, data reports that there were domestic sales of dicofol and imports of this substance into the country in subsequent years. With this, the action plans focus on clarifying the purpose for which dicofol was imported in 2018 and 2020, following the national restriction, to further strengthen import control and implement environmental monitoring studies in regions of the country where dicofol has been widely used, to identify contaminated areas.

Recently, a notable breakthrough was the approval of Project GEF **BRA/21/G31: Environmentally Appropriate Destruction of PCBs in Brazil**, which will provide integrated environmental management of PCBs, aiming to eliminate 15,000 tons of PCB-contaminated electrical equipment. This is a continuation of Project BRA 08G32- Establishment of Waste Management of Polychlorinated Biphenyls/PCBs and Disposal Systems, completed in 2019, which contributed to the strengthening of government and regulatory frameworks for the proper management of PCBs, enhanced the development of national capacity of technical personnel, and executed five demonstration projects for the environmentally proper management of PCBs through the development of pilot projects of PCBs inventories in electric companies. The next steps will be to implement measures for the reduction, disposal and destruction of PCB-contaminated waste. These actions, including volume calculations, removal, decontamination and final disposal of electrical equipment and waste identified as contaminated by PCBs, should result in the totality of the activities foreseen in the first NIP. The country has undertaken relevant initiatives to improve the management and disposal of PCBs and the implementation, updating and validation of the National PCB Inventory System is one of the current efforts underway.

The national inventory of Polybrominated diphenyl ethers - **POP-PBDEs** was reviewed and updated from 2015 to 2020. POP-PBDEs are compounds used as flame retardants in a variety of materials. Although there are no records on the production of flame retardants containing PBDEs in Brazil, the use of commercial mixtures, mainly decaBDEs, have been applied in plastic polymers in electrical and electronic equipment and in vehicle manufacturing. Several studies have indicated a predominance of decaBDE over other PBDEs also in environmental matrices. However, there is no monitoring of PBDEs in consumer goods in Brazil. The occurrence of PBDEs in polymers is a major challenge for the Stockholm and Basel Conventions, because several developing countries, including Brazil, lack appropriate facilities for recycling and destruction of these products. For these reasons, the action plans will aim to survey practices and techniques used in plastics recyclers to verify the current situation and necessary improvements, and support initiatives that promote vehicle recycling by states.

Hexabromocyclododecane - **HBCD** was listed in the Stockholm Convention in 2013 with some specific exceptions. Brazil has applied for the use of HBCD in polystyrene products for use in construction, however, the registration for this application expired in 2019. Although few institutions responded to the questionnaires sent out, those that responded reported having replaced the use of HBCD with other flame retardants in EPS and XPS. In Brazil, few studies have been conducted to assess the presence of HBCD in products and in the environment. Therefore, the implementation of a specific customs code for this compound and the monitoring of EPS and XPS that may contain HBCD and impact the environment and human health through recycling or final disposal of these products are highlighted as action plans for a better management of HBCD in the country.

According to the collected data, a former factory in Cubatão (State of São Paulo) produced from 5,000 to 9,000 tons of Hexachlorobutadiene - **HCBD** during the 1970 and 1980 decades. The company improperly buried a mixture of organochlorine substances during the years 1974 and 1993, in which the proportion of HCBD is estimated to be between 25 and 45%. The mixture was removed and deposited in a "waiting station" built in São Vicente, where it has remained since 1987, and currently, a total of 33,000 tons of HCBD-contaminated soil is estimated in the region. Other than that, it is highlighted that there are no records of HCBD production currently in Brazil and that, for a better monitoring of this POP, specific customs codes for HCBD should be implemented in order to assess the international trade of this substance. CETESB monitors the contaminated area.

In May 2015, the Polychlorinated naphthalenes - **PCNs** were added to the Stockholm Convention Annex A and C. PCNs were widely produced and sold as technical mixtures to produce transformer and capacitor fluids, lubricant additives etc. Overall, production of PCNs is now extinct in several countries. In Brazil, there are no records indicating its manufacture, but it was recorded in 2017, the import of this substance in the volume of 930 kg in a single year. No studies evaluating PCNs in Brazilian samples of any kind were found, however, considering the unintentional occurrence of PCNs, there may be a relevant gap of information on the occurrence of PCNs in the country, mainly due to the use of PCBs and SCCPs. To address this information deficit, one of the action plans will be to conduct chemical analyses of residual concentrations of these compounds in materials used in buildings, such as sealants, paints and external coatings.

Short-chain chlorinated paraffins - **SCCPs**, a subcategory of chlorinated paraffins (CPs), were added to the Stockholm Convention in 2017. It is possible that the raw material to produce CPs may contain other chemical compounds that could result in the unintentional formation of other POPs. To address this issue, measures will be taken to identify the chemical composition of CP-based products used in Brazil. There is evidence that CPs were produced in Brazil until the 1990s and that these compounds continue to be imported for use in the country. In addition, it is estimated that the importation of products that have CPs as additives in their manufacture, such as flexible PVC, is an important way for SCCPs to enter the national territory. Therefore, in addition to the need to implement specific customs codes to control the import of SCCPs, Brazil needs to invest in monitoring the life cycle of products that may contain SCCPs and their impacts on recycling and final disposal of waste.

Perfluorooctanoic acid - **PFOA**, its salts and related compounds are used in industrial applications and can be used in the synthesis of polymers and other substances. Due to their harmful effects on organisms, including humans, these compounds were listed in 2019 in the Stockholm Convention. Since their inclusion in the Convention, the production and use of PFOA, its salts and PFOA-related compounds can only occur for specific exceptions in signatory countries. However, Brazil did not request exceptions for the use of PFOA, as no evidence of production or use of PFOA was identified in the country. The action plans adopted for the control of PFOA, its salts and related compounds, cover creating mechanisms for greater engagement, control and inspection of industrial sectors to identify possible remaining uses of these substances, encourage studies and projects that aim to describe the situation of environmental contamination, especially in drinking water and food, which can have consequences for national public health.

The national inventory of Perfluorooctane sulfonic acid - PFOS, its salts and Perfluorooctane sulfonyl fluoride - PFOSF has been revised and updated. Brazil does not produce PFOS, however, data reported to the Secretariat of the Stockholm Convention, in 2018, reported an increase in the consume of PFOSF to produce EtFOSA, when compared to the quantities consumed between the years 2010 and 2015. Among the next steps for the control of PFOS, its salts, and PFOSF, some will be to improve information on other possible uses of PFOS, conduct studies to identify substitutes for EtFOSA to carry out the future phase out of EtFOSA, evaluate the degradation of EtFOSA to PFOSF and its environmental impact, and apply measures to reduce exposure risks and waste management practices in the industry.w

1. INTRODUCTION

Throughout the 20th century, evidence has accumulated that some chemical compounds, when released into the environment intentionally or unintentionally, can resist physical, chemical, and biological degradation and transformation; can disperse over long distances, reaching even the most remote regions of the planet; can contain high toxicity; and can accumulate in organisms, threatening wildlife and human life. Because of these characteristics, those chemicals are a global concern, as it is not possible to preserve the ecosystems and the citizens from the threats of chemical pollution using isolated measures.

1.1. Stockholm Convention

In May 2001, the Stockholm Convention on Persistent Organic Pollutants (POPs) was adopted, with an overall aim to protect the environment and human health from organic chemicals that persist in the environment for long periods, become widely distributed geographically, accumulate in human beings and wildlife, and have harmful impacts on human health or on the environment. The Stockholm Convention entered into force in May 2004, following the fiftieth instrument of ratification, acceptance, approval, or accession to the Convention. Currently, the Convention has 152 signatory countries and 185 countries Parties.

Initially, the Stockholm Convention listed a cluster of 12 chemicals for immediate adoption by countries. However, following the provisions in Article 8 of the Convention, a Party may submit a proposal to the Secretariat for listing a chemical as a POP in Annexes A, B and/or C, upon evaluation of the Persistent Organic Pollutants Review Committee (POPRC). Thus, new chemicals have been proposed and listed as POPs over time. Additional substances started to be listed as POPs at the 4th Conference of the Parties (COP-4), in 2009, and by the 9th Conference of the Parties (COP-9), in 2019, 18 additional substances have been listed as POPs (Table 1).

Table 1: Chemical compounds listed as POPs in the Stockholm Convention by the 9th COP, in 2019 (continue)

Compound	Annex	COP – year	Use/Source
Aldrin	A	COP 1 – 2001	Pesticide
Chlordane	A	COP 1 – 2001	Pesticide
DDT	B*	COP 1 – 2001	Pesticide
Dieldrin	A	COP 1 – 2001	Pesticide
Dioxins (PCDD)	C	COP 1 – 2001	Unintentional
Endrin	A	COP 1 – 2001	Pesticide
Furans (PCDF)	C	COP 1 – 2001	Unintentional
HCB	A and C	COP 1 – 2001	Indust.-Pestic.-Uninten.
Heptachlor	A	COP 1 – 2001	Pesticide
Mirex	A	COP 1 – 2001	Pesticide
PCBs	A* and C	COP 1 – 2001	Industrial-Unintentional
Toxaphene	A	COP 1 – 2001	Pesticide
Chlordecone	A	COP 4 – 2009	Pesticide
HBB	A	COP 4 – 2009	Industrial
Hexa and hepta-BDE	A*	COP 4 – 2009	Industrial
PeCB	A and C	COP 4 – 2009	Indust.-Pestic.-Uninten.
PFOS & PFOSF	B*	COP 4 – 2009	Industrial-Pesticide
Tetra and penta-BDE	A*	COP 4 – 2009	Industrial
α-HCH	A	COP 4 – 2009	Pesticide
β-HCH	A	COP 4 – 2009	Pesticide

Table 1: Chemical compounds listed as POPs in the Stockholm Convention by the 9th COP, in 2019 (continued)

Compound	Annex	COP – year	Use/Source
γ-HCH	A	COP 4 – 2009	Pesticide
Endosulfan	A*	COP 5 – 2011	Pesticide
HBCD	A*	COP 6 – 2013	Industrial
HCBD	A and C	COP 7/8 – 2015/2017	Industrial-Unintentional
PCNs	A* and C	COP 7 – 2015	Industrial-Unintentional
PCP	A*	COP 7 – 2015	Pesticide
DecaBDE	A*	COP 8 – 2017	Industrial
SCCPs	A*	COP 8 – 2017	Industrial
Dicofol	A	COP 9 – 2019	Pesticide
PFOA	A*	COP 9 – 2019	Industrial

Annex [A], elimination, with prohibited use and production (*with some specific exemptions/acceptable purposes); Annex [B], restriction (and perspective of elimination); Annex [C], unintentional production.

Source: Prepared by the author from http://www.pops.int/.

1.2. Stockholm Convention provisions

The Stockholm Convention text consists of 30 Articles and seven Annexes (UNEP, 2018a). Through this arrangement, the Convention stipulates that the Parties should adopt measures to reduce or eliminate the use, production, import and export of POPs, as well as their unintentional release; promote the use of best available techniques (BAT) and best environmental practices (BEP) for processes and products to reduce POP emissions; and provide environmentally adequate disposal of wastes and stockpiles of these chemicals.

- **Article 1**: presents the **Objective** of the Convention;
- **Article 2**: presents the **Definitions** of the Convention;

- **Article 3**: sets out **Measures to reduce or eliminate releases from intentional production and use** of POPs;
- **Article 4**: describes the mechanisms to the **Register of specific exemptions**;
- **Article 5**: sets out **Measures to reduce or eliminate releases from unintentional production** of POPs;
- **Article 6**: sets out **Measures to reduce or eliminate releases from stockpiles and wastes**;
- **Article 7**: establishes criteria for the development of **Implementation plans**;
- **Article 8**: establishes criteria for the **Listing of chemicals in Annexes A, B and C**;
- **Article 9**: endorses that each Party should undertake and facilitate **Information exchange**;
- **Article 10**: endorses that each Party should promote and facilitate **Public information, awareness and education**;
- **Article 11**: encourages Parties to undertake appropriate **Research, development and monitoring**, as well as collaborations, pertaining to POPs and, where relevant, to POP candidates and alternatives;
- **Article 12**: sets out criteria for **Technical assistance**;
- **Article 13**: sets out criteria for **Financial resources and mechanisms**;
- **Article 14**: rules on **Interim financial arrangements**;
- **Article 15**: sets out criteria for **Reporting** to the COPs;
- **Article 16**: rules on **Effectiveness evaluation**;
- **Article 17**: rules on **Non-compliance**;
- **Article 18**: rules on **Settlement of disputes**;
- **Article 19**: establishes criteria about the **COP's**;
- **Article 20**: establishes criteria about the **Secretariat**;
- **Article 21**: establishes criteria about the **Amendments to the Convention**;
- **Article 22**: establishes criteria about the **Adoption and amendment of annexes**;
- **Article 23**: establishes criteria about the **Right to vote**;
- **Article 24**: establishes criteria about the **Signature**;
- **Article 25**: establishes criteria about the **Ratification, acceptance, approval or accession**;
- **Article 26**: rules on the **Entry into force** of the Convention;
- **Article 27**: establishes criteria about the **Reservations**;
- **Article 28**: establishes criteria about the **Withdrawal**;
- **Article 29**: establishes that the Secretary-General of the United Nations (UN) shall

be the **Depositary** of this Convention; and

- **Article 30**: establishes criteria for the **Authentic texts**.

Annexes A, B and C list the substances whose use and production should be eliminated (Annex A), restricted (Annex B), and whose emissions and unintentional releases from anthropogenic sources should be reduced (Annex C). Annexes D, E and F set out criteria for proposing and selecting a chemical for inclusion in the Convention, criteria for assessing the risk profile and socio-economic considerations for the substance. Annex G describes the arbitration and conciliation procedures for settlement of disputes.

Parties must take specific measures to deal with POPs according to the Annexes they are listed. For POPs listed in Annex A (Elimination), Parties must take measures to eliminate the production and use of these chemicals. In some cases, specific exemptions and/or acceptable purposes for use or production are granted by the Stockholm Convention, but they are applied only to Parties that register for them. For POPs listed in Annex B (Restriction), Parties must take measures to restrict the production and use of these chemicals, in light of any applicable acceptable goals and/or specific exemptions granted. For POPs listed in Annex C (Unintentional Production), Parties must take measures to reduce the unintentional releases of these chemicals, with the goal of continuing minimization and, where feasible, ultimately eliminate their release.

According to Article 7 of the Convention, each Party should develop a National Implementation Plan (NIP) for the Stockholm Convention and submit it to the COP, within two years of the date on which this Convention takes effect, informing the measures and strategies that will be implemented and integrated into their national sustainable development plans in order to meet the commitments assumed in the framework of the treaty. Furthermore, the Parties should regularly assess whether it is affected by any external or internal factors that may lead to a need to review and update the NIP. As part of NIP review and update, Parties should also evaluate the efficacy of the adopted action plans, strategies, and measures included in their first or last updated NIPs.

1.3. Stockholm Convention implementation in Brazil

Brazil signed the Stockholm Convention on POPs during the act of its adoption on

May 23, 2001 and deposited the Brazilian ratification document within the UN on June 16th 2004. To submit this ratification, the National Congress, in accordance with Article 49, item I, of the Federal Constitution, approved the Convention through Legislative Decree n. 204, of May 7, 2004, and the Executive Branch promulgated the text of the Convention through Decree n. 5.472, of June 20, 2005. As a signatory and Party to this Convention, the Brazilian State acknowledges its commitment to the Stockholm Convention provisions.

The first Brazilian NIP for the Stockholm Convention was published in 2015 (MMA, 2015a). The NIP-Brazil-2015 presented the findings of an initial investigation on the state of implementation of the Stockholm Convention on POPs in Brazil, the occurrence and uses of POPs in the country, the management of their wastes and stocks, the contaminated areas as well as the national installed capacity for POP analysis. In addition, the NIP-Brazil-2015 identified the legislative and administrative measures already underway to protect human health and the environment from the effects of POPs and pointed out the gaps that needed to be filled, providing an action plan for the Brazilian State to meet the obligations of the Stockholm Convention.

The NIP-Brazil-2015 covered the 23 POPs listed by the 6th Conference of the Part AND ies (COP) in 2013. However, since 2015, seven additional chemicals and related compounds are listed as POPs in the Stockholm Convention during COPs 7, 8 and 9 (See Table 1). Therefore, after five years since the Brazilian NIP was transmitted to the Secretariat of the Stockholm Convention and considering the listing of new POPs, it became necessary to review and update the NIP-Brazil-2015, as one of the commitments of the Brazilian Government to the Stockholm Convention, as established in the Article 7 of the Convention.

1.4. Objectives of the reviewed and updated NIP

The review and update of the Brazilian NIP focused on some industrial POPs already addressed in the NIP-Brazil-2015 and on the seven additional chemicals listed as POPs since the first NIP submission.

For perfluorooctane sulfonic acid, its salts and perfluorooctane sulfonyl fluoride (PFOS

& PFOSF); Hexabromocyclododecane (HBCD); and polybrominated diphenyl ethers (POP-PBDEs), the main objectives were to: i) review the status of specific exceptions and acceptable purpose records requested by Brazil; ii) identify the progress achieved in the action plans defined in the initial NIP; iii) review the inventory of each of the chemicals researched to update the NIP data; and iv) list the samples and analyzes made for the identification of these POPs in the national territory.

Considering that no stocks or articles containing the POPs hexabromobiphenyl (HBB) and pentachlorobenzene (PeCB) were identified in the first inventory of new industrial POPs (MMA, 2015a), these compounds have not been reassessed in the present document. The NIP-Brazil-2015 also highlighted that there was no information indicating the production or application of HBB and PeCB in the past. In addition, the specific use of PeCB as an intermediate in the production of quintozene was evaluated in the only company registered to market this product in the country and the company reported never having used PeCB.

Regarding the seven additional chemicals listed as POPs since the first NIP submission — Hexachlorobutadiene (HCBD); Pentachlorophenol (PCP); Polychlorinated naphthalenes (PCNs); Decabromodiphenyl ether (decaBDE); Short-chain chlorinated paraffins (SCCPs) and products that may contain this substance above one percent by weight; Perfluorooctanoic acid (PFOA) and Dicofol — the main objectives were to: i) inventory each of the chemical substances listed; ii) present a proposal of action plans for each of the chemical substances listed; and iii) to list the samples and analyzes made for the identification of these POPs in the national territory.

Ultimately, the revision and update of the Brazilian NIP aims to:

1) Track progress from the first NIP;
2) Include the POPs listed after the first NIP publication;
3) Identify and apply synergistic actions with related national plans;
4) Raise public awareness and educate the public about POPs related international treaties;
5) Contribute to the environmentally adequate chemical management in Brazil;
6) Raise awareness on the POP issue for a more circular economy in the country;
7) Meet the obligations under the Stockholm Convention; and

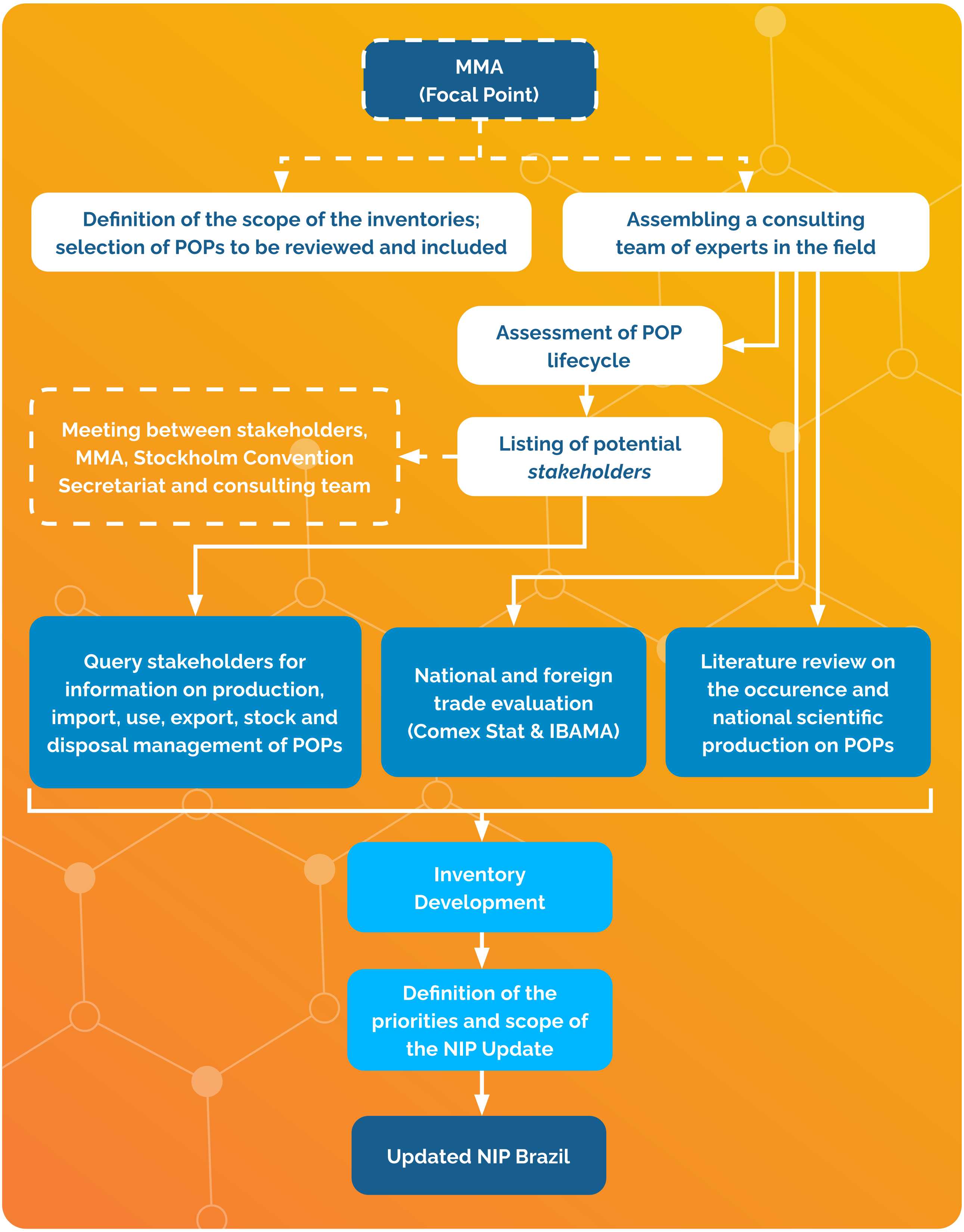
8) Reduce risks caused by POPs to human health and the environment.

1.5. NIP review and update methodology

In Brazil, the role of Technical Focal Point for the Convention is shared by the Ministry of the Environment and Climate Change (Portuguese acronym MMA) and the Brazilian Institute for the Environment and Renewable Natural Resources (Portuguese acronym IBAMA), that acts together with the Environmental Policy and Sustainable Development Division of the Ministry of Foreign Affairs, which is the Official Contact Point. The MMA also acts as the executing and coordinating agency for the development of POP inventories, action plans, and, ultimately, the NIP. To undertake all the necessary processes to elaborate the current NIP, Brazil used funds from the Global Environment Facility (GEF) and was supported by UNEP through an international cooperation project.

The main steps adopted during the process of development of the Brazilian NIP are summarized in Figure 1 and will be described in detail in the following subsections.

Figure 1: Flowchart of the steps adopted during the development of the updated NIP-inventories of Brazil.



Source: Prepared by the author.

1.5.1. Consultant team

The MMA sought assistance from the UNEP–GEF to contract a consultant team of experts on POPs to review and develop new POP inventories and an individual consultant to prepare the NIP document. The MMA chose to work with a national team of researchers, with academic backgrounds focused on the study of POPs, aiming to work with subject matter experts for the development or review of each inventory and to strengthen the national personnel qualification on this topic. The consultant team was trained by the technical coordinators of the project considering the guidelines provided by the Stockholm Convention Secretariat for the development of the NIP, as well as on the basis of the guidance for specific inventory of each POP and of the first Brazilian NIP.

1.5.2. Data survey with stakeholders

After an in-depth study of the entire lifecycle of the concerned POPs and their main applications, the consultant team listed — through an exhaustive search online — the stakeholders from the private sector and non-governmental organizations (NGOs) potentially involved in any stage of each POP lifecycle in the Brazilian territory. The listing was carried out by looking for the activities developed and products or services offered for which the consultants identified a potential use of the POPs contemplated in the project.

After listing the potential stakeholders, the MMA, together with the Stockholm Convention Regional Centre for Capacity-Building and the Transfer of Technology on POPs for Latin America and the Caribbean Region (São Paulo State Environmental Company; Portuguese acronym, CETESB), organized a meeting with the consultant team, international experts on POPs, the Secretariat of the Stockholm Convention and the main stakeholders. Furthermore, the MMA sent an official query by email to other Brazilian Ministries, to all the industrial federations and environmental bodies/secretariats of the 26 Brazilian states and the Federal District, to the 22 members of the National Commission for Chemical Safety (Portuguese acronym, CONASQ) (MMA, 2015a), to NGOs, to over a thousand industries and over a hundred industrial associations.

The questionnaires sent by the MMA provided information on the Stockholm Convention, the compounds listed and the role of the Brazilian State as a signatory party of the Stockholm Convention. The questionnaires also clarified the specific exceptions and acceptable purposes for the production and use of POPs and requested information on the entire lifecycle of POPs in qualitative and quantitative terms.

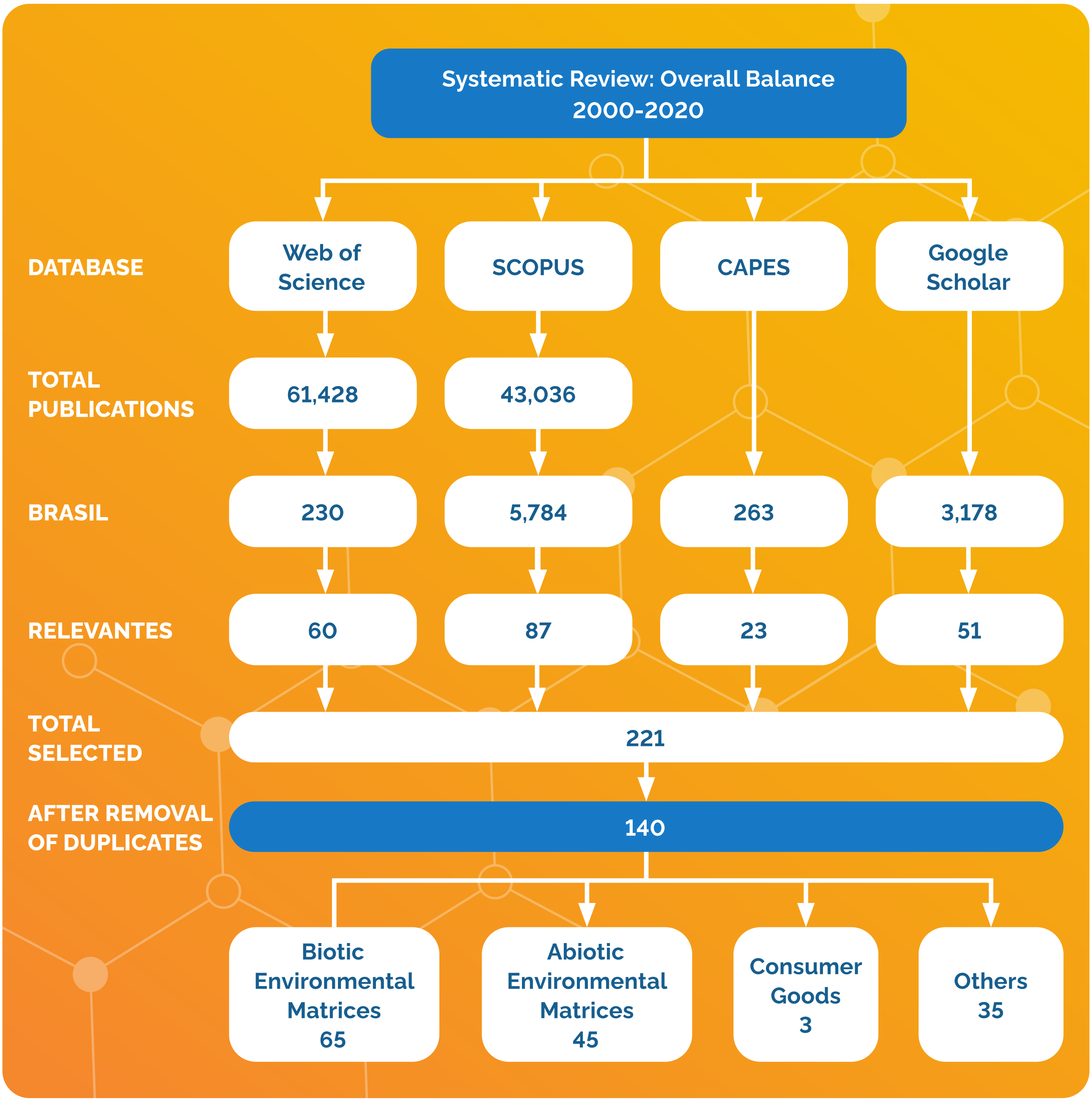
1.5.3. Foreign trade data assessment

Foreign trade data was assessed by the consultant team through the portal for free access to the Brazilian foreign trade statistics (Comex Stat platform: http://comexstat.mdic.gov.br/). The results obtained were presented within each inventory in a specific way for the respective POPs. Foreign trade data assessment was done by the South American Trading Bloc (MERCOSUR) Common Nomenclature (Portuguese acronym NCM) codes. NCM codes are specific codes of the MERCOSUR based on the harmonized codes (HC) made available by the United Nations Trade Statistics Database (*UN Comtrade Database*). However, NCM codes are two digits longer than HC, meaning that initial HC classifications are further subdivided using item (seventh digit) and subitem (eighth digit) classifications in the MERCOSUR economic bloc. This makes NCM codes more specific and thus more appropriate to assess foreign trade data than HC. Nevertheless, sometimes NCM codes are also not detailed enough to track specific POPs and can encompass a variety of substances leading to an overestimation of the marketed quantities of POPs. Where relevant, foreign trade data on products possibly containing the POPs of interest have also been assessed.

1.5.4. Literature review

A literature review was conducted to identify the reported occurrence of POPs in Brazil. The review also intended to put light on the national scientific production. Therefore, two international databases for peer-reviewed scientific publications (Web of Science and SCOPUS) and a national database for thesis and dissertations produced in Brazil (Sucupira platform) were assessed following the PRISMA Protocol (MOHER et al., 2015). Due to the lack of relevant results in the above-mentioned databases for some POPs, the review was expanded to a more generalist database (Google Scholar) to obtain further reports in addition to peer-reviewed scientific articles in *Web of Science* and SCOPUS and thesis and dissertations in the Sucupira platform. The review was carried out from September 28 to October 28, 2020 for each POP. The protocols, selection criteria and keywords were presented within each respective POP inventory, considering their specificities. Figure 2 shows the total number of papers in each step of the review process, considering the ten POPs evaluated for the NIP update.

Figure 2: Scheme with general results of the protocol followed for the literature review, considering the ten POPs evaluated for the NIP update.



Source: Prepared by the author.

1.5.5. Review and development of POP inventories

In broad terms, ten inventories were reviewed or developed for the NIP update. The review and update of the POP inventories included in the first Brazilian NIP (HBCD, PBDEs, PFOS & PFOSF) considered the revision of the status of specific exceptions and acceptable purposes requested by Brazil; the identification of the progress achieved since the first NIP transmission in 2015; the review and update of stakeholder consultation; the review and update of foreign trade data assessment regarding POPs traded as chemicals and main consumer goods potentially containing POPs; the review and update of the estimates of POP stock and POP content in consumer goods that need environmentally adequate management in Brazil; as well as the literature review on POP occurrence in the country and evaluation of the national scientific production on POP studies. Thus, in light of the reviewed and updated information, new action plans were proposed considering current national priorities and specific POP inventories were developed. Regarding the seven additional chemicals listed as POPs since the first NIP transmission to the Stockholm Convention Secretariat (HCBD, PCP, PCNs, decaBDE, SCCPs, PFOA and dicofol) specific inventories were developed for each POP according to their guidance documents available in the Stockholm Convention website (http://www.pops.int/) and considering the same steps described above for the review and update of POP inventories. Besides, considering the gathered information, a list of action plans was proposed for each POP. The ten individual POP inventories are publicly available (in Portuguese only) at the website of the Ministry of Environment and Climate Change of Brazil.

1.5.6. Review and update of the NIP according to national priorities

To support the drafting of the updated NIP, the MMA provided the consultant with relevant information on the current projects of this Ministry, the new set of national priorities, the ten POP inventories consolidating the most relevant information on the POP situation in Brazil, as well as the following up of the action plans established in the NIP-Brazil-2015. Based on that information and on the ten POP inventories, the NIP was updated. A final draft of the updated NIP was submitted to the MMA and UNEP and after the appreciation of the MMA and UNEP, the final version of the updated NIP was prepared by the consultant and delivered to the MMA for a validation process with stakeholders. The update of the Brazilian NIP provides an overview of the national situation regarding the new POPs and based on its findings and identified critical points, indicates the main challenges and priorities that should be considered for the efficient implementation of the Stockholm Convention in the country.

1.6. NIP structure

The Brazilian National Implementation Plan (NIP Brazil) follows the structure recommended in Annex 10 of the Guidance for Developing a NIP for the Stockholm Convention on POPs (UNEP, 2017a). In broad terms, the NIP is built under three main chapters as follows:

1. Introduction – Where the reader can find an informative and concise summary about POP issues, the Stockholm Convention and its provisions, the Stockholm implementation in the country, the objectives and priorities of the NIP, as well as the methodology applied for the NIP development and the NIP structure. Information on socio-economic and gender considerations is also included.

2. Country baseline – Where the reader can find an informative and concise overview of the country profile, covering main aspects of the national geography, population, environment, health system, economy, industrial production, chemical industry, energy matrix and regional cooperation; the institutional, policy and regulatory framework linked to POPs and the Convention provisions; the assessment of POP issues within the country; and the current implementation status of the action plans set in the previous NIP.

3. Strategy and action plans – Where the reader can find a policy statement about the Government's commitment to address POP issues in the country; the strategy and action plans set for the thorough implementation of the Stockholm Convention, as well as the resources needed; a timetable for the implementation of the action plans set and measures of success; and the status of the current NIP.

1.7 Further relevant considerations

1.7.1. Socio-economic considerations

The relevance of performing a socio-economic assessment (SEA) when developing and updating the NIP and implementing the provisions of the Stockholm Convention are notable throughout the text of the Stockholm Convention.

In the decision SC-1/12 taken by the COP, the Secretariat of the Stockholm Convention was requested to develop additional guidance on SEA in collaboration with other organizations and subject to resource availability. For that, circumstances of countries with developing and transition economies should be considered. In response to that request, the Secretariat developed the draft guidance on SEA for NIP development and implementation under the Stockholm Convention. The first guidance on SEA was made available in 2007 and updated in 2017. The SEA guidance is a systematic appraisal of the potential socio-economic impacts of activities such as the management of POPs, contaminated areas and impacted populations in all sectors of society (including civil society, government, local communities and groups and private sectors). The SEA guidance intends to enable proper analysis and management of planned interventions — such as plans, policies, programs and projects — regarding intended and unintended socio-economic impacts, both positive and negative, and any social change processes invoked by those interventions.

Therefore, the guidance should enable to identify the changes that provoke adverse impacts on human health, on the environment and on economic development such as:

a) Deterioration of human and environmental ecosystem health;
b) Worker's productivity loss;
c) Changes in living costs;
d) Levels of child labor used;
e) Changes in income distribution;
f) Opportunities for enterprise development including Small and Medium Enterprises (SMEs); and
g) Changes in demand of health public services.

A comprehensive SEA should enable the Parties to take more appropriate and more effective actions to carry out their NIPs. It should also help to minimize negative impacts for all sectors of the society, industry and government and to improve the success of the NIP implementation. However, the SEA should always a precautionary approach to avoid biased decisions due to the lack of information on external costs and other relevant information gaps.

For instance, the negative impacts of chemical pollution on the environment and human health are supported by an indisputable body of data. The environmental exposure to chemicals, including POPs, is a major contributor to health associated costs even in developed countries (ATTINA et al., 2016; SCHERINGER et al., 2012; TRASANDE et al., 2015; UNEP & WHO 2013). Moreover, Grandjean and Bellanger (2017) performed a health economic estimation associated with environmental chemical exposures and estimated that the cost may exceed 10% of the global domestic product. However, more comprehensive SEAs ought to be done to encompass other associated costs like environmental impacts, biodiversity loss, industrial and commercial activities as well as social costs beyond health costs.

In March 2021, the Ministry of Economy of Brazil issued a general guide for socio-economic impact analysis of infrastructure projects (ACB Guide). The guide aims to facilitate systematic adoption of socioeconomic cost-benefit analysis in the evaluation and selection process of infrastructure projects (including environmental impact assessment (EIA)), considering direct and indirect impacts throughout the project's life cycle. The methodology established through the guide is mandatory for new large projects. In November 2020, the Investment Partnership Programme (Portuguese acronym PPI), which is part of the former Ministry of Economy, published Proposals of Guidelines for Terms of Reference for Environmental Studies to improve and harmonize EIA in environmental licensing processes for oil and gas offshore production, large hydropower plants, and offshore wind. The human resource capacity for SEA is currently limited and needs to be strengthened for the NIP development and implementation under the Stockholm Convention to be achieved. When performing the SEAs related to POP management and POP impacts, the recent changes adopted by the European Union (EU) in the acceptable daily/weekly intake limits for substances such as dioxins and furans (now seven times lower), PFOS (now 100 times lower) and PFOA (now 1500 times lower) should be considered. The EU is one of the main importers of Brazilian commodities, such as animal origin products, that might be impacted even by low POP concentrations in air, soil and water (TORRES et al., 2013; WEBER, 2017; WEBER et al., 2018).

Up to now, only initial SEA have been performed for PCBs[1] but the following topics are considered highly relevant and are intimately related to the country's environmental policy and sustainable development strategies, as well as to the implementation of other international treaties:

1) Food and water safety (including POPs exposure of population and contamination of commodities);
2) Exposure of vulnerable and highly exposed groups;
3) Management of chemicals and waste;
4) Cost of destruction and end of life management and treatment of POPs and other hazardous waste;
5) Cost of contaminated areas remediation;
6) Costs of implementing chemical alternatives to POPs; and
7) Social, environmental, economic and health costs of implementing the NIP.

1.7.2. Gender considerations

The NIP must take into consideration some important dimensions regarding the roles and tasks performed by men and women and their asymmetries in the national reality. Socially and environmentally, men, women, and children might be more or less exposed to different kinds of chemicals and biological factors, such as physiological

[1] https://www.thegef.org/projects-operations/projects/3282 and https://www.thegef.org/projects-operations/projects/10368

and size differences among them, will have relevant implications on the adverse effects caused by chemical exposure. Therefore, gender considerations are very relevant for the design, implementation, monitoring and evaluation of the NIP, because they may have an impact on the lives of women and men, contributing to closing the gender gaps or to preventing them from getting deeper.

Brazil has signed and ratified the International Treaties in force on the recognition and protection of women's human rights and the promotion of gender equality, whereby, as a result of its binding nature, the country takes on explicit commitments, such as:

- The Universal Declaration of Human Rights (1948);
- ILO Convention No. 100 on Equal Remuneration between Men`s and Women's Labor for Work of Equal Value (1951);
- Convention on Political Rights of Women (1953);
- ILO Convention No. 111 on Discrimination of Employment and Occupation (1958);
- Convention on the Elimination of All Forms of Discrimination Against Women (1981);
- Inter-American Convention for the Prevention, Punishment and Eradication of Violence against Women and the Family (Belém do Pará), June 9, 1994;
- Fourth Global Women's Conference and Beijing Platform for Action (1995); and
- Facultative protocol of the Convention on the Elimination of All Forms of Discrimination against Women (1999).

In recent decades, Brazil has developed a series of laws and public policies that promote gender equality and guarantee women's human rights, from the Federal Constitution, enacted in 1988, to specific laws, such as:

- The Federal Constitution, which establishes that men and women have equal rights and obligations and which mandates the protection of women in the labor market, by means of specific incentives;
- Law 11,340/2006, named as Maria da Penha, which recognizes the right of all women to live a life without violence and considers this type of aggression as a violation of women's rights. The law obliges the State and the society to protect women from domestic and family violence, regardless of age, social class, race, religion and sexual orientation;
- Law 13,104/2015. Pursuant to this law, femicide is now listed as a hideous crime and it was included under Article 121 of the Brazilian Penal Code;
- Law 13,880/2019, which determines the seizure of firearms in the possession of assailants of domestic violence cases;

- Law 13,882/2019, which guarantees the enrollment of dependents of women, who are victims of domestic and family violence, in elementary education institutions, which are closest to their residence;
- Law 13,827/2019, which amends the Maria da Penha Law (Law No. 11340) to allow the application of an emergency protective measure by the judicial or police authority to women in situation of domestic and family violence, or to their dependents;
- Law 9,799/1999, which establishes the banning of all kinds of discrimination, including gender, among others. It sets forth the protection of the status and of the access or preservation of the work position of pregnant women; and
- Law 12,227/2010, which establishes the Annual Social and Economic Report on Women.

In the last three decades, Brazil has geared several efforts to promote advancements in specific public policies for women. The main policies are the following:

- National Policy Plan for Women 2013 – 2015, which contributed to the strengthening and institutionalizing of the National Policy for Women adopted in 2004 and endorsed in 2007 and 2011. Some of the guiding principles were: (i) autonomy of women in all dimensions; (ii) pursuit of effective equality between men and women in all fields; (iii) respect for diversity and fight against all forms of discrimination; (iv) universalization of the services and benefits offered by the State; (v) active participation of women in all phases of public policies; and (vi) comprehensive implementation as a guiding principle for all public policies; and
- Multiannual Plan 2020 – 2023, which is a government-planning tool that defines the guidelines, objectives, and goals of the federal public administration for a 4-year time horizon. Within the Multiannual Plan guidelines, the following agendas are established, among others: The promotion and defense of human rights, focusing on family support and the National Strategy for Economic and Social Development is maintained as one of its main guidelines, in which the social pillar states: "To promote the welfare of citizens and social inclusion with a focus on equal opportunities and access to quality public services, through the reduction of social and regional inequalities".

The data that will be now presented refer to projections made by IBGE for 2020, due to the non-completion of the demographic census during the period of the Covid-19 pandemic. The estimated population for Brazil in 2020 was 210.74 million people, from which approximately 51 % are women and 49% are men. The life expectancy of women is 80 years old and that of men is 73 years old. In 2018, 25% of the population earned an income below the poverty line (USD 5.50 per day), equivalent to BRL 420 per month or 44% of the current minimum wage. This indicator does not show significant differences between men and women. However, there is a significant difference between being a white woman (15%) and being a mixed-race woman (34%). In terms of inequality, the Gini index at the national level was 0.545 (IBGE, 2019). The main indicators of education by gender in Brazil do not show major differences. For instance, the literacy rate of women and men from 15 to 24 years old in 2018 is similar at around 99%; the net primary school enrollment rate was around 95% in 2015; and the net secondary school enrollment rate was higher for women at 83% versus 80% for men in 2015.

Despite social advances and transformations in favor of women in Brazil, the indicator of the number of hours spent on care of people or domestic work by gender shows that by 2016, women spent 73% more hours on this type of activity than men (18.1 hours versus 10.5 hours). Upon disaggregating by region, the survey shows that in the northeast region women spent about 80% more hours than men in such activities, totaling 19 hours a week. The workload is a determining factor of the labor participation of women, and it is defined by the gender division of work. Women need to balance remunerated and non-remunerated work (domestic chores and care), which will eventually allocate them in occupations of reduced workload. Therefore, part-time jobs have a high concentration of women. Regionally, women account for a higher number of part-time jobs in the north and northeastern regions. According to their ethnicity, black women (31%) hold more part-time positions than white women (25%). In 2018, the working-age population was 169.25 million people, from which the employed population was 92.33 million. The employment rate of men was 64.4% while that of women was 45.6%. The unemployment rate of women (4%) is higher than that of men (1%), while the underemployment rate of women is 29% and that of men 21%.

Upon analyzing the employed population per sector of activity, a persistent gender-based division of work is observed, which depicts the roles traditionally assigned to men and women. Thus, women work mainly in care-related sectors such as health, education, trade and technical services; while men focus on construction, transportation and agricultural activities. For example, the domestic service sector relies mainly on women (5.8 million women and 458 thousand men; while the construction sector relies mainly on men (6.5 million men and only 235 thousand women), according to data from 2018 (IBGE, 2019). Women who have no education or rely on incomplete basic education levels show a higher labor concentration in the agricultural, domestic service, hospitality and food services sectors.

Although schooling is not always associated with the rating of an occupation, as schooling progresses, the average income increases for both genders. The higher the level of education, the higher the rate of labor participation and this plays a greater influence on women. In 2018, the participation rate for women with complete higher education was 2.6 times higher than for women with no education or basic or incomplete education, while for men this ratio is 1.5 times higher (IBGE, 2019). Overall, the Brazilian labor force has a low level of education. In 2018, 41.3% of employees had not completed high school. However, in all groups analyzed according to the length of schooling, women earn less than men, even though they have higher schooling levels on average. There is also a significant difference between white and black women incomes, being the income of the black women approximately 40% lesser than the income of the white women.

Regarding the environmentally adequate management of chemicals, the NIP aims to minimize the risk of exposure of human beings and the environment to POPs, in an environmentally sustainable market approach in Brazil. In this context, the gender considerations for the cross-disciplinary gender approach during the NIP implementation will further enhance results by taking into account the realities and needs differentiated by gender; as well as give visibility to the contribution of women and men in the achievement of inclusive sustainable development in the different components and activities proposed, within an environment sensitized to the gender approach. Specific gender considerations are:

1) To raise awareness of gender approach concepts vis-à-vis the project technical team and other key stakeholders to achieve sustainable and inclusive development in POP management;
2) To provide gender-disaggregated information on occupational exposure to POP and diseases associated with this exposure;
3) To promote actions that protect the health of men and women, considering gender-differentiated exposure to POPs; and
4) To improve spaces for women's participation and empowerment as agents of change in the proper management of POPs, POP-containing products and POP wastes.

Further specific gender action plans have been developed for the sound management of PCBs in the country[2].

[2] https://www.thegef.org/projects-operations/projects/3282 and https://www.thegef.org/projects-operations/projects/10368

2. COUNTRY BASELINE

2.1. Country profile summary

Brazil is a country with continental dimensions, the fifth largest country in the world and the largest in the South American Continent. The nation has borders with almost every other country in South America, except for Chile and Ecuador. The Brazilian landscape is very diverse, as is its population. The country landscape is characterized by dense forests, like the Amazon and the Atlantic rainforest, dry grasslands, rugged hills, immense plateaus, wetlands, mangroves and a long coastal plain. Brazil is among the major global agricultural, minerals and oil producers, and hydropower generates most of its electricity. Furthermore, Brazil is the most industrialized nation in South America, producing petrochemicals, chemicals, steel, cars, aircrafts and has heavily urbanized areas, such as the megacity of São Paulo. Brazil is a federal republic with a President, a National Congress and a strong judiciary system. The political-administrative organization of the Federative Republic of Brazil comprises the Union, 26 States, the Federal District and 5,570 Municipalities, all autonomous, in the terms of its Constitution. Other general information about Brazil is summarized in Table 2.

Table 2: Summary general information about Brazil (cont.)

Official name:	Federal Republic of Brazil
Form and system of government:	Presidential Republic
Language:	Portuguese
Currency	Real (R$)
Area:	8.514.204,9 km²
Border extensions:	15,735 km with 10 neighboring counties and 7,367 km of coast facing the Atlantic Ocean
Capital:	Brasília
Religion:	Catholics 50%, Evangelicals 31%, no religion 10%, Spiritists 3%, *Umbanda*, *Candomblé* and other afro Brazilian religions 2%, others 2%, atheists 1%, Jew 0,3% (DATAFOLHA, 2019)
Life expectancy:	77 Years in 2019. Men 73.6 years and women 80.5 years (IBGE, 2021)
Child mortality:	11.20 deaths per Thousand births (IBGE, 2021c)
HDI:	0.754 – 87º place (UNDP, 2022)
Literacy rate:	99,7% (IBGE, 2019b)

Unemployment rate:	7,9 % (IBGE, 2022a)
GDP:	R$ 9.9 trillion in 2020 (IBGE, 2022b)
Participation in GDP:	Agriculture and livestock 7.9%; Industry 23.9%; Services 68.2% (IBGE, 2022b)
Number of land motor vehicles:	115.1 million (IBGE, 2022)
Tourism:	6,3 million foreign tourists (MTUR, 2019)
Climates:	Equatorial, tropical, altitudinal tropical, Atlantic, subtropical and semiarid.

Source: Adapted by the author from MMA, 2015a.

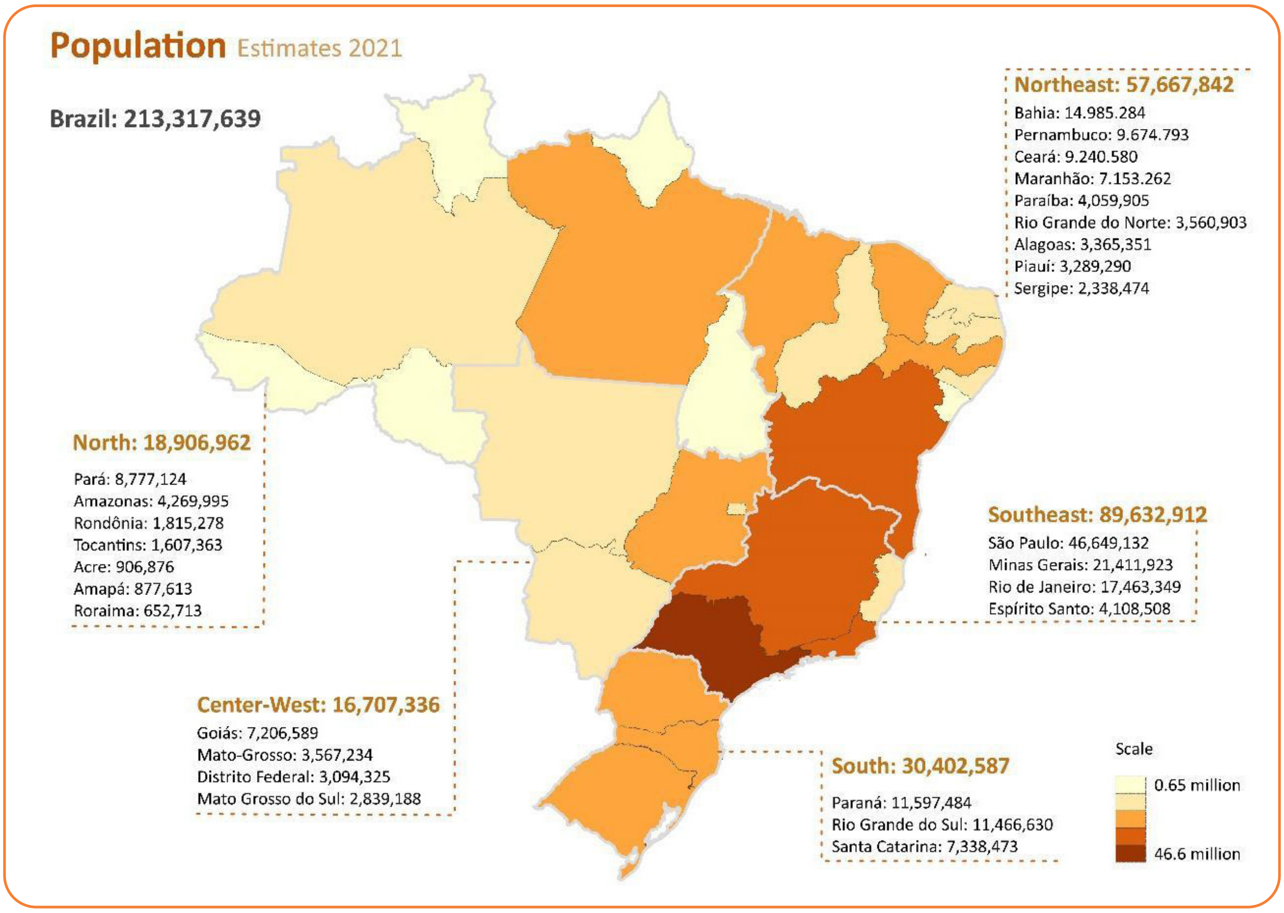
2.1.1. Population

According to the most recent estimate provided by the Brazilian Institute of Geography and Statistics (Portuguese acronym IBGE), the Brazilian population currently accounts for 213,317,639 inhabitants (IBGE, 2021c). Among those, 42% are concentrated on the Southeast region, 27% on the Northeast, 14% on the South, 9% on the North and 8% on the Centre-West (Figure 3).

Concerning the distribution of age groups, the Brazilian population was, until the beginning of the 1980's, considered mostly young. Nowadays, however, while people until 14 years old represent 21% of the inhabitants, the "active age population" (Portuguese acronym PIA; 15 to 64 years old) accounts for 69% of the population, and elderly people (above 65 years old) for 10% (IBGE, 2021c). According to the projections carried by the IBGE, there is a current growth tendency for the older population that might reach 25.5% of the population by 2060.

Regarding the color of the Brazilian population, the Continuous National Survey by Household Sample (Portuguese acronym PNAD) carried during the fourth trimester of 2022 reveals that, among the 214.680 participants, 97,833 are self-identified as dark-skinned (*pardo*) (45.6%), 92,033 as white (42,9%), 22,347 as black (10.4%), and the remaining 2,467 (1.1%) as indigenous, yellow or non-declared (IBGE, 2022c).

Figure 3: Brazilian population estimates, by federal states.



Source: Adapted by the author from IBGE, 2021b

Brazil is also a country of great religious diversity. The most recent survey carried by the Datafolha Institute (2019) showed that the majority of the population is self-declared as Catholic (50%) — although this percentage is decreasing in recent decades — followed by the evangelicals (31%) and those with no religion (10%), being the rest represented by other existent religions (8%). An expressive number of people also declared that they follow spiritism or Umbanda and Candomblé. Formerly, the data compiled by the last Demographic Census in 2010 pointed out that the catholic population represented 64.6% of Brazilians, protestants 22.2%, people without religion 8%, spiritualists 2% and the remaining religions summed 3.2% (SOMAIN, 2012).

The demographic density in Brazil is quite heterogeneous, ranging from 2.7 hab/km^2 in the State of Amazonas, followed by the State of Roraima with 2.9, hab/km^2, to 537.1 hab/km^2 in the Federal District, followed by the State of Rio de Janeiro with 339.2 hab/km^2. The states with the lowest population densities are located in the North or Midwest regions and those with the highest population densities are distributed in the South, Southeast and Northeast regions.

Regarding the Human Development Index (HDI), according to UNDP, 2022, Brazil dropped two positions comparing with the previous year and ended up with the 5th best HDI among the 12 countries in Latin America. With this, the country ranks 87th in the world, behind Chile (0,855), Argentina (0,842), Uruguai (0,809) and Peru (0,762) from the same region.

Brazilian states have different levels of development, also reflecting different social and economic realities in their territory. The states in the North and Northeast regions occupy the lower positions in the ranking, while the states in the Center-South present high Human Development Indices.

Table 3: Temporal Evolution of the HDI in Brazil, at federal state level

	2010	2016	2017	2021
Very high (0,800 - 1,000)	1	3	3	2
High (0,700 - 0,799)	12	19	19	17
Medium (0,600 - 0,699)	14	5	5	8
Low (0,500 - 0,599)	-	-	-	-
Very low (0,000 - 0,499)	-	-	-	-

Source: Prepared by the author from the Atlas of Human Development in Brazil, 2021 (http://www.atlasbrasil.org.br/ranking).

2.1.2. Brazilian Environment

The Brazilian vegetation can be categorized in six broad continental biomes: Amazon Forest, Cerrado (savanna), Caatinga, Atlantic Forest, Pantanal (wetland) and Pampa (lowland/grassland), shown in Figure 4. The largest Brazilian continental biome is the Amazon, with 49.5% of extension and the smallest is the Pantanal, with 1.8%. The area of each Brazilian biome is shown in Table 4.

Table 4: Absolute and relative extension of the Brazilian continental biomes (cont.)

Biome	Approximate area (km^2)	Participation in the area of Brazil (%)
Amazon Forest	4.212.742	49,5
Cerrado (savanna)	1.983.017	23,3
Atlantic Forest	1.107.419	13,0
Caatinga (xeric shrubland)	862.818	10,1
Pampa (lowland/grassland)	193.836	2,3
Pantanal (wetland)	150.988	1,8

Source: Prepared by the author from IBGE, 2019c.

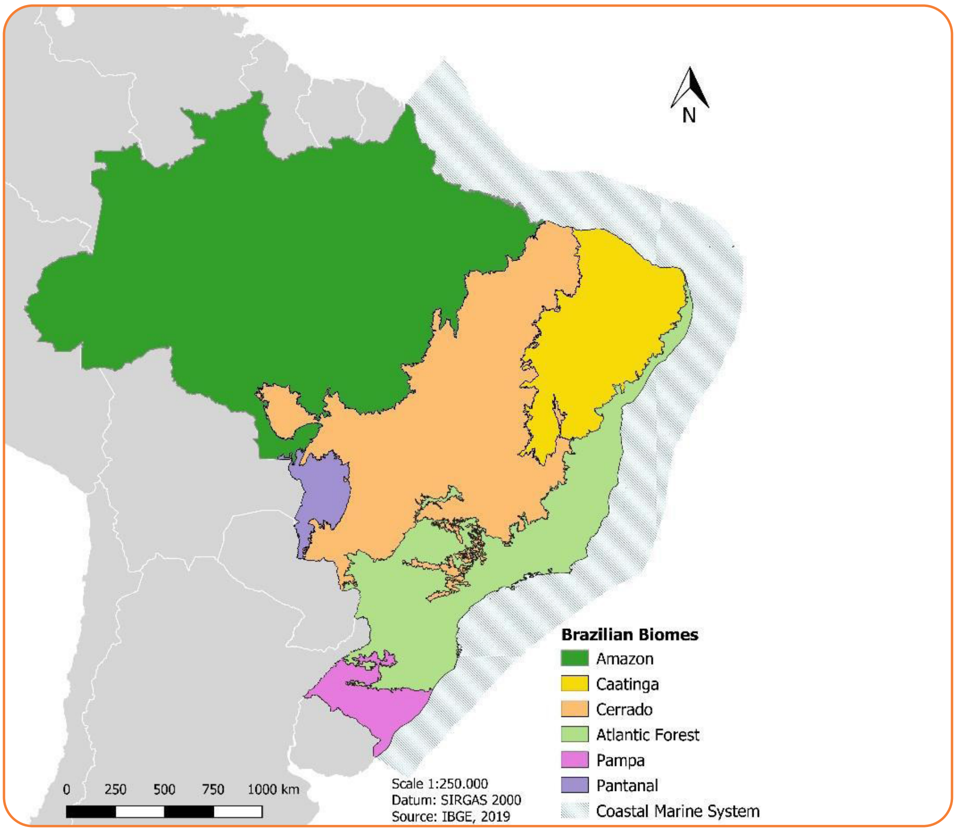
The Brazilian native vegetation cover currently corresponds to about 66.8% of its original extent and occupies a prominent global position in terms of native forest area, being one of the countries that most maintains its forest cover in the world. However, one cannot neglect that 10.25% of this native cover was lost between 1985 and 2019 — corresponding to around 87.2 million hectares — of which more than half occurred in the Amazon (44 Mha) and being the Cerrado the biome with the greatest proportional loss: 28.5 Mha or 21.3% of its original area (IPAM, 2020).

Unlike common sense, the Atlantic Forest biome does not consist of a single type of landscape made up solely of its typical humid forests. On the contrary, it represents a heterogeneous biome, composed of various ecosystems, strongly shaped by particular abiotic factors and which harbor distinct animal and plant populations, adapted to life in such ecosystems. Thus, we have ecosystems that vary widely depending on factors such as salinity, temperature and soil structure: the sandbanks (restingas), typical of coastal environments, the mangroves, located in estuarine environments, and the altitude grasslands, typical of mountainous peaks that extend mainly along the southeastern coast of the country.

The grassland biomes, on the other hand, tend to present a more uniform aspect. Particularly in certain parts of the Pampa, fields composed almost exclusively of grasses can be observed. In the other campestral biomes, however, landscapes composed of steppes, shrubs and sparse small trees are more common. In certain cases in which woody plants are present in larger quantities, one has the "wooded steppe". Even more wooded are the Cerrados or savannas, which occupy a large part of central Brazil. The Caatinga, however, is characterized by twisted bushes that grow sparsely on mostly stony soils.

This mosaic of vegetation combinations fits in various ways into the territorial structure of the Brazilian state. Some units of the Federation, such as Acre and Rio de Janeiro, lie entirely within a single biome — the Amazon and the Atlantic Forest, respectively. Most UFs (17 out of 27), however, are located in two or more biomes. The most diversified UFs are Bahia, Minas Gerais, Mato Grosso and Mato Grosso do Sul, which have portions of three biomes within their boundaries. In more precise quantitative terms, Bahia is the most plural UF of the Federation, since the proportions between the "slices" of the three biomes are the most balanced: Atlantic Forest (19.5%), Cerrado (18.3%), and Caatinga (62.2%) (IBGE, 2019c).

Figure 4: Delimitation of the areas occupied by the Brazilian biomes.



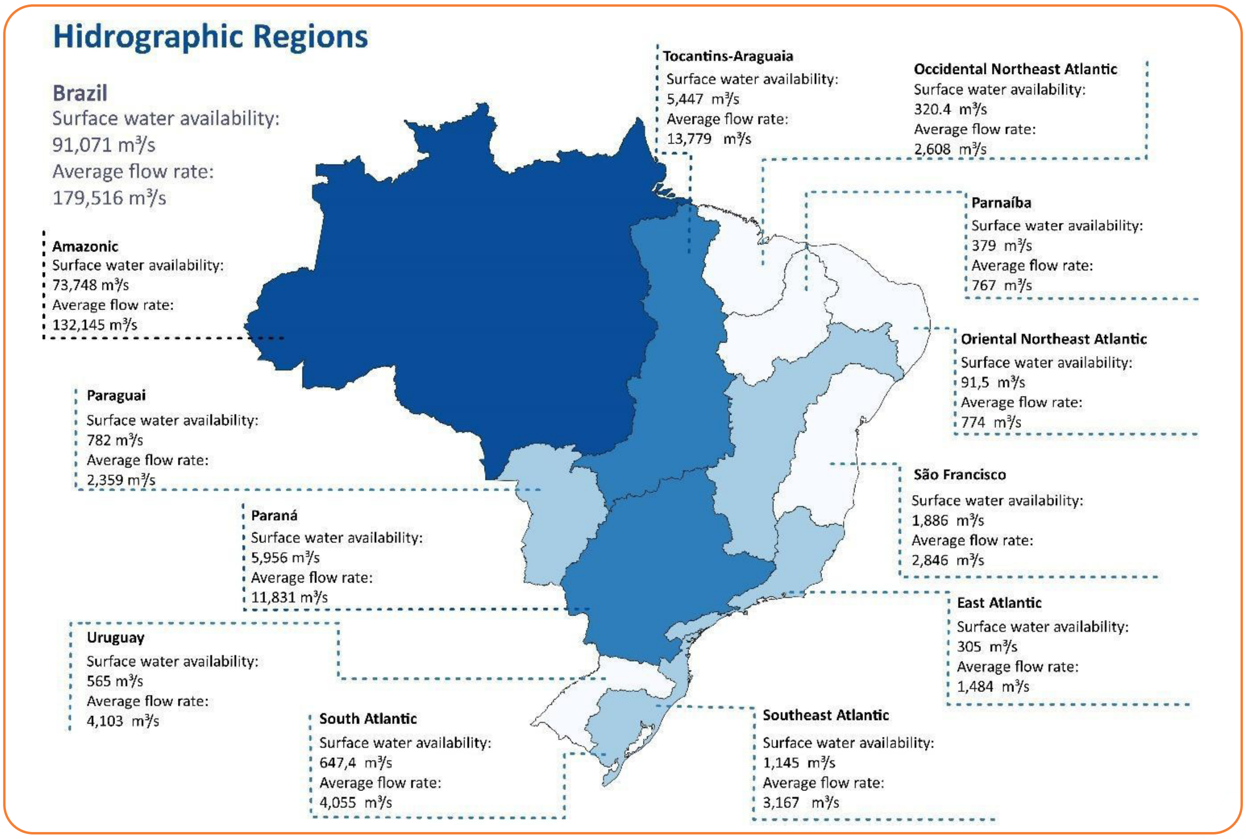
Source: Adapted by the author from IBGE, 2019c.

The Amazon Rainforest is considered to be the greatest biological reserve on the planet, with indications that it is home to at least half of all living species on the planet. The Cerrado, meanwhile, is considered the savannah with the greatest biodiversity in the world (IBGE, 2019c). The six biomes and its extensive marine coastal zone, in a country of continental dimensions, elevates Brazil to the position of nation with the greatest biodiversity in species on the planet (MMA, 2020a). Moreover, many of the Brazilian species are endemic, and several plant species of global economic importance — such as peanuts, Brazil nuts, cassava, cashews, and carnauba — originate in Brazil.

In addition to its rich biodiversity, the country is also home to a vast cultural heritage, translated into a wide range of traditional populations that reside in the territory. With regard to the indigenous population, the 2010 Demographic Census estimated a total of 817,963 inhabitants, among 305 distinct ethnic groups and 274 languages spoken (FUNAI, 2013). There are also several other groups considered traditional communities, including quilombolas, caiçaras and rubber tappers, who have extensive knowledge regarding the conservation and use of the local biodiversity.

Brazil occupies a privileged position in the world regarding the availability of water resources. The average annual flow of the rivers in the Brazilian territory is about 270 thousand m^3/s, being that the water produced in the country reaches about 180 thousand m3/s. This value corresponds to approximately 12% of the world availability of water resources, which is 1.5 million $m^3/_s$ (ANA, 2020; PAGNOCCHESCHI, 2016). Overall, there are 12 hydrographic regions, quite heterogeneous in terms of surface water availability and average flow per inhabitant (Figure 5).

Figure 5: Brazilian hydrographic regions with respective surface water availability and average flow rates.



Source: Adapted by the author from ANA, 2015.

The country is considered rich in terms of average flow per inhabitant, with about 31,000 m^3/hab/year, but it presents a great spatial and temporal variation of flows. The Amazon hydrographic region, for example, holds 80% of surface water resources and is inhabited by less than 5% of the Brazilian population, presenting an average flow per inhabitant of 558,000 m^3/hab/year (WORLD BANK, 2014; ANA, 2015).

On the other hand, the lowest average flow per inhabitant is observed in the Occidental Northeast Atlantic hydrographic region, with an average of less than 1,200 m^3/hab/year. In some basins of this region values lower than 500 m^3/hab/year are registered. This hydrographic region is almost entirely contained in the Northeastern semi-arid region, where high rates of evaporation and reduced precipitation lead to prolonged droughts (ANA, 2015).

Some other hydrographic regions, such as the East Atlantic, Parnaíba and São Francisco, also stand out as regions with low relative availability. Also affected by droughts, local populations frequently face severe issues of water scarcity. Therefore, the use of dams is widely used as a strategy to store water and regulate the flow of intermittent rivers in order to guarantee human supply, animal feeding and irrigation, among others.

2.1.3. Health system

The Brazilian Federal Constitution of 1988 defined health as a universal right and a state responsibility. Thus, Brazil counts on a Unified Health System (Portuguese acronym SUS) that was established by article 198 of the Federal Constitution of 1988 and regulated by Law N° 8,080/1990 and Law N° 8,142/1990. SUS is the official public health care model, implemented in 1990, and is directed by the Ministry of Health (Portuguese acronym MS) on the federal level, by the State Health Secretariats on the state level and by the Municipal Health Secretariats on the municipal level. Hospitals, health centers, foundations and research institutes are also part of the SUS.

Law No 8,142, in its first article provides for the participation of civil society in SUS and establishes that each level of government, without prejudice to the functions of the Legislative branch, will rely on the Health Conference and the Health Council, as collegial bodies. The private sector has a supplementary role, serving the government through agreements and contracts, which are regulated by law.

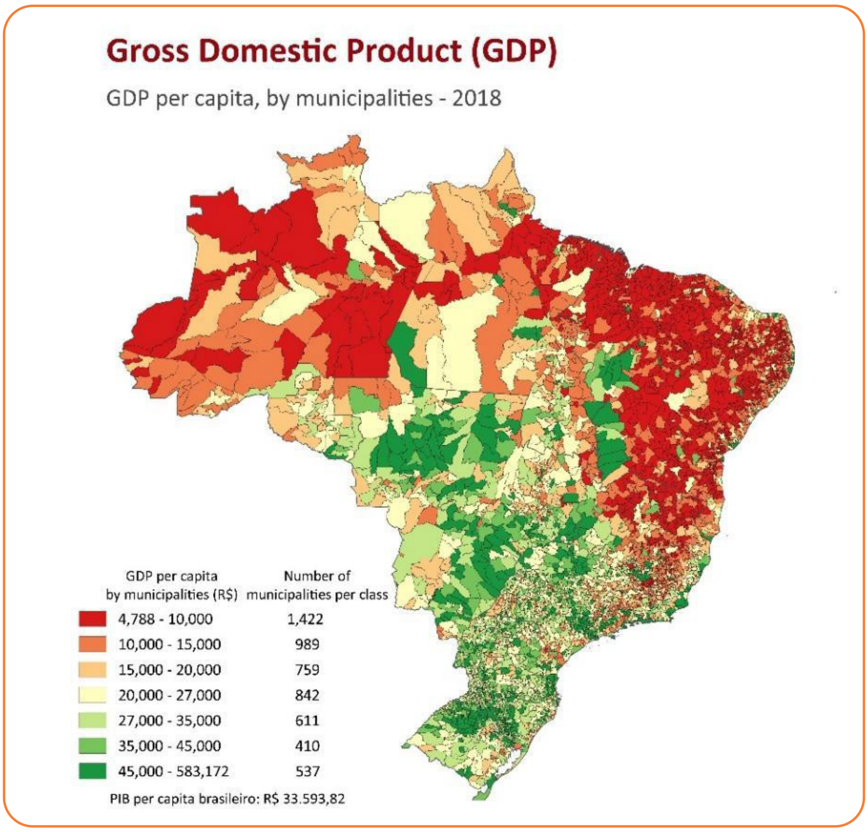
2.1.4. Brazilian economy

Brazil is currently the 9th largest economy in the world (IMF, 2022), with a gross domestic product (GDP) of R$ 9.9 trillion in 2022. The Services sector is the one exerting larger influence over the national GDP, followed by the industry, tax revenues and finally, agriculture and livestock (Table 5).

About 70% of Brazil's GDP is concentrated in five states: São Paulo, Rio de Janeiro, Minas Gerais, Paraná and Rio Grande do Sul, all located in the South and Southeast regions. The state of São Paulo leads the list, while the states of Roraima, Acre and Amapá appear in the last positions, with shares of 0.1% and 0.2% of the national GDP. The municipal values for the *per capita* GDP for 2018 are depicted in Figure 6 and Table 6, which present the percentage participation per region in the GDP over the years.

Regarding the Brazilian scenario in the international market, the main commercial partners of the country are currently China, the United States of America and Argentina, which in 2020 represented 32.6%, 10.7% and 4.19% of the total exports, respectively. The main exported product is soybean, that accounts for US$ 28.6 billion (14% of the exported products), followed by iron ore and concentrates (US$25.8 billion — 12%) and crude petroleum or bituminous mineral oils (US$19.6 billion — 9.4%) (MDIC, 2021).

Figure 6: GDP per capita at municipal level, for the year 2018.



Source: Adapted by the author from IBGE, 2018 (https://www.ibge.gov.br/apps/pibmunic/).

Table 5: Brazilian GDP for the year 2020, by sectors, in million Reais (R$)

Sector	Value (R$ 1.000.000)	Share (%)	Sub-sector	Value (R$ 1.000.000)	Share (%)
Agriculture and livestock	439838.43	5.9	Agriculture and livestock	439838.43	5.9
Industry	1314555.09	17.7	Extractive Industry	185579.97	2.5
			Transformation Industry	727647.56	9.8
			Electricity and gas, water, sewage, waste management activities	188864.46	2.5
			Construction	212463.09	2.9
Services	4686369.94	62.9	Commerce	874033.10	11.7
			Transport, storage and postal services	277673.29	3.7
			Information and communication	224726.55	3.0
			Financial, insurances and related services	452147.68	6.1
			Real Estate Activities	660605.75	8.9
			Other service activities	1044592.27	14.0
			Administration, defense, public health and education, social security	1152591.31	15.5
Tax revenues	1007094.79	13.5	Tax revenues	1007094.79	13.5
Total GDP			**R$ 7,447,858.25 million**		

Source: Prepared by the author from IBGE, 2021b.

Table 6: Temporal evolution of the participation of the Brazilian geographic regions on the national GDP.

Large Regions	Percentage share in Gross Domestic Product (%)							
	2012	2013	2014	2015	2016	2017	2018	2020
North	5.3	5.5	5.3	5.3	5.4	5.6	5.5	6.3
Northeast	13.6	13.6	13.9	14.2	14.3	14.5	14.3	14.2
Southeast	56.7	55.3	54.9	54.0	53.2	52.9	53.2	51.9
South	16.9	16.5	16.4	16.8	17.0	17.0	17.1	17.2
Center west	8.8	9.1	9.4	9.7	10.1	10.0	9.9	10.4

Source: Prepared by the author from IBGE, 2020.

2.1.5. Agriculture and Livestock

For historical, socio-economic and geographic reasons, agriculture and cattle ranching remains a relevant activity on the national scene and in international trade. The agricultural sector contributed with 5.9% of Brazil's GDP in 2020, and used approximately 28%[3] of the national territory for its production. However, the agribusiness GDP, which includes, in addition to agriculture and livestock, industries and services linked to the sector, corresponded to 25.7%[4] of the Brazilian GDP in 2020, according to data from the Center for Advanced Studies in Applied Economics (CEPEA/ESALQ/USP).

The Brazilian agricultural sector is divided in two major categories, which clearly differ in terms of labor, size of the establishments, cultivated products and to which market-spheres each of them supply. On the one hand, the internal market is widely supplied by the familiar agriculture, which is responsible for the production of over 70% of the food consumed by the Brazilian population, mostly characterized by small to medium size establishments. These agents, despite the difficulties in accessing technical assistance, increased the amounts contracted within the scope of rural credit. In 2017, Pronaf's participation, for example, in the total granted was 13.6%[5], in 2020 this participation increased to 15.1%[5].

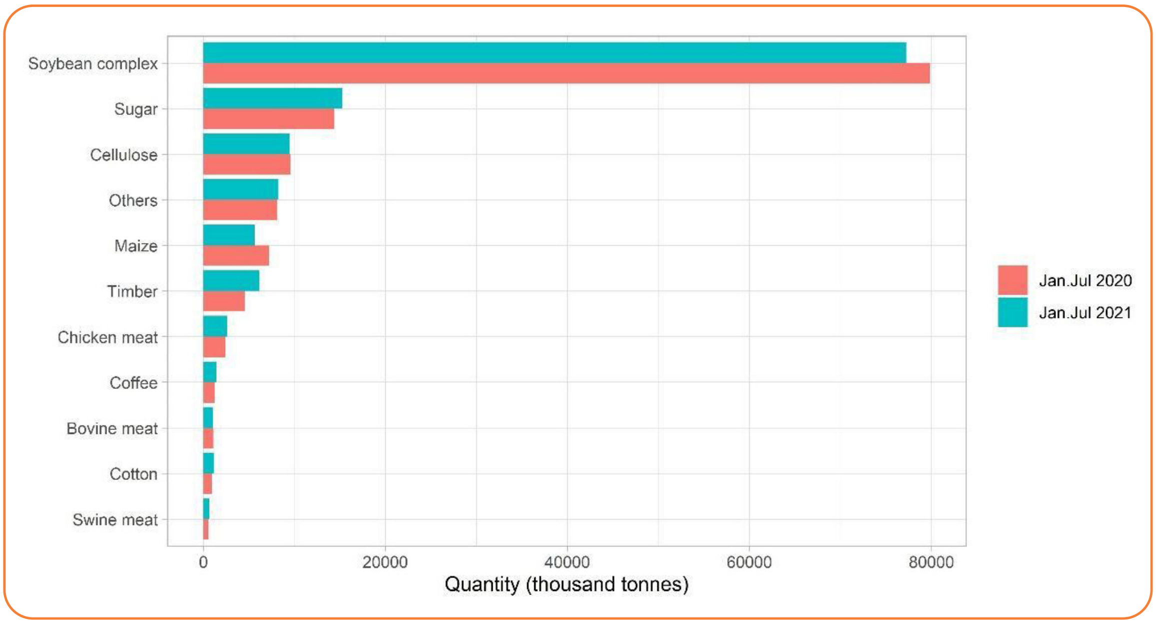
On the other hand, the non-familiar agriculture is widely characterized by large-scale and highly mechanized properties, which export most of their production. In 2020,

[3] Considers the area, in hectares, used for crops, pastures and agroforestry systems.
Source: https://sidra.ibge.gov.br/tabela/6883.
[4] Source: https://www.cepea.esalq.usp.br/br/pib-do-agronegocio-brasileiro.aspx.
[5] Considers data from Pronaf and the total contracted within the scope of rural credit, tables 8.1 and 3.1, respectively.
Fonte: https://www.bcb.gov.br/estabilidadefinanceira/micrrural.

soy grain producers, for example, exported 64.8%[6] of their production and received US$ 28.6 billion[6]. The internal production of soybeans, the bran and oil industries also exported 47%[6] and 11.6%[6] of their production, respectively, and received a total of US$ 6.74 billion.

In July 2021, the main exported products were grains, meat, sugar and coffee. However, the products that set a record in exported volume during the first semester of 2021 were coffee, sugar, cotton and pork (KRETER et al., 2021). Wheat, in turn, is the main agricultural product that Brazil imports, having corresponded to 33% of the products imported by the agricultural sector in 2020 (MDIC, 2021).

Figure 7: Exports of the agricultural sector, in value and quantity, referring to the years 2020 and 2021.



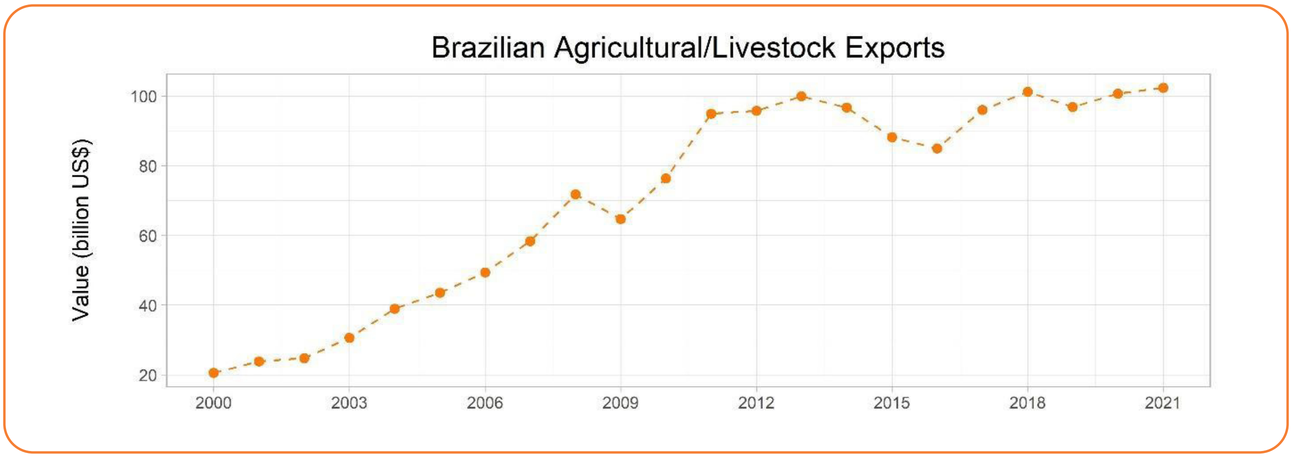
Source: Prepared by the author from MAPA, 2019.

Between 2005 and 2016, the Brazilian grain production rose from 112,5 million tonnes[7] in the 2004/2005 crop to 240,6 million tonnes in the 2016/2017 crop. At this moment, the number of grains produced by the country had increased 113.9% in just over a decade. In 2019, the records obtained so far were surpassed, registering a production of 241,5 million tonnes[8] of grains. Soybean production, which represents 47% of the cultivated grains, rose from 51,6 million tonnes[7] to 115 million[8] in the analyzed period. In the case of corn, production rose from 35 million tonnes[7] to 99,5 million[8]. Regarding the exports of the sector, there has been an expressive increase during the last two

[6] Source: https://abiove.org.br/estatisticas/.
[7] Source: https://biblioteca.ibge.gov.br/visualizacao/periodicos/8/lspa_prog_2005_dez_supl.pdf.
[8] Production data for cereals, vegetables and oilseeds, in tons, in December.

decades, in which the exported value rose from 20 billion dollars in the year 2000 to over 100 billion in 2021 (Figure 8).

Figure 8: Time series of the exports by the agricultural/livestock sector, in billion US dollars.

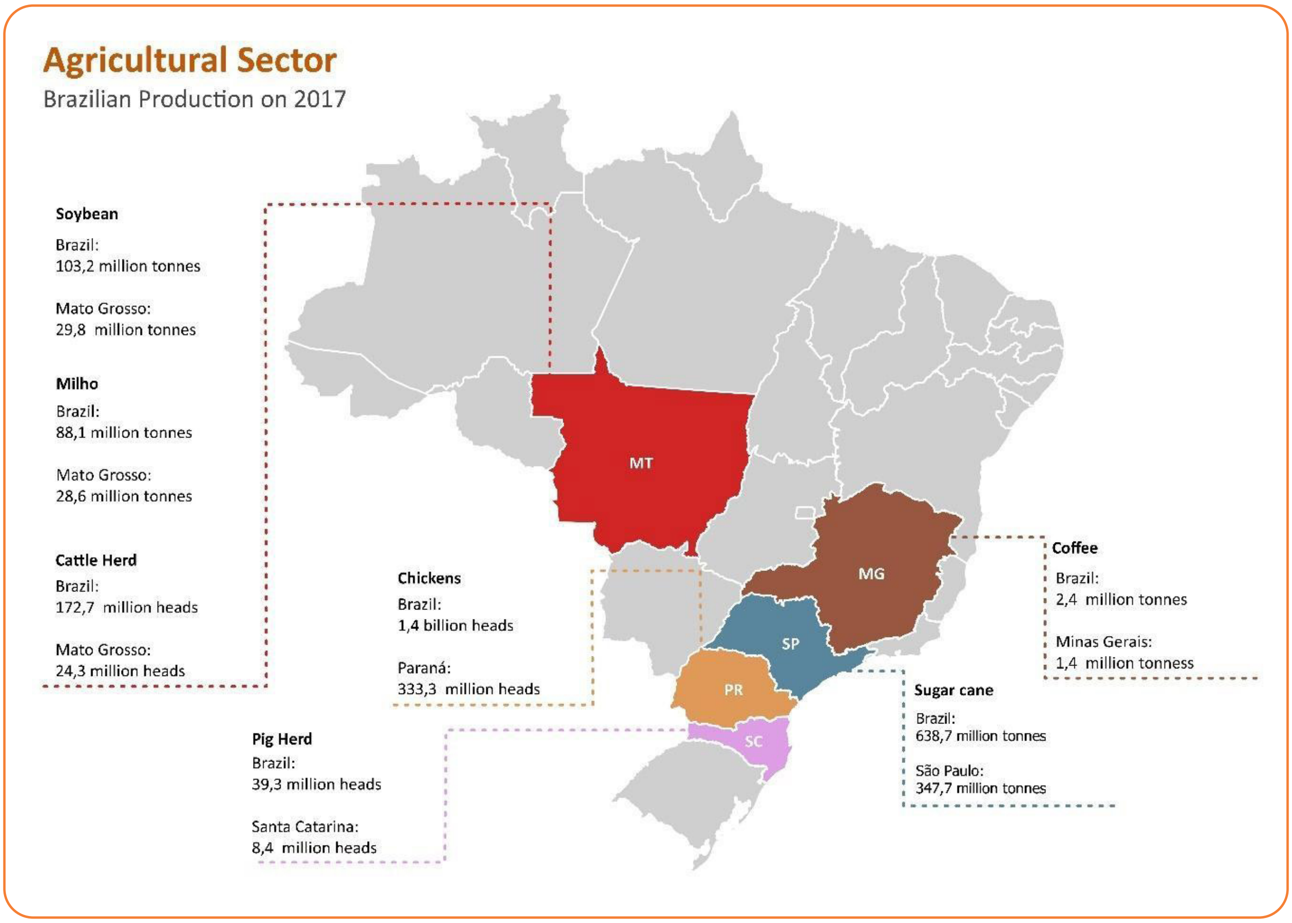


Source: Prepared by the author from MAPA, 2021.

According to data from the Agricultural Census, in 2017, Brazil had a total of 4,996,287 agricultural establishments occupying an area of 351 million hectares, of which 28% correspond to woods and forests.

Figure 9 illustrates the largest producing federal states of each of Brazil's main agricultural and livestock products, according to the latest Agricultural Census for 2017. Regarding the cattle herd in Brazil, more recent data reveal that in 2020 the country constituted the largest cattle herd in the world — reaching 219.2 million heads of cattle — and the largest producer of beef, as well as the world's leading exporter of this type of meat (IBGE, 2021e).

Figure 9: Exponents of Brazilian agricultural and livestock production, according to data from the 2017 Agricultural Census.

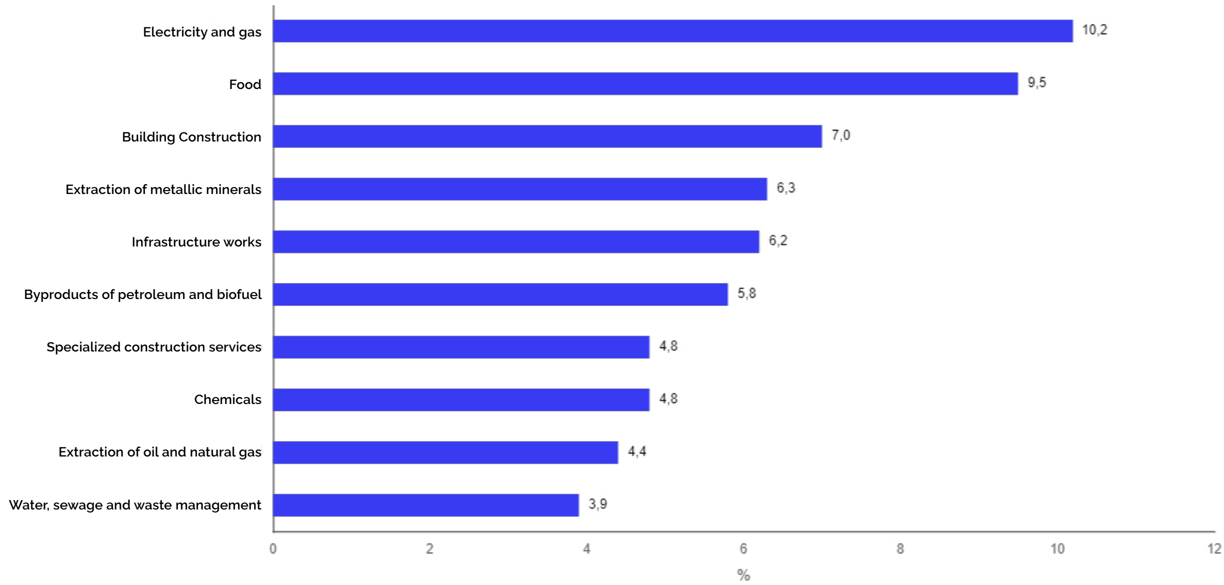


Source: Adapted by the author from IBGE, 2017.

2.1.6. Industrial production

Brazilian industry plays an important role in the national economy, being responsible for 23.9% of GDP; 69.3% of exports of goods and services; and 34.4% of federal tax collection (Portal da Indústria, 2022; IBGE, 2022). The major categories can be classified into capital goods, intermediate goods, durable, semi-durable and non-durable consumer goods industries, with the former standing out in both production and turnover. The main sectors of Brazilian industry and their relative participation in the country are shown in Figure 10.

Figure 10: The ten main sectors of the Brazilian industry in 2020



Source: Portal da Indústria, 2020.

According to IBGE, in 2019, there were about 306,000 companies operating in the industrial sector in Brazil, which employed 7.61 million people, with an average of 25 people per company. The number of companies was 0.84% lower than in 2018, when there were 308,940. The occupied personnel, meanwhile, is down 0.69% in one year (there were 7.67 million in 2018). Companies in the industrial sector pointed in 2019 net sales revenue of approximately R$3.24 trillion, with an average of R$10.57 million per company (IBGE, 2019d).

According to IBGE, from August 2020 to 2021, the activities with the largest share in the total industry in terms of added value were manufacture of machinery and equipment (29.4%); manufacture of motor vehicles, manufacture of textile products (25.5%); trailers and bodies (22.3%); manufacture of non-metallic mineral products (19.6%); metallurgy (19.1%); manufacture of wood products (17.6%); preparation of leather and manufacture of leather goods, travel goods, and footwear (16.1%); manufacture of clothing and accessories (15.6%); manufacture of metal products, except machinery and equipment (15.3%); and manufacture of machinery, appliances, and electrical materials (14.5%) (IBGE, 2021g).

In the same period, in the North Region, the products that stood out in terms of sales value were beverages (5.03%) and other transport equipment (3.28%). In the Northeast, other chemical products stood out (1.41%). In the Southeast, the highlights were automotive vehicles, trailers, and truck bodies (9.53%) and Pulp, Paper, and Paper Products (3.73%). In the South, machinery and equipment (7.95%) and apparel and accessories (3.56%) had the highest percentages. In the Center-West region, metallic minerals (0.22%) and automotive vehicles, trailers, and truck bodies (0.92%) were the most representative activities (IBGE, 2021h).

2.1.7. Chemical industry

The chemical industry represents one of the most important sectors of the Brazilian economy and is among the 10 largest in the world. According to the Brazilian Chemical Industry Association (Portuguese acronym ABIQUIM), the Brazilian chemical industry ranks 6th in the world chemical industry, having reached revenues of 100.8 billion dollars in 2020, or 3.1% of the world's revenues, estimated at 3,938.5 billion dollars (ABIQUIM, 2020).

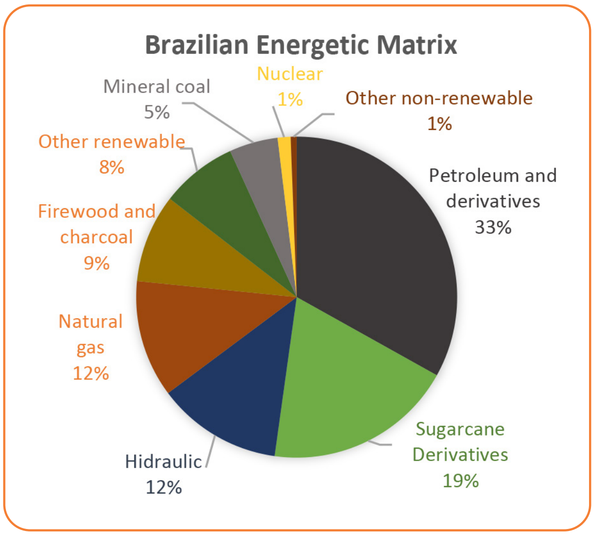
The chemical industry contributed 2.3% of Brazil's GDP in 2019, establishing itself as the 3rd largest manufacturing sector in Brazil, behind only the food and beverage industries; and the petroleum products and biofuels sector (ABIQUIM, 2020). In 2019, the sector employed 4% of the working force employed in transformation industries throughout the country.

According to ABIQUIM, in 2020 there were 961 chemical plants for industrial use, particularly concentrated in the state of São Paulo, where about 56% of chemical industrial plants are located. Brazil is a major importer and exporter of chemicals, with emphasis on the import of petroleum fuel oils and chemical fertilizers and fertilizers and, the export of thermoplastic resins (ABIQUIM, 2020). Despite recording one of the highest sector revenues in the world, the Brazilian chemical industry is witnessing a certain stabilization trend in the national industrial production. In addition, a large part of the country's consumption is met by products from foreign markets.

2.1.8. Energy matrix

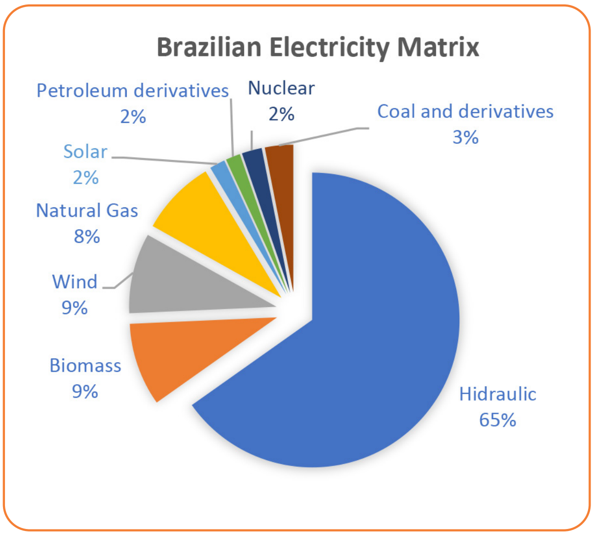
In absolute terms, Brazil is one of the countries with the largest share of renewable energy in the world. As shown in Figure 11, in 2018, 65% of Brazil's electricity supply was from hydroelectric plants and only 13% from fossil fuels. Worldwide, renewable energy represented 14% of the total supply in 2018, according to the Energy Research Company (Portuguese acronym EPE, 2021). However, despite hydropower being traditionally considered a clean energy source, the ecological and social effects surrounding the whole process of altering the natural dynamics of rivers and their surrounding environments for the construction of dams have been increasingly debated.

Figure 11:
Brazilian energy and electricity matrix (2018)



Source: Prepared by the author from EPE, 2019.

Figure 12:
Brazilian energy and electricity matrix (2018)



Source: Prepared by the author from EPE, 2019.

The extraction of oil and natural gas assumes a prominent position in the national economy given the vast coastline of the country and the abundance of existing reservoirs, especially the "Pre-Salt" area. In 2020, the annual average of oil production was 2,940 thousand barrels/day, while the natural gas production was around 127 million m^3/day. In both cases, the state of Rio de Janeiro leads national production, accounting for 80% of oil and 61% of gas production; moreover, the company Petrobras accounts for about 95% and 91% of the country's total production of oil and gas (ANP, 2021).

Although the country is a major producer and user of natural gas, having registered an import of e 26.3 million m^3/day in 2020, there was a 6% drop in domestic demand for the fuel compared to the previous year, attributed to the 13% decrease in industrial consumption during the period.

Brazil also has a great potential for uranium exploration for use in new nuclear plants. However, the process is more complex due to environmental issues, high investment costs, and the importation of technology, thus delaying the construction of new nuclear plants.

In general, the country has a good installed capacity for the generation of renewable energies besides hydroelectric (Table 7) and has the perspective of expansion, especially for wind and solar energies. The diversification of the national energy matrix is currently seen as an alternative for the reduction of water dependency, especially for the "Polygon of Droughts" region. Of the energy sources that came into operation in 2020, wind and solar are the most promising, ranking 2nd and 3rd, respectively, in terms of additions, according to the National Agency of Electric Energy (Portuguese acronym ANEEL, 2021). Particularly in the case of wind energy, there is also great potential for expansion along the coasts of the Northeast, Southeast and South of the country.

Table 7: Brazilian energetic matrices and respective power (kW).

Renewable		Non-Renewable	
Matriz	**Potência (kW)**	**Matriz**	**Potência (kW)**
Biomass	15,556,726.45	Petroleum and others	9,201,984.75
Hydric	109,394,386.2	Natural Gas	16,285,510.39
Solar	4,574,334.61	Mineral coal	3,582,830
Wind	20,107,538.86	Nuclear	1,990,000
Undi-electric	50		

Source: Prepared by the author from ANEEL, 2021.

2.1.9. Regional cooperation

Brazil is one of the five countries that make up the tariff union of MERCOSUR, also formed by Argentina, Paraguay, Uruguay, and Venezuela. Venezuela, which joined the bloc in 2012, has been suspended since December 2016 for non-compliance with its Accession Protocol. Besides the five main country-parties, the other seven South American countries relate to the bloc as associated partners, namely: Bolivia, Chile, Colombia, Ecuador, Guiana, Peru and Suriname. From those, Bolivia is currently in the process of accession to the bloc.

MERCOSUR, created in 1991, aims for economic integration, cooperation, and development among the countries, with the objective of increasing trade between them. Economically, the bloc is the third largest in the world, behind the North American Free Trade Agreement (NAFTA) and the EU.

With a population of 265.7 million inhabitants (62.2% of the South American population and 3.5% of the world population), MERCOSUR occupies an area of 11.9 million km^2, equivalent to almost three times the area of the EU and 67% of the territory of South America. In 2019, the bloc presented the 8th largest GDP in the world, adding up to US$2.38 trillion and corresponding to 69.2% of South America's total (MRE, 2019).

2.2. Institutional, policy, and regulatory frameworks

The Federal Constitution of Brazil (1988), in its Article 225, recognizes the essential right to an ecologically balanced environment, which is an asset of common use and essential to a healthy quality of life and both the Government and the community shall have the duty to defend and preserve it for present and future generations. To ensure the effectiveness of this right, Article 225 of the Constitution established specific obligations and duties for public authorities. In particular, the obligation established in Article 225, paragraph 1, item V: "it is incumbent upon public authorities to control the production, marketing and use of techniques, methods or substances which pose a risk to life, to the quality of life and to the environment". The control exercised by the government over the use and production of hazardous substances, including POPs, is based on this constitutional mandate. Since the Federal Constitution of 1988, Brazil has developed a comprehensive yet complex environmental institutional framework.

2.2.1. Environmental institutional and regulatory framework

In Brazil, the administrative responsibility for protecting the environment, combating pollution, and taking care for the health and well-being of the population is shared among the federal government, the States, the Federal District and the municipalities. Supplementary Law No 140, dated 8 December 2011, established rules for cooperation among the three levels of government in the exercise of this joint responsibility.

As for the prerogative to legislate on environmental matters, Article 24 of the Federal Constitution confers concurrent jurisdiction among the three levels of government. It assigns the regulation of issues of national interest to the Federal Government by establishing rules and general guidelines for the entire country. States, in turn, regulate regional issues; and municipalities, local specificities, if state and municipal regulations do not contradict federal law. They are only allowed to adopt more restrictive measures than those adopted by the federal government. In cases where there is no federal law establishing general rules, the states may exert full legislative jurisdiction. In this manner, each specialized body from the three levels of government has autonomy to establish norms according to its legal jurisdiction.

To deal with the many challenges of its decentralized environmental institutional framework, Brazil created a National Environmental System (Portuguese acronym SISNAMA) which represents the coordination of all environment agencies at all levels of government for environmental management in the country. SISNAMA is formed by a Government Council to advise the President of the Republic on the subject; the National Environmental Council (Portuguese acronym CONAMA), which is an advisory and deliberative body, formed of representatives of various sectors; and the MMA, which is the central body responsible for coordinating the System and the Environmental Secretariats of the states and the Federal District, which are the Sectional Bodies, and the Environmental Secretariats of the municipalities, which are the Local Bodies. Two other bodies form SISNAMA, which are: the Brazilian Institute for the Environment and Renewable Natural Resources (IBAMA) and Chico Mendes Institute for Biodiversity Conservation (ICMBio), both responsible for executing the implementation of the environmental policy in the framework established by legislation. SISNAMA structure is represented in Figure 13.

Figure 13: Institutional structure of the National Environmental System (SISNAMA).

Superior Authority	Consultative and Deliberative Authority	Central Authority
Government Council	CONAMA	Ministry of Environment
Executing Authorities	Sectional Authorities	Local Authorities
IBAMA and ICMBio	Federal States	Municipalities

Source: Adapted by the author from MMA, 2021 (https://antigo.mma.gov.br/governanca-ambiental/sistema-nacional-do-meio-ambiente/apresentacao-sisnama.html).

All states and most large municipalities have their own environmental agencies, but the level of development between institutions varies considerably. While for most states and municipalities environmental agencies have limited capacity, CETESB, since 2009, acts as Regional Center of the Stockholm Convention for Training and Technology Transfer in the Region of Latin America and the Caribbean.

In Brazil, most states and municipalities do not consistently monitor the condition of the environment and the outcomes of their environmental policies. For this reason, within the scope of the NIP implementation, as one of its practices, the MMA will carry out workshops and training courses for the technical staff of state environmental agencies, aiming to efficiently work on one of the goals established by the Stockholm Convention at a local level.

As an example, the CONAMA Resolution nº420/09 establishes that state-level organizations should develop reports regarding the identified contaminated sites, to be then sent and centralized by IBAMA in a unified database, forming the National Database on Contaminated Areas (Portuguese acronym BDNAC). In a consultation carried out with BDNAC (IBAMA, 2019), information was found referring only to which states make information available to the public (São Paulo, Minas Gerais and Rio de Janeiro) and which are available, with a link directing to the page of each of the state institutions mentioned. In the following, Table 8 summarizes the roles and responsibilities of the main federal institutions that deal with POPs.

Table 8: Roles and responsibilities of federal institutions that deal with POPs. Adapted from MMA, 2015 (cont.)

Authority	Competences
Ministry of the Environment and Climate Change (MMA)	As SISNAMA's central authority, it is responsible for the formulation of national environmental policies; for the development of strategies, mechanisms, and legal, economic, and social instruments for the improvement of environmental quality and the protection of natural resources, **in which issues related to pollution, risk management of chemical substances, and hazardous waste are included**.
National Environmental Council (CONAMA)	Is a collegiate body of normative, deliberative and advisory character belonging to the MMA's structure; establishes norms, criteria and standards related to the control and maintenance of the quality of the environment, in order to guarantee a rational use of environmental resources. Brings into force regulations that might be related to the protection of the environmental quality, as the **Resolution 420/09, which provides criteria for evaluating chemical substances in soils and guidelines for the environmental management of contaminated areas**.
Brazilian Institute of the Environment and Renewable Natural Resources (IBAMA)	As the executing agency of the national environmental policy, in the federal sphere, it is linked to the Ministry of the Environment and Climate Change. It is the institution that effectively **exerts control over the production, use, commercialization, movement, and destination of chemical substances and dangerous residues**, and carries out environmental supervision at the regional and national levels. It **participates in the registration of pesticides** (agricultural and non-agricultural), carrying out the evaluation of the environmental hazardousness of these products. It also registers wood preservatives and remediators. It **is one of the consenting bodies for the foreign trade of several products, among them chemicals controlled in international conventions**. Moreover, it is currently the **technical focal point for the international chemical-related conventions**: Stockholm, Rotterdam, Basel, and Minamata, acting to coordinate activities for their implementation.

Table 8: Roles and responsibilities of federal institutions that deal with POPs. Adapted from MMA, 2015 (cont.)

Authority	Competences
Ministry of Health (MS)	Formulates and implements the National Health Policy; coordinates and oversees the SUS; promotes environmental health and adopts actions to promote, protect, and recover individual and collective health, including that of workers and indigenous populations, and maintains the health information system. It **operates in environmental monitoring and control related to human health and drinking water quality**: chemical and physical environmental contaminants; natural disasters; accidents involving hazardous products Has formerly been responsible to emit authorizations for the use of pesticides, having in 1998 removed several POPs from the list of permitted substances for agricultural and domissanitary applications in the country.
National Agency of Health Surveillance (ANVISA, Portuguese acronym)	Linked to the MS, it **operates in the regulation, control, and inspection of products and services related to chemicals that involve risk to public health**: of dietary products and food additives, limits of contaminants, residues of veterinary drugs and pesticides in food, hygiene products, perfumes, cosmetics, dyes, in the registration process of pesticides and related products. It **participates in the registration process of pesticides, conducting the toxicological evaluation of these products and the re-evaluation of the registration of those that are suspected of causing harm to health**. Exercises control and quarantine at ports, airports and borders.
Oswaldo Cruz Foundation (FIOCRUZ)	Linked to the MS, it develops **teaching, research, and publication activities in the areas of public health, workers' health, ecotoxicology, and related subjects**, besides promoting postgraduate courses in these areas. In the universe of chemical substances involved in its activities are the POPs.
Ministry of Labor and Pension (MTP)	Formulates and proposes guidelines for labor inspection, as well as norms for **worker safety and occupational health**. Supervises and monitors the activities of inspection and occupational safety and health, in the ambit of the decentralized units, and follows up on the fulfillment, at the national level, of the agreements and conventions ratified by the Brazilian government with international organizations, especially with the International Labor Organization (OIT), in matters of its competence.
Jorge Duprat Figueiredo Foundation for Occupational Safety and Medicine (Fundacentro)	Linked to the MTE, it carries out studies and research related to safety and health at work, with competence to plan, coordinate, monitor, and evaluate programs, projects, research, and services, with the objective to **identify, prevent, and control the exposure of workers to factors, conditions, and risk agents in the working environment**. It carries out essays and tests to evaluate the quality of individual protection equipment, relying on specialized laboratories. It investigates and analyzes occupational accidents. It acts in the identification of chemical agents in the work processes used in phytotechnology and zootechny, proposing measures to control the risks of such agents in the work environments.

Table 8: Roles and responsibilities of federal institutions that deal with POPs. Adapted from MMA, 2015 (cont.)

Authority	Competences
Ministry of Transport (MT)	Formulates and implements the country's transport policy, including the matrices for rail, road and waterway transport, as well as participating in the coordination of air transport. The agencies linked to the MT - the National Agency for Land Transport (ANTT) and the National Agency for Waterway Transport (ANTAQ) are responsible for **establishing the standards and complementary technical norms relative to the operations of land and waterway transport of special and dangerous cargo**.
Ministry of Agriculture and Livestock (MAPA)	Proposes guidelines for formulating agricultural policy with respect to defending agriculture and livestock and promoting agribusiness competitiveness; **exerts control and supervision of production, marketing and use of pesticides, their components and related products. It participates in the registration of pesticides, evaluating the agronomic efficiency of the active ingredients**. It also registers veterinary products.
Ministry of Development, Industry, Trade and Services (MDIC)	Its area of competence includes: industry, services and trade development policy; metrology, standardization, quality and industrial innovation; foreign trade policies, regulation and execution of programs and activities related to foreign trade. It manages **Comex Stat, the computerized system responsible for integrating the activities of registration, monitoring and control of foreign trade operations**.
National Institute of Metrology, Standardization and Industrial Quality (INMETRO)	Linked to the MDIC, it has, among other competencies, the attribution to plan and execute the accreditation activities of test calibration laboratories, of proficiency test providers, of certification, inspection, training and other organisms, necessary for the development of the services infrastructure in the country. In this scope of activities, it includes the **accreditation of laboratories that can perform, among others, the necessary analysis for the detection and characterization of POPs**.
Ministry of Science, Technology and Innovation (MCTI)	Responsible for the development and implementation of national policies related to science and technology; **acts as Permanent Executive Secretariat of the commission for the implementation of the Convention for the Prohibition of Chemical Weapons (CPAQ, Portuguese acronym; promotes and develops clean production techniques for industries**.
Ministry of Mines and Energy (MME)	Its areas of competence include, among others, mining and metallurgy; oil, fuel and electric energy, including nuclear; rural energization and agro-energy, including rural electrification, when financed with resources linked to the National Electric System. It has an important role in the **management of electric equipment (transformers, capacitors and circuit breakers) containing PCBs**, together with the ANEEL.
Ministry of External Affairs (MRE)	Articulates the Brazilian position in the negotiation of international instruments; **acts as representative of the country in the meetings of international conventions**, besides managing political aspects and environmental issues in general.

Table 8: Roles and responsibilities of federal institutions that deal with POPs. Adapted from MMA, 2015 (continued)

Authority	Competences
Ministry of Justice and Public Security (MJSP)	Through the Federal Police and the Federal Highway Police, the Ministry of Justice operates in the **inspection of national and international transport of dangerous products and in the repression of the contraband of goods prohibited in the country**. The Federal Police is active in the maritime, air, and border areas.
Ministry of Integration and Regional Development (MDR)	It coordinates civil defense actions throughout the national territory. Civil defense actions have the objective of reducing disasters and include prevention, preparation, and response to national emergencies and natural disasters. It is a multi-sector action and must be executed by the three levels of government - federal, state and municipal - with broad community participation.

Source: Adapted by the author from MMA, 2015a.

In addition to these federal bodies, the states, municipalities and the Federal District have their own institutional arrangements and structures to comply with obligations that are their responsibility. Moreover, the civil society and the private sector have representatives in some environmental bodies, alongside the competent public authority.

2.2.2. Environmental policy and legislation

Brazilian environmental legislation dates to the XVII century. However, the current legislation is mostly based on the Federal Law N° 6,938, published in 1981, which established the National Environmental Policy (Portuguese acronym PNMA). The law innovated by presenting the environment as a specific object of protection and introduced the objectives, guidelines, principles and tools of Brazilian environmental policy, incorporating aspects of environmental sustainability to the country's development. It was a groundbreaking step in the history of Brazilian public administration. Since then, along the past forty years, Brazil has structured environmental policies, approved several environmental regulations, created mechanisms for the control and management of natural resources as well as for preventing pollution; and has also strengthened the participation of society in developing national policies.

Among the instruments created by the PNMA, the mandatory environmental licensing of potentially pollutant activities and natural resources use is noteworthy. This mechanism translates the prevention approach into concrete actions, encompassing the polluter-pays principle. Environmental licensing procedures for various activities and undertakings are regulated by CONAMA Resolutions. The prevention, precautionary and polluter-pays principles, which guide environmental law, are depicted in many of the instruments established by the PNMA and other rules that make up Brazilian environmental legislation.

The Federal Constitution of 1988 enabled a set of laws that consolidated Brazil as a global example regarding environmental legislation. However, there are certainly gaps between the legal provisions and the practices adopted in the country, mainly due to the challenge of surveying the entire national territory. Some of the main legislations pertaining to the Stockholm Convention implementation are presented below:

- **Law 7,797/1989** — Created the **National Environmental Fund** to support the development of projects encouraging more rational and sustainable uses of natural resources, as well as the recovery, maintenance and improvement of the environment and life quality.
- **Law 9,433/1997** — Created the **National Water Resources Policy**, which established the National System for the Management of Hydric Resources (SINGREH, Portuguese acronym). This legislation established that water is an asset of public domain, multiple use, and decentralized management with the participation of users. Decree 4,613/2003, regulated the National Council of Hydric Resources (CNRH, Portuguese acronym), its competencies and composition.
- **Law 9,605/1998** — Created the **Environmental Crimes Law**, which established administrative and penal sanctions to environmentally harmful actions. This law allowed the civil and criminal responsibilities of violators and created mechanisms for the recovery or compensation of damages caused in the environment.
- **Law 9,795/1999** — Created the **National Policy of Environmental Education (PNEA**, Portuguese acronym), which established the implementation of environmental education at all levels of formal and non-formal educational modalities. Decree 4,281/2002 regulated the National Policy for Environmental Education, its implementation and management.
- **Law 9,666/2000** — On the **basic principles to be obeyed in the movement of oil and other hazardous or dangerous substances in organized ports, port**

facilities, platforms, and ships in waters under national jurisdiction. This law established criteria for the prevention, control and inspection of the discharge of oils and hazardous substances in national waters. The CONAMA Resolution 306/2002 established the requirements for environmental audits to evaluate the environmental management and control systems in ports, platforms and refineries for the purposes of compliance with legislation and environmental licensing by the oil, natural gas and derivatives industries.

- **Law 11,445/2007** — Created the **National Policy for Basic Sanitation**, which established national guidelines for basic sanitation, encompassing water supply, sewage, drainage and rainwater management, urban cleaning, and solid waste management. It established the fundamental principles for the provision of public sanitation services, its ownership, planning, and regulation. **Decree 7,217/2010 regulated the National Policy on Basic Sanitation and established the National Sanitation Information System**.
- **Law 12,305/2010** — Created the **National Solid Waste Policy**, which establishes the set of principles, objectives, instruments, guidelines, and targets adopted for the integrated management and environmentally sound management of solid waste. It also establishes reverse logistics for packaging and used or obsolete products, shared responsibility among manufacturers, importers, distributors, traders, and consumers, cooperation between public agencies and companies, and incentives the formation of cooperatives of recycling workers. Decree 7,404/2010 regulates the National Solid Waste Policy.
- **Law 14,026/2020** — Updated the legal framework for basic sanitation and amended Law 9,984, of July 17, 2000, to attribute to the National Water and Sanitation Agency (ANA, Portugueses acronym) competence to edit reference standards on the sanitation service.
- **Law 14,250/2021** — On the **elimination of PCBs in the country**, provides for the controlled elimination of materials, fluids, transformers, capacitors, and other electric equipment contaminated by PCBs and their residues.

Regarding PCBs, the main national laws and regulations directly related to PCBs in Brazil in chronological order are:

- Interministerial Ordinance MIC/MI/MME No. 19, of 01/29/1981 - Prohibited the manufacture and commercialization of PCBs;

- Ordinance MINTER 157/1982, which prohibited the release of effluents containing non-degradable substances with a high degree of toxicity, including PCBs, into the waters of the Paraíba do Sul River;
- Normative Instruction SEMA/STC/CRS No. 01/83 - Handling, Storage and Transport of PCB's and/or waste contaminated with PCB's;
- ABNT NBR-8371/ 1984, 1997 and 2005 – PCB fluids for transformers and capacitors: Characteristics and Risks;
- ABNT/NBR 8840/1985, 1992 and 2013: Guidelines for sampling insulating liquids;
- ABNT NBR 11,175/1990, which addresses the incineration of hazardous solid waste – performance standards and establishes an EDR of 99.999% for PCBs and dioxins;
- ABNT NBR – 13882/1997, 2005, 2008, 2013 - Electric insulating liquids: Determination of the content of polychlorinated biphenyls (PCB): Defines the use of gas chromatography in the 2008 and 2013 revisions;
- Conama Resolution 316/2002: Provides for procedures and criteria for the operation of waste thermal treatment systems, those whose minimum temperature is 800 °C and residence time greater than 1 second, establishing for PCB the rate of destruction and removal efficiency of 99.99%; It defines the maximum emission limit for Dioxins and Furans: TEQ (total equivalent toxicity) of 2,3,7,8 TCDD (tetrachloro-dibenzo-para-dioxin):
- Legislative Decree nº 204/2004 – Approves the EC text on POP, adopted on May 22, 2001;
- Federal Decree No. 5472/2005 – Promulgates the EC text on POP, adopted on May 22, 2001;
- ANP Resolution 36/2008 – which establishes the specifications for type A and type B insulating mineral oils, of national or imported origin, sold throughout the national territory, among which, it establishes that the PCB content must be undetectable, according to ABNT NBR 13882. This resolution revoked ANP Resolution 25/2005, which in turn revoked DNC Ordinance nº 46/94 – both also established that the PCB content should be undetectable;
- ANP Resolution 16/2009 - designates NBR 8371/2005 as the standard to be followed for the disposal of electrical insulating oils;
- ANP Resolution 19/2009 – establishes the necessary requirements for authorization to carry out the activity of re-refining used or contaminated lubricating oil, and its regulation. Requirement of own laboratory for PCB control, among others;

- ABNT/NBR 16432/2016: Insulating mineral oil — Determination of the content of chlorinated products that includes analysis by potentiometry, but includes analysis by colorimetry; • Law No. 14,250, of November 25, 2021, which provides for the controlled disposal of materials, fluids, transformers, capacitors and other electrical equipment contaminated by polychlorinated biphenyls (PCBs) and their waste.

2.2.3. International Environmental Agreements and Treaties

Brazil has been very active — particularly after the UN Conference on Environment and Development in 1992 (Rio 92) — in all the most relevant forums and negotiations related to chemicals and wastes. Below are the main multilateral agreements adopted by Brazil related to chemicals:

The Vienna Convention for the Protection of the Ozone Layer and the Montreal Protocol In 1990, Decree No. 99,280 promulgated the Vienna Convention for the Protection of the Ozone Layer and the Montreal Protocol on Substances that Deplete the Ozone Layer. Brazil engaged in adopting actions that reduce the emission of substances that deplete the ozone layer. To meet the obligations undertaken as a Party to the treaty, the Brazilian Programme to Phase-out Production and Consumption of Ozone Depleting Substances was created.

The Basel Convention on the Transboundary Movements of Hazardous Wastes and their Disposal

The Brazilian Government acceded to the Basel Convention, and it was promulgated by Decree No. 875 on July 19, 1993. Currently, national procedures to control waste imports are standardized by CONAMA Resolution No. 452/2012, which restricted the imports of hazardous waste. When the National Solid Wastes Policy was enacted through Law No. 12,305/2010, the importing of hazardous wastes was definitively banned both for final disposal and recycling purposes. Guidelines drafted and published by the Convention help countries carry out environmentally adequate management of various kinds of waste and have been important references for developing national policies and legislation.

The Rotterdam Convention on Prior Informed Consent Procedures for Certain Hazardous Pesticides and Chemicals in the International Trade — the PIC Convention

Brazil signed the Rotterdam Convention in 1998 and promulgated it by Decree No. 5,360, on January 31, 2005. The Prior Informed Consent of The Rotterdam Convention (PIC) aims to control the transboundary movement of hazardous chemicals (agrochemicals and industrial chemicals) that have been banned or severely restricted for health or environmental reasons by the country Parties. It is based on the principle of prior consent of the importing country and in the shared responsibility for the international trade of these chemicals.

The Minamata Convention on Mercury

The Minamata Convention on Mercury emerged after recurring discussions in United Nations Environment Programme (UNEP) on the risks of the use of mercury. Altogether, 140 countries participated and approved the final text in October 2013. The treaty entered into force on the ninetieth day after the date of deposit of the fiftieth instrument of ratification. Brazil, who signed the Convention already in 2013, had its text approved and ratified by the National Congress in 2017, just before the Minamata Convention entered into force internationally. Nationally, the Convention entered into force through the Legislative Decree 9,470/2018, signed on 14th August 2018. With a balanced text, the Convention includes measures applicable to different realities, an essential element for multilateralism in environmental issues in the 21st century. The Convention brings together a set of provisions that can be grouped into control measures, development of specific policies or voluntary and facilitating measures, in addition to administrative provisions and means of implementation. Through a GEF/UNEP Project "Initial Assessment of the Minamata Convention on Mercury", MMA developed preparatory activities for the implementation of the Minamata Convention.

Strategic Approach to International Chemicals Management (SAICM)

Adopted in 2006, SAICM aimed to support the Johannesburg Plan, agreed upon in 2002 at Rio+10, and to ensure that by 2020 chemicals would be produced and used in a manner that significantly reduces their harmful effects on the environment and human health. However, the fourth session of the International Conference on

Chemicals Management (ICCM4), through resolution IV/4, initiated an intersessional process to prepare recommendations regarding the Strategic Approach and the adequate management of chemicals and waste beyond 2020. To achieve this goal, the Global Action Plan included in SAICM suggests that national infrastructures for chemical management should be built, by establishing responsibilities, institutional governance arrangements, legal framework and formulation of appropriate policies and national programs. Brazil, a SAICM signatory, has undertaken efforts to ensure the effective implementation of the objectives of the Global Action Plan in the country. In 2015, Brazil started discussing the development of a legislation for the environmentally adequate management of chemicals, which will be an important milestone for the agenda. Furthermore, the SAICM goals and measures, needed for its achievement, were incorporated into the MMA's Strategic Plan for 2014-2022 as a measure of institutionalization and implementation commitment of the SAICM.

Bill 6,120/2019, which creates the National Inventory of Chemical Substances to consolidate an information base about chemicals produced or imported in the Brazilian territory, and to make other provisions, represents an important advance in the management of chemicals in the country. Bill 6,120/2019 is under analysis by the Chamber of Deputies, awaiting the opinion of the Rapporteur of the Constitution and Justice and Citizenship Commission (Portuguese acronym CCJC).

2.3. Assessment of POP issues in Brazil

According to the national priorities established by the MMA and the outcomes from the first Brazilian NIP, the reviewed and updated NIP focused on the current situation of ten POPs (PFOS & PFOSF, POP-PBDEs, HBCD, HCBD, PCP, PCNs, DecaBDE, SCCPs, PFOA and Dicofol). This section presents a summary of each POP inventory used for the NIP update considering their historical, current and projected future production, application, import and export, stock and the waste management of POPs and POP-containing products. Furthermore, it brings an overview on the occurrence of those POPs in the Brazilian territory and on the existing policy and regulatory framework pertaining to each assessed POP.

2.3.1. Assessment of POP pesticides (Annex A, Part I)

Historically, Brazil produced, imported, and used POP pesticides in industrial scales and, during the last century (from early 1940's to late 1990's), POP pesticides were used for agricultural activities and for public health campaigns in the country (MMA, 2015a). Most POP pesticides were last legally used to fight insect-borne diseases in the 1990's, when Brazil banned their use in sanitation campaigns in 1998 (BRAZIL, 1998). However, most POP pesticides had already been banned for agricultural activities in 1985 (BRAZIL, 1985). Nowadays, all POP pesticides are prohibited in Brazil. Brazil has not made use of the specific exemptions approved by the COP for Mirex, Endosulfan and Lindane.

Considering that POP pesticide issues have been broadly addressed in Brazil, their inventories were not updated at this time, being their initial assessment available at NIP-Brazil-2015 (MMA, 2015b). The follow-up of the Action Plans established in the NIP-Brazil-2015 for POP pesticides is presented in Chapter 2.4. However, to make sure that this topic is no longer relevant in the country and that the provisions of Stockholm Convention have been fully addressed, the review and update of POP pesticides inventories in Brazil is recommended for the next NIP update. On the other hand, for the POP pesticides listed after the NIP-Brazil-2015 transmission to the Secretariat of the Stockholm Convention, national inventories were recently developed, and their assessments are individually presented within this section. However, the reviewed national assessment of PFOS, its salts and PFOSF, which is related to pesticide uses in Brazil, is presented in the subchapter 2.3.9.

2.3.1.1. Assessment of Pentachlorophenol - PCP (Annex A)

PCP under the Stockholm Convention

In 2015, the Stockholm Convention decided for the inclusion of PCP, its salts and esters (Na-PCP, PCP-L, PCA) into the Annex A, with specific exceptions for its production and use in utility poles and crossheads. Their toxicity is related to the activity on inhibition of enzymes involved in oxidative phosphorylation, as well as of sulfotransferase (SEILER, 1991). Besides this main mode of action, adverse effects such as endocrine interference and the induction of liver and kidney damage have also been described.

Moreover, PCPs have been also classified by the International Agency for Research on Cancer as a Group 1, i.e., carcinogen substance (IARC, 2016). They are also considered environmentally persistent compounds and that may potentially be toxic to humans and animals (ATSDR, 2001).

Several countries have produced PCP, its salts and esters in the past, among them Brazil, China, and the former Czechoslovakia and Soviet Union. These compounds were also produced by countries in the EU (Denmark, France, Germany, Poland, Spain, Switzerland, and the United Kingdom), which ended production of PCP and its salts in 1992, and PCP-L in 2000 (UNEP, 2017b). Currently, PCP is produced in Mexico (6600 tonnes/year) and its formulation is made in the United States, while in India 1800 tonnes of Na-PCA are produced annually (UNEP, 2014a; 2017b).

In the past, the application of PCP and its salts and esters was widespread in the agricultural and industrial sectors, including in textile production, the paint industry, and oil drilling (CANADA, 2012). In addition to its main application, PCP, Na-PCP and PCP-L were used until the 1980s as molluscicides in the control of schistosomiasis, as insecticides, in the treatment and prevention against termites, as bactericides, algicides, herbicides, as preservatives in paints, starches, glues and adhesives, and were also applied in the synthesis of pharmaceutical products (SEILER, 1990; UNEP, 2017b). Currently PCP and Na-PCP are still used in the industrial sector for the preservation of wood for the manufacture of poles, crossbars and for non-residential construction, on the other hand, according to UNEP (2017b), in 2014 no country used the compound PCP-L.

PCP situation in Brazil

In Brazil, products containing PCP and its derivatives were used as pesticides, with domestic use and application in agriculture and industry being reported (KUSSUMI et al., 2004). Na-PCP is commonly known in Brazil as "*Pó da China*." Due to the recognition of the toxic potential of these compounds, the application of PCP as agrochemical was prohibited in Brazil by the Ministry of Agriculture Ordinance No. 329, September 2, 1985. Subsequently, its use was prohibited in public health campaigns and, also, for domissanitary use by the Ministry of Health (Ordinance No. 11 of January 08, 1998), being kept only its specific use as a wood preservative. In 2006, the use of PCP as wood preservative was also prohibited in Brazil (resolution: RDC 164/2006). In the environmental context, the Normative Instruction of IBAMA n°. 132, of November 10, 2006, also adopted measures to restrict the continued use of PCP and its salts in Brazilian territory.

IBAMA considered the evaluations that pointed out such compounds as endocrine disruptors, presenting high persistence in the environment, water solubility, high toxicity (liver and kidney) to animals and humans, and the presence of other contaminants (for example, dioxins and HCB) as byproducts of their synthesis. According to the regulation, new registrations and import licenses for active ingredients and products containing PCP and its salts were denied. In addition, it was also foreseen in the regulation the prohibition, as of March 30, 2007, of the commercialization in packages of all products listed in its Annex I. According to the regulation, the trade of the products listed in Annex I was allowed only to users identified until June 30, 2007. The regulation also provides for priority in the analysis of applications and renewal of registrations of products that replace compounds containing PCP and its salts. All products registered in Annex I as wood preservatives have already substituted Na-PCP as their active ingredient. According to the information disclosed by the companies, nowadays no product contains PCP and its salts and esters.

Production, use and stockpiles of PCP

A total of 10 industrial associations and 137 individual companies involved in the processing and trade of treated wood, leather tanning and the chemical sector were contacted through official letters sent by the Ministry of the Environment and Climate Change. Only six of the selected institutions replied to the query, stating that they do not currently use or produce PCP, and denying knowledge about the occurrence of contaminated stocks and areas (MMA, 2020a).

However, two institutions consulted for other POP inventories sent information about PCP contamination related to a former production unit of this compound and other organochlorines in Baixada Santista, São Paulo. In fact, according to Arruda Júnior (2004), in the 1960s the company Rhodia S/A operated inside another company called Carbocloro, producing PCP in the municipality of Cubatão, São Paulo (PCP inventory, 2020). The estimated production of PCP and Na-PCP between the end of the 1960s and 1982 was 22,200 tonnes, being imported in the same period another 2,000 tonnes (ALMEIDA et al., 2007). Later in 1984, it was disclosed that there were 11 clandestine dumps used for the disposal of toxic organochlorine by products such as hexachlorethane (C_2Cl_6), HCBD (C_4Cl_6) and HCB (C_6Cl_6) in the surroundings of the company Rhodia S/A (SILVA, 1998; ARRUDA JÚNIOR, 2004; ALMEIDA et al., 2007; MMA, 2015b). In 1993 the PCP production plant and its incinerator were shut down, after contamination by PCP, HCB and other organochlorine compounds were found in the surrounding soils and water table (ALMEIDA et al., 2007; MMA, 2020f).

According to information provided to the MMA, following the remediation of contaminated soils and groundwater of the area, the CETESB issued in September 2017 a technical statement reporting the area as rehabilitated (MMA, 2020a). The second report sent to the MMA confirmed the improper waste management at the time of PCP production in the municipality of Cubatão, citing the existence of areas highly contaminated with PCP and HCB, being the areas potential sources of contamination in the region. Another document, elaborated by the Association for the Combat of Pollutants (Portuguese acronym, ACPO) and sent to the Federal Public Ministry, describes the occurrence of "toxic dumps" containing PCP and other contaminants in the metropolitan region of Baixada Santista (MMA, 2020a). According to the document, several toxic chemicals were stored clandestinely in the period between the late 1970s and the early 1980s in the area, and part of this waste was later stored in mag-sacs (polyethylene containers containing about one ton of waste). According to the document, CETESB's reports confirmed the occurrence in the "toxic chemical dumps" of PCP concentrations ranging from 2,000 to 36,800 mg kg^{-1} (MMA, 2020a).

In addition to reports of contamination derived from past use, the current 41 products with insecticidal, fungicidal and insecticidal/fungicidal action marketed for wood treatment were investigated (IBAMA, 2019), revealing that no product contains PCP and its salts and esters as active ingredients (MMA, 2020a).

PCP Trade

For the period between 1989 and 1996, it was possible to identify two custom codes related to PCP, its salts and esters — NBM 2908100201 and NBM 2908100299 — both corresponding to the two codes that have been adopted from 1997 onwards:

NCM 29081100 (“PCP (ISO) and its salts”) and NCM 29081919 (“other halogenated derivatives and their salts, containing chlorine”). From 1989 to 1996, a total of 674,600 net kilograms have been imported under both NBMs (MMA, 2020a).

Regarding the NCMs, the following specific codes were selected: NCM 29081016 (“PCP and its salts”), NCM 38083025 (“herbicide based on PCP/its salts, etc.”) and NCM 29081100 (“PCP (ISO) and its salts”), being the imports of the former two discontinued in the years 2007 and 2004, respectively. There was also an importation of 20 tonnes of products using NCM 29081100 in the year 2007, which then reduced to zero in the following years. The peak importation in Brazil (more than 1,500 tonnes) occurred in 1998 for the NCM 38083025, the same year that registered the highest export volume of PCP-derived compounds for this NCM, reaching almost 1,300 tonnes. According to the database, the export of this NCM was discontinued in 2006. The export of NCM 29081100 was also registered between the years 2011 and 2014, however, with extremely low values (0.003 to 0.12 tonnes) (MMA, 2020a). The foreign trade balance for PCP is summarized in Table 9.

In addition to the search in the Brazilian foreign trade database, import information was also requested from IBAMA, since it is a consenting agency for the NCM 29081100. According to the agency, in the years 2017 and 2018, only 0.1 g year-1 of PCP were imported (MMA, 2020a).

Table 9: Trade balance (imports and exports in net kilograms) of products registered under NCM codes: 29081016 – pentachlorophenol and its salts; 29081100 – pentachlorophenol (ISO) and its salts; and 38083025 – Pentachlorophenol-based herbicide / its salts, etc., in the period from January 1997 to December 2019 (cont).

NCM 29081016			NCM 29081100		NCM 38083025	
Year	Import	Export	Import	Export	Import	Export
1997	192.350	-	-	-	578,917	1,033,650
1998	172.000	-	-	-	1,550,204	1,296,700
1999	288.001	-	-	-	160,212	210,760
2000	264.000	-	-	-	166,611	407,875
2001	270.000	-	-	-	53,280	468,012
2002	239.575	-	-	-	26,640	210,243
2003	290.001	-	-	-	43,718	203,914
2004	240.000	-	-	-	65,775	218,632
2005	414.600	-	-	-	-	109,727
2006	186.400	-	-	-	-	264,000
2007	-	-	20.000	-	-	-
2008	-	-	0	-	-	-
2009	-	-	0	-	-	-
2010	-	-	0	-	-	-
2011	-	-	0	118	-	-
2012	-	-	0	3	-	-
2013	-	-	0	22	-	-
2014	-	-	0	6	-	-
2015	-	-	0	-	-	-
2016	-	-	0	-	-	-
2017	-	-	0	-	-	-
2018	-	-	0	-	-	-
2019	-	-	0	-	-	-
Total	**2.556.927**	-	**20.000**	**149**	**2,645,357**	**4,423,513**

Source: Data available at Comex Stat platform (http://comexstat.mdic.gov.br).

Occurrence of PCPs in Brazil

In the literature review, nine studies reporting PCP contamination in Brazilian samples were selected. From those, three publications mentioned the occurrence of PCP in biological samples and six referred to the abiotic environment. Only one publication related to the topic was found in the CAPES platform for thesis and dissertations. Other two publications, initially not detected due to the absence of mentions to PCPs in the title, abstract, and keywords, were further included (MMA, 2020a).

The publications reporting PCPs in abiotic matrices covered residential dust, soils and groundwater from industrial areas, landfills and chemical waste dumping sites. One study also analyzed riverine surface waters and sediments (DEL GRANDE; REZENDE; ROCHA, 2003; CODOGNOTO et al., 2004; NASCIMENTO et al., 2004; AIROLD et al., 2005; MACHADO et al., 2005; POHREN et al., 2012). Most studies were conducted in the state of São Paulo, and one of them at Rio Grande do Sul. Only one publication on PCAs was found, analyzing marine surface sediments and particulate matter in the state of Rio de Janeiro (GALVÃO et al., 2014).

The studies in biotic samples involved an epidemiological study using blood samples in Rio Grande do Sul (PICCOLI et al., 2016), another analyzing blood plasma from anurans in agricultural areas of Mato Grosso (MOREIRA et al., 2012), a study with riverine fish from the Amazonian region (GUIDA et al., 2018), and lastly a study with brown mussels from Rio de Janeiro. All studies reported PCAs in the analyzed samples (GALVÃO et al., 2015).

2.3.1.2. Assessment of Dicofol (Annex A)

Dicofol in the Stockholm Convention

Dicofol is an organochlorine pesticide used primarily as an acaricide. Composed of two isomers: *p,p'*-Dicofol and *o,p'*-Dicofol. The technical product (95% pure), with a viscous appearance in the form of a brown oil, is composed mainly of the *p,p'*-Dicofol isomer (80-85%), with a small fraction of the *o,p'*-Dicofol isomer (15-20%) and up to 18 reported impurities. The purest form of Dicofol (>95% purity) generally contains less than 0.1% DDT and its related compounds (Σ-DDT, i.e., DDT, DDE and DDD) (WHO, 1996). The intended uses of Dicofol cover fruits, vegetables, ornamentals, field crops, cotton, Christmas tree plantings, and non-agricultural outdoor buildings and structures (USEPA, 1998, LI et al., 2014).

Dicofol can be manufactured by hydroxylation of DDT, or directly without isolation of DDT by the reaction of trichloroacetaldehyde with monochlorobenzene in the presence of oleum (SO3 and H2SO4), followed by dehydrochlorination, chlorination and hydrolysis (VAN DE PLASSCHE et al, 2003). In several countries there are regulations regarding the content of DDT in commercial Dicofol. However, there is evidence that production does not always meet the DDT limits, and products may be commercialized with higher DDT content than allowed VAN DE PLASSCHE et al, 2003). This means that production and use of Dicofol can also be an emission source for DDTs.

Dicofol is persistent in low pH water bodies and soils (USEPA, 1998, 2009). Also, Dicofol has been detected in deep layers of sediments dating back several decades (ZHONG et al., 2012). Its metabolites and degradation products are also persistent in the environment, sometimes even more than Dicofol itself (UNEP, 2016). Based on models, it is possible to predict that Dicofol has the potential for long range transport and may be capable of enrichment in the Arctic. It also seems to be an endocrine disruptor in fishes and birds and toxic to mammals (BISHNU et al, 2009; UNEP, 2016).

Due to its toxic, persistent, bioaccumulative and wide environmental dispersion properties, the Stockholm Convention Secretariat decided in 2019 to list Dicofol as a POP under Annex A. Dicofol production and use in signatory countries should be prohibited, with no specific exemptions.

Dicofol in Brazil

In Brazil, Dicofol was used as an acaricide for cotton, citrus and apple crops. However, these uses were prohibited after the registration for the use of Dicofol as a pesticide was removed in 2015 (BRAZIL, 2016).

Production of Dicofol

A query was sent to 63 institutions regarding production, use and commerce of Dicofol (MMA, 2020k). Two companies replied with relevant information. The first one reported having the registration for a Dicofol product but stated that do not produce, import, or market the product. The second company reported to have imported, produced and commercialized Dicofol based products (MMA, 2020b). The company informed that it used to import technical Dicofol in order to produce commercial pesticides, but all registrations were canceled in September 2015.

In 2016, Brazil reported to the Stockholm Convention Secretariat that the country was no longer among the Dicofol-producing countries (MMA, 2020b). Based on an agreement between the Federal Public Ministry and local producers, the national production of Dicofol was interrupted in 2014, under a lawsuit (MMA, 2020b). The registrations for the six (6) Dicofol-based products (being two (2) technical products and four (4) formulated products) were then suspended in 2015, after the remaining stocks were properly disposed of. Brazil also reported that 90 tonnes of Dicofol based products were produced between 2010 and 2011. Production decreased to 32 tonnes in 2012 and 18 tonnes in 2013, the latter being the last year in which Dicofol was produced in the country (MMA, 2020b).

However, examination of the IBAMA Electronic Pesticides Reporting System database shows that the above information reported to the Secretariat is not of national production but that of national sales of Dicofol (MMA, 2020b). Production of Dicofol in Brazil has actually ceased in 2012, and, between 2010 and 2012, 231 tonnes of Dicofol as an active ingredient were produced (MMA, 2020b).

Trade of Dicofol

From 1989 to 1996 Dicofol foreign trade was tracked under a specific NBM code (2906290300). From 1997 onwards, the code changed to a specific NCM code (29062920). The consultation carried out through the Comex Stat database revealed that Brazil imported around 3,665 tonnes of Dicofol between 1989 and 1996. There is no registry of exports at this time. From 1997 to 2019, approximately 2,973 tonnes of Dicofol were imported, these imports mainly coming from Israel, Italy and Spain (MMA, 2020b). It is noteworthy that there are two imports from India from after 2015. In 2018, Brazil imported 3 tonnes of Dicofol from India and in the first semester of 2020, 1.6 tonnes. There was also the export of 23.7 tonnes of Dicofol to Argentina and 28 kg to the United States between 1997 and 2019 (MMA, 2020b).

Regarding domestic sales of Dicofol, the IBAMA database was consulted. Over 90% of all Dicofol sales were in southeastern states. More specifically in São Paulo (221.5 tonnes - 78%) and Minas Gerais (45.5 tonnes - 16%). Besides these, Paraná (11 tonnes - 4%) and Goiás (7 tonnes - 2%) also stood out in Dicofol consumption from 2009 to 2014.

The states of Alagoas, Bahia, Mato Grosso do Sul and Rio Grande do Sul also figure among the states in which Dicofol was commercialized over these years. However, their shares are less than 1% of the total Dicofol marketed in Brazil.

The commercialization of Dicofol, from IBAMA's control of domestic sales suggests that Brazil commercialized domestically a quantity very close to the quantity produced nationally, being 227.5 tons between 2009 and 2014. However, there is Dicofol import data since the late 1980s, also reported in 2018 and 2020.

Estimates of Dicofol used in Brazil

Based on import, export and national production values, it is possible to estimate that in the past 30 years (1989–2019) the total amount of Dicofol used in Brazil was approximately 6,845 tonnes (MMA, 2020k).

Occurrence of Dicofol in Brazil

Food

The first report found regarding the occurrence of Dicofol in Brazil was a master's thesis defended in 2007, which aimed to evaluate the action of sanitary surveillance regarding the reduction of pesticide residues concentrations in strawberries produced in the mountainous region of Rio de Janeiro (RJ) (SAEGER, 2007). Although the study itself did not quantify the presence of Dicofol, it was reported that in 2005, two out of 18 samples (11%) of strawberries from the mountainous region of Rio de Janeiro tested positive in qualitative analysis for the presence of Dicofol, although in Brazil the use of Dicofol has never been allowed in strawberry crops. Dicofol was only allowed in Brazil for foliar applications in cotton, citrus and apple crops (ANVISA, 2020a - http://antigo.anvisa.gov.br/registros-e-autorizacoes/agrotoxicos/produtos/monografia-de-agrotoxicos/excluidas).

Other studies, such as those published by Caldas & Souza (2004) and Ferreira et al (2018), have evaluated the impact of Dicofol residues, as measured by the Pesticide Residue Analysis Program (PARA), on ADI values. These studies were not initially accounted for in the systematic review process. However, it is worth noting that both studies reported an excess of the ADI based on the average national food consumption and the Brazilian maximum residue level (MRL) (CALDAS & SOUZA, 2004; FERREIRA et al, 2018).

Analyzing the data made available by PARA, from 2001 to 2012 several foods were reproved due to the presence of Dicofol in crops for which its application was not allowed. In this period, samples of papaya, strawberry, tomato, lettuce, bell pepper, cucumber, pineapple and carrot were reproved for having detectable amounts of Dicofol. The crops in which Dicofol was most frequently detected were crops for which its application was permitted, such as apple and orange, in which Dicofol detection was up until the year 2015 for both. However, the maximum residue level (MRL) was not exceeded for both crops. The adopted MRL for Dicofol was 5 mg kg^{-1} for apple and citrus crops and 0.01 mg kg^{-1} for cotton.

Kolberg et al (2011), published a study on the development of a rapid multiresidue method for the determination of pesticides in dry samples. After validation of the method, the authors analyzed a total of five samples of wheat, white flour and bran. Only one wheat sample showed Dicofol concentration above the method's quantification limit. However, Dicofol has never had a permitted application for this crop.

Alves et al (2012), also in a methodological study, comparing different techniques for the determination of pesticide residues in citrus essential oil samples, reported that a sample of orange essential oil even contained more than 35 mg L^{-1} of Dicofol. This value is seven times higher than the MRL of Dicofol for the orange crop.

Avancini et al (2013), aimed to determine the concentration of organochlorine pesticide residues in pasteurized milk samples from the state of Mato Grosso do Sul, researched the presence of these substances in milk. Residues of Dicofol (average of 5.11 ng g^{-1} and a range of 2.75 to 9.61 ng g^{-1} lipid weight) were quantified in 14 of 100 pasteurized milk samples. Neither the Brazilian MRL (100 ng g^{-1}) nor the European MRL (20 ng g^{-1}) for Dicofol were met. The fact that residues of Dicofol were reported below the MRL in such samples does not mean that this result should not be interpreted with caution in relation to human exposure, especially when taking into account that for other organochlorine pesticides the MRL was exceeded and such compounds may present synergistic effects in relation to damage to human health. Here it is worth mentioning another study, which although it was not included in the systematic review selection because it did not report the occurrence of Dicofol itself in Brazilian samples, reports that the washing process is not sufficient to completely remove Dicofol residues from orange samples treated with this pesticide (RIBEIRO et al., 2000).

Biota

The only study found that evaluated the presence of Dicofol above the limit of quantification in Brazilian biological samples was the study conducted by Sánchez-Sarmiento et al (2016). In this study, the authors evaluated the occurrence of organochlorine pesticides in liver and fat samples of green turtles (Chelonia mydas) from three regions of Brazil. A total of 64 samples from green turtles, captured in Praia Grande and Ubatuba, São Paulo, and Vitória, Espírito Santo, were analyzed. Residues of Dicofol were quantified in 15 liver and 16 fat samples from green turtles, nine of which were captured in Vitória, six in Praia Grande and one in Ubatuba. In the liver samples, Dicofol concentrations were 8.9 ± 20.6 ng g^{-1} lipid weight. In the fat samples, Dicofol concentrations were 81.7 ± 325.4 ng g^{-1} lipid weight.

Air

In a recent study, Rauert et al (2018), reported for the first time the presence of Dicofol indicators in atmospheric air in the Latin American and Caribbean region. Among the nine locations monitored in seven countries at the region, two sampling points were in Brazil. The monitoring took place between the years 2014 and 2015. The point located in the municipality of São José dos Ausentes, Rio Grande do Sul, was considered a control point, while the point located in the municipality of São Luís, Maranhão, was considered an urban point.

The Dicofol indicators, that is, its degradation products, were quantified only in the municipality of São Luís. In the year 2014, the presence of the p,p'-DCBP isomer was verified in the last two sampling periods (Jun-Sep: 3.9 pg m^{-3} and Sep-Dec: 4.6 pg m^{-3}). In the year 2015, only the first two sampling periods were monitored in São Luís and the *p,p'*-DCBP concentrations were 3.3 pg m^{-3} (Dec-Mar) and 2.1 pg m^{-3} (Mar-Jun).

The presence of Dicofol was not expected in an urban area. However, the authors suggested that the unique concentrations of the p,p'-DCBP isomer may originate from secondary emission sources, such as evaporation from soil or water, or even other chemical precursors, such as DDT, chlorobanzilate or chloropropylate. The ratio of o,p'-DDT/p,p'-DDT isomers also reinforced the use of the technical formulation of DDT in this region. Therefore, it cannot be said that the presence of the Dicofol indicator measured in the atmospheric air samples in São Luís, have their origin in the direct application of Dicofol.

2.3.2. Assessment of Polychlorinated biphenyl - PCBs (Annex A, Part II)

Although Brazil has actively worked to address the provisions of the Stockholm Convention regarding PCBs, the national inventory of PCBs was not reviewed/updated within this NIP-update project and basic information can be found in a document prepared by the MMA (MMA, 2015b).

The management and regulation of Polychlorinated Biphenyls have been addressed in Brazil since 1981, from the publication of the Interministerial Ordinance MIC/MI/MME nº 19, of January 29 of that year, which prohibited the manufacture, commercialization and use of PCBs in Brazil. In addition to this Ordinance, the following regulations were published:

- Normative Instruction SEMA/STC/CRS No. 01, of 1983, which disciplined the handling, storage and transport of PCBs and their residues;
- Standard ABNT NBR 8371, from the Brazilian Association of Technical Standards (ABNT), prepared by the Brazilian Electricity Committee in 1984, revised in 1997 and 2005, whose objective is to describe the ascarables (PCBs) for transformers and capacitors, their characteristics and risks, and establish guidelines for their handling, packaging, labeling, storage, transport, procedures for equipment in operation and final destination; and
- Law No. 14,250, of November 25, 2021, which provides for the controlled disposal of materials, fluids, transformers, capacitors and other electrical equipment contaminated by polychlorinated biphenyls (PCBs) and their waste.

From the technical point of view, the NIP-Brazil-2015 refers to a study published in 2000 that estimated the total existence of 130,000 metric tonnes of PCBs in Brazil, mainly owned by the power industry and other large industrial and commercial sectors (MMA, 2015b). In 2009, a survey-based inventory was carried out by ANEEL, which comprised 75 electricity transmission and 64 power distribution utilities. This inventory estimated that around 80% of the existing PCBs in Brazil were found in the electric power industry, representing a volume of 2,665 tonnes of liquid oils with PCBs.

In 2015, the MMA carried out another survey (ranging from 2012–2013) to evaluate PCB stocks, existing equipment in operation and out of use that contains PCBs, outside the power industry. It included large areas at risk, such as schools, shopping centers, hospitals and universities according to the priorities set forth in Annex A, Part II of the

Stockholm Convention (populated areas). The sample was made up of 3,339 items, identifying 1,904 items with PCBs contamination with 823.8 tonnes of oil suspected of contamination with PCBs. Approximately 80% of all equipment inventoried was found in the states of Sao Paulo (56%), Minas Gerais (15%) and Espírito Santo (8%) (MMA, 2015a).

According to Annex A (Elimination), Part II of the Stockholm Convention, Parties of the Convention are required to eliminate electrical equipment and oils containing PCBs from the use by 2025 and to manage those wastes using environmentally adequate practices and techniques by 2028. Based on the estimates from these PCB holding sectors, it was estimated that at least 51,516 tonnes of equipment contaminated with PCBs still require elimination before 2028. It was also estimated a PCB contaminated oil volume of 15,455 tonnes. It includes permeable solid waste of materials capable of absorbing PCBs, such as paper, cards, wood and other construction elements of transformers and capacitors. This is consistent with the estimated number of electrical transformers in the country, of about 8.1 million units, assuming that, by 2020, 70% of which belongs to the power companies and the remaining 30% to private owners (large industries) and third parties like sensitive sites. Considering that other countries in the Latin America and Caribe region present 6% of electrical transformers contaminated with PCBs, it can be estimated that 486,000 transformers contaminated with PCBs need to be eliminated or disposed of in an environmentally adequate manner in Brazil.

Recently, a noteworthy progress is the integrated environmental management of PCBs, which was leveraged through the implementation of the UNDP/GEF PCBs Project 63774[9] "Establishment of PCBs Waste Management and Disposal System in Brazil[10]" , an initiative formulated in accordance with the "NIP Action Plan for PCBs" included in the NIP-Brazil-2015. The implementation of the project started in 2009 and was completed in 2019 which contributed to the strengthening of the governmental and regulatory frameworks for the appropriate management of PCBs, the development of national capacity for technical personnel and the execution of five demonstration projects for the environmentally adequate management of PCBs, through the development of pilot inventories of PCBs in companies in the electric sector. The project also delivered the PCB Management Manual, recently published by the MMA.

It is important to highlight that a new initiative was approved by GEF in 2021. The Project BRA/21/G31 "Environmentally sound destruction of PCBs in Brazil"2 will provide Global

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[9] https://www.thegef.org/projects-operations/projects/3282

[10] https://www.thegef.org/projects-operations/projects/10368

Environmental Benefits in terms of reduction and disposal/destruction and avoidance of chemicals of global concern, eliminating 15,000 tonnes of PCBs contaminated wastes and directly benefiting the 211.7 million inhabitants of the country. This Project should result in the total inventory activities including volume calculations, the removal, decontamination and final disposal of electrical equipment and wastes identified as contaminated by PCBs, integrating technical, operational, economic and financial planning, definition of the criteria for choosing and implementing the Best Available Techniques and the Best Environmental Practices (BAT/BEP), taking into account the available methodologies and the environmental and safety criteria for self-sufficiency and functional recovery.

The country has conducted relevant initiatives to improve the management and elimination of PCBs, as they represent risks for workers, public health and the environment in the event of leaks, electrical failures and fires. The Ministries of Environment and Climate Change (MMA) and of Mines and Energy (MME) published the MMA/MME Interministerial Ordinance no. 107, of April 25, 2022, which regulates the controlled elimination of Polychlorinated Biphenyl (PCBs), approves the PCB Management Manual for electric equipment, and implements the PCB National Inventory System.

The actions aim at solving important challenges regarding the management of chemical products in Brazil; one from the environmental and financial aspects is logistics, given the long distances between the PCBs stockpiles with respect to the locations of the elimination/destruction companies and the major use of road transport. Further information can be found in the follow-up of the Action Plans established in the NIP-Brazil-2015 for PCBs, presented in Chapter 2.4.

2.3.3. Assessment of POP-PBDEs (Annex A), HBB (Annex A, Part I) and HBCD (Annex A, Part I and Part VII)

2.3.3.1. PBDEs in the Stockholm Convention (c-pentaBDE and c-octaBDE)

For the process of the NIP updating, the national inventory of POP-PBDEs (MMA, 2015b) was revised and updated from 2015 to 2020. (MMA, 2020c). The POP-PBDEs belong to a class of compounds that are widely used as flame retardants in a variety of materials. These compounds are found in several biotic components around the planet, reaching even remote areas (RAHMAN et al., 2001).

PBDEs may have from one to ten bromine atoms in its molecules. These atoms vary not only in number, but also in the position they occupy in the diphenyl rings. For this reason, there are 209 possible PBDE congeners. They are classified in homologue groups based on the number of bromine atoms and are identified by numeric prefixes (USEPA, 2010; ANNUNCIAÇÃO et al., 2018; RAHMAN et al., 2001). Commercial mixtures (c-) have been predominantly composed of c-pentaBDE, c-octaBDE and c-decaBDE, and may vary in congeners composition (LA GUARDIA et al., 2006; PESTANA & BORGES, 2008).

Due to their physicochemical characteristics, PBDEs have a wide variety of uses. Their main applications include civil construction, electronics, furniture, textile and carpet industries, means of transportation and recycling. PBDEs began to be commercially produced in the 1970s as flame retardants, to be applied by the industry (IPCS, 1994). In the 2000's, there was enough scientific evidence of PBDE deleterious effects on the environment and human health, mainly for c-pentaBDE and c-octaBDE mixtures, to warrant restrictions and prohibitions (UNEP, 2010a).

Commercial mixtures c-pentaBDE and c-octaBDE were listed in 2009 in Annex A of the Stockholm Convention, which establishes the elimination of use and production for these substances. However, countries may allow the recycling of articles that contain or may contain PBDEs, as well as the use and final disposal of articles manufactured from recycled materials that contain or may contain PBDEs, until 2030. The commercial product c-pentaBDE is a mixture that has a higher concentration of BDE-47, BDE-99 and BDE-100 (ANNUNCIAÇÃO et al., 2018). The commercial product c-octaBDE is a mixture of several congeners, including BDE-183, BDE-197, BDE-203, BDE-196, BDE-206, BDE-207, BDE-153, BDE-154, BDE-180, BDE-171, BDE-209.

POP-PBDEs in Brazil

The Stockholm Convention prohibits the production and use of c-pentaBDE and c-octaBDE since the fourth meeting of the Conference of the Parties on POPs, held from May 4 to 8, 2009. If signatories apply, they can request an exception for related substances, as is the case in Brazil, where "products containing this commercial mixture can still be used and recycled" until 2030.

In the European Union there is the Directive 2002/95/EU since 2003 (with updates in 2011 and 2015), known as RoHS (Restrictions of the use of Certain Hazardous Substances), which limits among other substances and elements the use of PBDEs in electrical and electronic equipment (EEE). In Brazil, there are still no specific regulations restricting the use of these substances in manufacturing processes in electro-electronic equipment. However, the Normative Instruction No. 1, of January 19, 2010 (BRASIL, 2010), which provides on the criteria for environmental sustainability in the acquisition of goods by the Federal Public Administration, determines in its Article 5:

> *IV. that the goods do not contain hazardous substances in a concentration above that recommended in the RoHS (Restriction of Certain Hazardous Substances) directive, such as mercury (Hg), lead (Pb), hexavalent chromium (Cr(VI)), cadmium (Cd), polybrominated biphenyls (PBBs), polybrominated diphenyl ethers (PBDEs).*

The Ministry of Environment and Climate Change prepared a Conama Resolution proposal in 2018 regarding the control of notably hazardous substances in electro-electronic equipment — Brazilian RoHS Working Group, in the scope of Conasq. This proposal has not yet been presented to the Conama, and it is necessary to evaluate whether it would still be pertinent to publish a Resolution on the subject.

In a study conducted with companies in Brazil, it was identified that foreign companies adopted RoHS for commercialization in Europe and, expanding to all products, regardless of the market of operation. National companies, on the other hand, adopted the directive for participation in government sustainable procurement bids (BRESCANSIN et al., 2015). Despite the restrictions on the use of the compounds, there is no impediment for goods prior to the ban to continue to be used and recycled, and this may contribute to the release of these contaminants into the environment.

Production of POP-PBDEs

The previous NIP-Brazil-2015 did not identify c-penta or c-octaBDE production in Brazil (MMA, 2015b). For the development of the current inventories, the MMA sent queries to over 700 companies, 26 industry federations, 38 environmental secretariats and 234 CONASQ representatives (MMA, 2020c). Replies were less than expected and none replied with relevant information on c-penta or c-octaBDE production. Therefore, c-penta and c-octaBDE mixtures seem to not have been produced in Brazil.

Trade of POP-PBDEs

Brazil's foreign trade statistics were accessed through the Comex Stat. Currently, products containing PBDEs do not have specific custom codes and are traded using generical codes also used for products that does not contain PBDEs (MMA, 2020c). From 1989 to 1996, foreign trade was tracked using the Brazilian Nomenclature of Goods, (Portuguese acronym NBM) codes. There was a NBM code for decabromo-diphenyl, probably referring to decaBDE mixtures. Despite extensive searching, no specific NCMs or NBMs for c-penta- or c-octa-BDE were found (MMA, 2020c). According to ANNUNCIAÇÃO et al. (2018), there are no records on the production of flame retardants containing PBDEs in Brazil, and the use of these substances is carried out through imports.

A query was sent to IBAMA — consenting agency for the import of some substances controlled by the Stockholm Convention —, which informed that it is not responsible for the licensing of PBDEs.

There are import records for the generic NCM codes, which includes brominated derivatives, halogenated derivatives, with bromine only, and aromatic ethers, but they cannot be safely used to assess the truth volume of POP-PBDEs imported into Brazil (MMA, 2020c). Despite the lack of specific data for the import of commercial mixtures, it is likely that a large number of consumer goods containing POP-PBDEs were imported into the country. Therefore, assessing the mass fraction of POP-PBDEs in consumer goods is very important to understand the relevance of POP-PBDEs in the Brazilian waste management, recycling streams and environment.

Estimates of POP-PBDEs in the polymeric fraction of electrical and electronic equipment and its waste in Brazil

The largest share of POP-PBDE commercial mixtures have been applied as flame retardants in plastic polymers of certain electrical and electronic equipment (EEE) and related waste (WEEE), mainly in Cathode Ray Tube (CRT) casings. Thus, the inventory of such equipment in the country provides a good estimate of the rate of POP-PBDEs, especially for c-octaBDE (hexa and heptaBDE), which was the most widely used mixture in this type of equipment (SINDIKU et al. 2014; WAEGER et al. 2010).

Estimates of POP-PBDEs in plastics from CRT monitors and televisions in Brazil – Tier I

Among electronic equipment, TVs and tube monitors are known for the high amount of PBDEs (WÄGER et al. 2010). To make this estimate, it was necessary to identify the occurrence rate of these products in the country, through comparison to countries of similar economic development and consumption habits (UNEP, 2021). Besides this, the "32nd FGVcia Annual Survey: IT Use in Companies" (MEIRELLES, 2021) and the "National Household Sample Survey" (PNAD), conducted by the Brazilian Institute of Geography and Statistics (IBGE), were used to obtain recent data about these consumer goods. PNAD provides indicators for general household characteristics, including the ownership of goods and services, contemplating, for example, the ownership of television and microcomputers (see Table 10 for some of those goods).

In PNAD, the differentiation between tube and LCD TVs only started to be carried out from 2013, when the use of CRTs was already reduced due to the adoption of LCD and plasma TVs. As of 2015, the number of thin-screen TVs surpassed the number of CRT tube TVs, the estimated number was 104.6 million sets (97.1% of households owned at least one TV), with approximately half of them being tube TVs (44.5% - IBGE, 2013; 2015). According to another survey by Fundação Getúlio Vargas (FGV), the total number of TV sets in the country is estimated at 260 million (MEIRELLES, 2020), if we consider that tube TVs are present in only 26% of households according to the most recent data (PNADc, 2019), we could estimate at least 68 million tube TVs. The total number of computers in the country was estimated at 198 million, 102 million of which are portable (Notebooks + Tablets), that is, with LCD screens (MEIRELLES, 2020). If we apply the same proportion of CRT:LCD TVs, we would have 26% of desktops with tube monitors (24 million). Adding up TVs and computers with CRT monitors, we would arrive at 92 million, or 0.43 per capita, a value slightly lower than that estimated by the 2015 NIP (0.53 CRT per capita). This value is higher than the average stipulated for Latin America (0.36%), but lower than that calculated for North America (1.11%) (GREGORY, 2009).

Following the most recent guidance on preparing inventories of POP-PBDEs (UNEP, 2021), the Brazilian population size (213,680,044 people), the estimated number of CRT monitors and televisions per capita (0.53), the average weight (25 kg) and polymer content (30%) of CRTs and the estimated POP-PBDE content ([0.00047 + 0.00137] /2) applied in those products were used to assess the total amount of POP-PBDEs and impacted plastics in Brazil (MMA, 2020c). The total amount of impacted plastics was estimated at 849,378.2 tonnes and the content of c-octaBDEs in plastics from CRT monitors and televisions in Brazil was estimated ranging from 399,208 kg to 1,163,648 kg; in average 781,427.9 kg (MMA, 2020c).

Considering that currently the recycling rate of WEEE in Brazil still below 3% of the total generated (GREENELETRON, 2021), it is possible that the largest part of CRT monitors and TVs have already been disposed of. In addition, since in Brazil most of the municipal solid waste is disposed of in landfills or discarded irregularly, it can be expected that a considerable amount of PBDEs might have been released into the environment, mainly nearby landfills and dumping sites.

Estimates of POP-PBDEs in plastics from other relevant EEE in Brazil – Tier II

POP-PBDEs may be present in different fractions of EEE, and therefore further estimation should be performed. The objective of this part is then to estimate the total volume of POP-PBDEs in EEE and the WEEE. This requires information on the amount of EEE and WEEE in the country, the relevant polymers contained in this equipment, and the amount of POP-PBDEs in each of these polymers. Information on recycled polymers and the amount of imported WEEE is essential. In the end, the total POP-PBDEs in EEE and the volume of impacted plastic can be calculated (UNEP, 2021).

$$M_{PBDE\ (i)} = M_{EEE\ (j)} \times f_{Polymer\ (k)} \times C_{PBDE\ (I);\ Polymer(k)}$$

Where: $M_{PBDE\ (i)}$ = quantity of PBDEs (i) in polymer (k) of EEE (j) expressed in kg;

$M_{EEE\ (j)}$ = amount of EEE (j) imported, stored or entering the waste chain, expressed in tonnes;

$f_{Polymer}$ = total fraction of polymer by weight (%);

$C_{PBDE(i);\ Polymer}$ = PBDE content (hepta/hexa/BDE) (i) in the total polymer fraction [kg/tonne].

For the development of a comprehensive inventory, consideration of the main categories of consumer goods containing PBDEs is required (Table 10). In addition, the inventory must address the three stages of the lifecycle of EEE: Import of new or used

EEE; EEE in use or stocked; and waste of EEE (WEEE).

Table 10: Expected presence of PBDEs in categories of electrical and electronic equipment. Adapted from UNEP (2021)

	EEE category	PBDE content
1	Large domestic appliances	• Not present or at average concentrations at least one order of magnitude below 0.1% by weight • Heating appliances around 0.1% by weight
2	Small domestic appliances	• Expected concentration considerably below 0.1% by weight
3	IT and telecom equipment	• Average concentrations in CRT computer monitors above 0.1% by weight and in other products below or around 0.1% by weight
4	Consumer Equipment	• Average concentrations in CRTs and LCD TVs above 0.1% by weight and in other equipment at average concentrations below or around 0.1% by weight

Source: Prepared by the author

Imported EEE and WEEE

The entry of other relevant EEE into the country was evaluated using the Comex Stat database (Table 11). The period was divided from 1997 to 2005 (beginning of the database until the end of the period of intense use of POP-PBDEs) and 2006 to 2020 (after the longest period of POP-PBDE use). These data totaled 601,557,849 kg of imported equipment for the period 1997–2005 and 3,406,902,636 kg for the period 2006–2020. However, only EEE imported (other than CRTs) in the period of intense use of POP-PBDEs were considered in this estimate.

Table 11: Imports of EEE from 1997 to 2020 (cont.)

EEE category	Description	HS Code	Imports 1997-2005 (kg)	Imports 2006-2020 (kg
1	Ironing machines and presses, including fusing.	845130	2,142,413	6,157,348
1	Other ovens; stoves, cooking plates, boiling rings; grillers and roasters, electrothermic, for domestic use.	851660	7,351,986	209,832,500
1	Electric instantaneous or storage water heaters and immersion heaters; electric space-heating apparatus and soil-heating apparatus; electrothermic hairdressing apparatus (for example, hairdryers, hair curlers).	8516	112,813,052	1,150,193,585
3	Automatic data-processing machines and units thereof; magnetic or optical readers, machines for recording data on a carrier medium in coded form and machines for processing such data, not elsewhere specified or included.	8471	165,729,146	313,520,655
3	Printing machinery used for printing by means of the printing type, blocks, plates, cylinders and other printing components of heading 8442; ink-jet printing machines, other than those of heading 8471; machines for uses ancillary to printing.	8443	76,274,910	712,523,502
3	Calculating machines and pocket-size data-recording, reproducing and displaying machines with calculating functions; accounting machines, postage-franking machines, ticket-issuing machines and similar machines, incorporating a calculating device.	8470	7,787,516	34,216,520

Table 11: Imports of EEE from 1997 to 2020 (continued)

Categoria do EEE	Descrição	HS Code	Quantidade importada 1997-2005 (kg)	Quantidade importada 2006-2020 (kg
3	Electrical apparatus for line telephony or line telegraphy, including line telephone sets with cordless handsets and telecommunication apparatus for carrier-current line systems or for digital line systems; videophones.	8517	69.211.036	457.437.220
4	Reception apparatus for radio-telephony, radio-telegraphy or radio-broadcasting, whether or not combined, in the same housing, with sound recording or reproducing apparatus or a clock.	8527	80.474.807	238.173.720
3 e 4	Reception apparatus for television, whether or not incorporating radio-broadcast receivers or sound or video recording or reproducing apparatus; video monitors and video projectors.	8528	14.688.759	124.350.103
4	Turntables (record-decks), record-players, cassette-players and other sound reproducing apparatus, not incorporating a sound recording device.	8519	8.936.199	3.052.310
4	Video recording or reproducing apparatus, whether or not incorporating a video tuner.	8521	27.592.598	123.831.726
4	Transmission apparatus for radio-telephony, radio-telegraphy, radio-broadcasting or television, whether or not incorporating reception apparatus or sound recording or reproducing apparatus; television cameras; video camera recorders.	8525	28.555.427	33.613.447
Total			**601.557.849**	**3.406.902.636**

Source: ComexStat (2021)

In Brazil, the importation of used EEE is prohibited, with some specific exceptions according to DECEX N°8, of 13/05/1991. Brazil has also ratified the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (Decree No. 875/1993), which establishes control mechanisms for import and disposal of hazardous products (including EEE). Also noteworthy are the National Solid Waste Policy (Law No. 12.305/2010) and CONAMA Resolution No. 452/2012, which prohibits and presents control procedures for importing hazardous waste and tailings. Thus, used EEE import data were not considered in this estimate.

Therefore, considering the total amount of relevant EEE imported from 1997 to 2005, their respective mass fraction of polymers and PBDE content (Category 1 = 0.05; category 3 = 0.12; category 3 and 4 = 0.10; and category 4 = 0.08), it was estimated that around 210,213,057 kg of plastics would need be treated in an environmentally adequate manner and that around 21,160 kg of c-octaBDE could be released to the environment from those imported EEE (MMA, 2020c).

EEE in use or stored with consumers

Stocks of EEE in use or stored with consumers can be divided into 3 groups: private consumers (households); institutional consumers (public institutions, government, health and education sectors); corporate consumers (hotels, industries and businesses). Since most POP-PBDEs are present in computer and TV (CRT) monitors, private consumers' stocks are likely to represent the largest proportion, as they tend to keep the products for longer, as well as buy second-hand equipment. Institutional consumers tend to stock old equipment for a longer period of time, as do private consumers. Corporate consumers, however, change equipment more frequently and therefore should have fewer problematic stocks with respect to PBDE contamination. Table 12 presents the current usage data for the analyzed assets, as well as the estimated c-octaBDE content.

Table 12: Quantity of electro-electronic equipment stored or in use and estimated c-octaBDE.

Equipment	Quantity	Mean weight	Stocked quantity	Total plastic (%)	C-octaBDE in EEE plastic	Total impacted plastic (tonnes)	Total c-octaBDE mass fraction (kg)
	[millions]	[kg]	$M_{EEE\ (j)\ stocked}$ [tonnes]	$F_{Polymer}$ [%-mass]	$C_{PBDE\ (I);\ Polymer(k)}$ [kg/tonnes]	$M_{EEE\ (j)\ stocked} \times F_{Polymer\ (k)}$ [%-mass]	$M_{PBDE\ (i)} = M_{EEE\ (j)} \times f_{Polimero\ (k)} \times C_{PBDE\ (I);\ Polimero(k)}$
TV[1,2]	*260*						
-- CRT	68	31.6	2,148,800	30	0.47	644,640	302,980.8
-- Flat Screen	192	13.0	2,496,000	37	0.009	923,520	8,311.68
Computers[2]	*198*						
-- Laptop and Tablet	102	1.5	153,000	42	0.12	64,260	7,711.2
-- Desktop	88	9.9	871,200	42	0.12	365,904	43,908.48
Monitors	*88*						
-- CRT	24	14.1	338,400	30	1.37	101,520	139,082.4
-- Flat Screen	64	4.7	300,800	37	0.009	111,296	1001.66
Cell phone	242	0.1	24,200	42	0.12	10,164	1,219.68
Total						**2,221,304**	**504,215.9**

Source: MMA (2015), UNEP (2021), [1]IBGE (2015), [2] MEIRELLES (2020)

Thus, considering the information raised in the updated national inventory of POP-PBDEs (MMA, 2020c), the amount of c-octaBDE in the polymeric fraction of EEE stored in households, public and private institutions was 504,215.9 kg. The total amount of impacted plastics was estimated at 2,221,304 tonnes.

Estimates of POP-PBDEs in the polymeric fraction of WEEE

The amount of PBDEs in WEEE can be estimated according to the formula:

$$M_{PBDE;\ WEEE(j)} = M_{WEEE(j)} \times f_{Polymer} \times C_{\Sigma hexa/heptaBDE\ or\ decaBDE\ in\ polymers}$$

Where: $_{MPBDE;\ WEEE\ stocked(j)}$ = amount of decaBDE + hexa/heptaBDE in WEEE(j) in [kg];

$M_{WEEE(j)}$ is the amount of WEEE(j) generated in a year [tonne];
$f_{Polymer}$ = total polymer fraction in [weight-%];
$C_{PBDE(i); Polymer}$ = PBDEs content (hepta/hexa/BDE or decaBDE) (i) in the total polymer fraction [kg/tonne].

To perform this estimation, the paper "Reverse Logistics of Electrical and Electronic Equipment. Technical and Economic Feasibility Analysis" by (ABDI, 2012), was used. The same as in NIP 2015 (MMA,2015) with updated PBDEs content values (UNEP, 2021). Small waste encompasses television/monitor, LCD/plasma, DVD/VHS, audio products, desktop, notebooks, printers, cell phones, mixer, blender, electric iron, drill. The value used in the calculation for small waste is the estimate for the year 2020, of 540,000 tons of WEEE (ABDI, 2012). According to MEIRELESS (2021), the annual sale of cell phones is 4x greater than that of televisions, while the TV:computer ratio is 1:1. With this, we can consider that at the very least we would have the generation of category 3 waste (CRT monitor, LCD monitor, Desktop PC, Laptop, Printer, Mobile phone) 2x greater than category 4 waste (CRT-TV, Flat Screen TV, Radio, HiFi and others). That is, 360,000 tons of category 3 equipment, and 180,000 tons of category 4 waste. The percentage of equipment chosen was based on the percentage obtained from the equipment inventory profile in Table 12. The values used in the estimate are shown in Table 13. Considering the most relevant categories, around 229,443 tonnes of plastics contaminated with PBDEs might be disposed of per year in Brazil. This estimate resulted in approximately 31,718.5 kg of c-octaBDE being disposed of alongside WEEE in the country.

Small waste includes television/monitor, LCD/plasma, DVD/VHS, audio products, desktop, notebooks, printers, cell phones, mixer, blender, electric iron, drill and others. The value used in the calculation for small waste is the estimate for the year 2020, 540,000 tons of WEEE (ABDI, 2012). According to MEIRELES (2020), the annual sale of cell phones is 4x higher than that of televisions, while the TV:computer ratio is 1:1. With this, we can consider that at least we would have the generation of waste category 3 (CRT monitor, LCD monitor, PCDesktop, Laptop, Printer, Mobile) 2x greater than the waste category 4 (CRT-TV, Flat Screen TV, Radio, Hi-Fi and others). That is, 360,000 tons of category 3 equipment and 180,000 tons of category 4 waste. The percentage of equipment chosen was based on the percentage obtained from the estimate of Brazil's National Implementation Plan for the Stockholm Convention on Persistent Organic Pollutants 103EEE in use and stored in the country. Considering the most relevant categories (MMA, 2020c), about 229,443 tons of plastics contaminated with

PBDEs can be discarded annually in Brazil. This estimate resulted in approximately 31,718.5 kg of c-octaBDE being discarded along with WEEE in the country.

Table 13: Amount of c-octaBDE in WEEE.

Relevant Category	Amount of WEEE	Total Polymer Fraction	C-octaBDE in Plastics	Total c-octaBDE mass fraction (kg)
	$M_{WEEE(j)}$ [tonne]	$f_{Polymer}$ [%-mass]	$C_{PBDE(i); Polymer}$ [kg/tonne]	$M_{PBDE; WEEE(j)} = M_{WEEE(j)} \times f_{Polymer} \times C_{\Sigma hexa/heptaBDE\ or\ decaBDE\ in\ polymers}$ [kg]
EEE without CRT (cat 3)	342,000	42	0.12	17,236.8
Monitor computer CRT (cat 3)	18,000	30	1.37	7,398
TV CRT (cat 4)	47,100	30	0.47	6,641.1
Flat screen TV (cat 4)	132,900	37	0.009	442.6
Total				**31,718.5**

Source: Prepared by the author.

Estimates of POP-PBDEs in the transport sector

The transportation sector constitutes one of the largest material goods flows and is therefore highly relevant to waste flow and management (UNEP 2021a; VERMEULEN et al. 2011). C-decaBDE has been extensively used in vehicles and is the main flame retardant found in vehicles in Japan (KAJIWARA et al. 2014). Studies conducted in Japan show that cars produced before the 2000s had high average decaBDE content, corresponding to approximately 80 g decaBDE per vehicle. Concentrations reduced to approximately 24 g decaBDE in a passenger car produced after the 2000s (Japanese Ministry of Environment, MOE, 2011). Whereas c-pentaBDE was mostly used in US vehicles (ALCOCK et al. 2003; ABBASI et al. 2014) and are only detected at high levels in US produced cars produced before 2005 (LIU et al. 2019; LESLIE et al. 2013). Worldwide vehicle production can be considered to contain no decaBDE as of 2017(UNEP,2021).

Cars, trucks and buses are the largest part of the transport sector, containing the largest volume of PBDEs (UNEP,2021) and therefore the focus of this inventory will be on these vehicles, as performed in the 2015 NIP (MMA, 2015). For practical calculation purposes, vehicles produced before 2005 will be estimated to contain 80 g PBDEs, while vehicles produced from 2005 to 2017 are estimated to contain 20 g PBDEs (UNEP,2021). For all regions where studies have been conducted decaBDE is the dominant congener, and for vehicles produced in the US before 2005, a 50% percentage of c-pentaBDE should be assumed.

To estimate the fraction of PBDEs in vehicles in the country we use the following formula:

PBDEs in vehicles = Vehicles (1970-2004) x 80 g decaBDE*/ vehicle + Vehicles (2005-2017) x 20 g/vehicle

**For vehicles imported from the US a content of 40 g decaBDE and 40 g c-pentaBDE was considered in vehicles produced before 2005.*

Data on production, domestic sales, exports, imports, of motor vehicles (1970 to 2017) were obtained by the National Association of Motor Vehicle Manufacturers (ANFAVEA). Vehicle imports were only released from 1990 onwards. The summarized data was presented in Table 14, this was the data used for the calculation. To understand the percentage of vehicles imported from each country, especially those imported from the US before 2005, the Comex Stat was consulted for the respective NCMs (categories 8702, 8703, 8704, 8705, 8427). For the calculation, two sets of data were used: historical data between 1989 and 1996, only available in NBM codes, whose validity ended in 1996; and the most recent import data (1997-2017) were obtained from the database in NCM. The latter, besides presenting data on total weight and imported value, brings the quantity of imported vehicles. The NBM data, however, only provides information about the total weight and value imported, so the calculation had to be adapted for these two sets of data.

From 1990-1996 the percentage of vehicle imports related to each country and year was calculated based on the total weight imported, while for the 1997-2017 data the percentage was calculated based on the quantity of imported vehicles (providing a more accurate estimate). After calculating the percentage regarding cars imported from the US (for the pentaBDE estimate), this percentage was multiplied by the data from the ANFAVEA database to finally have the estimate of cars imported from the US. With this, for cars imported from the US a content of 40 g decaBDE and 40 g c-pentaBDE was considered in vehicles produced before 2005.

Table 14: Estimated number of vehicles in the country.

Period	Total licensing	Domestic licensing	Imported Licensing	Production	Export	US Import (%)	US import total
1970-2004	35,634,717	33,307,220	2,327,497	38,172,261	4,838,518	11.2	259,825
2005-2017	37,141,429	31,207,111	5,934,318	38,124,779	7,028,253	--	--

Source: ANFAVEA (2021) and ComexStat (2021)

With this data we can estimate the total burden (c-pentaBDE and c-decaBDE) in the vehicle sector:

c-pentaBDE: US Imports (1970–2004) x 0.040 kg = 0.040 x 259825 = 10,393 kg

c-decaBDE: [Vehicles (1970–2004*) x 0.080 kg] + [Vehicles (2005–2017) x 0.020] + [US Vehicles (1970–2004) x 0.040 kg*] = [35,374,892 x 0.080 kg] + [37,141,429 x 0.020] + [259,825 x 0.040] = 3,583,213 kg

** Total licensing, with the exception of vehicles imported from the USA, which are considered to have 50% of the c-pentaBDE load.*

Besides the total quantity, it is also necessary to verify which of these vehicles are still in use and which have reached the end of their useful life, to then estimate the loads for these two categories. These data were obtained through analyses performed by the National Union of the Automotive Vehicle Component Industry (SINDIPEÇAS, 2018). The average age of the Brazilian vehicle fleet in the year 2017 was 9 years and 7 months, with vehicles from 2005 to 2017 representing approximately 76.5% of the fleet, while vehicles from 2004 on down represent approximately 18%. The total number of vehicles in the circulating fleet is estimated at over 43 million vehicles, approximately 60% of the total ever licensed. Through these data we can observe that of the vehicles from 1970-2004 (37,141,429), only 10,212,225 are still in use (27%). As for the vehicles from 2005-2017 (37,141,429), 33,158,775 are still in use, or approximately 89%.

From these data we can estimate the burden of PBDEs (c-pentaBDE and c-decaBDE) in vehicles in use:

c-pentaBDE: US Imports (1970–2004) x 0.040 kg (pentaBDE) x (% dos veículos ainda em uso) = 0.040 x 259825 x 0.27 = 2806.2 kg

c-decaBE: [Vehicles (1970–2004*) x 0.080 kg x (% of vehicles still in use)] + [Vehicles (2005–2017) x 0.020 kg x (% of vehicles still in use)] + [US Vehicles (1970–2004) x 0.040 kg* x (% of vehicles still in use)] = [35,374,892 x 0.080 kg x 0.27] + [37,141,429 x 0.020 x 0.89] + [259,825 x 0.040 x 0.27] = 1,428,021 kg

**Total licensing, except for vehicles imported from the USA, which are considered to have 50% of c-pentaBDE load.*

Therefore, it was estimated that 10,393 kg of c-pentaBDE has been imported to Brazil in vehicles. Among these, it is estimated that the vehicles currently in use may still contain around 2,806.2 kg of c-pentaBDE (MMA, 2020c).

Occurrence of PBDEs in Brazil

A systematic review of the scientific literature regarding PBDEs in Brazil was conducted in the reviewed and updated inventory of PBDEs in Brazil. The aim was to investigate the occurrence of PBDEs in environmental samples as well as in consumer goods. The review protocol found 43 studies, in most of which the authors measured the substances in biotic samples (MMA, 2020c).

Most of the studies on biotic samples investigated marine aquatic ecosystems. It is plainly clear, from the review, that c-pentaBDE seems to be the main contributor to the total PBDE concentration in marine organisms from Brazil. Concentrations were measured in fishes, crustaceans, mollusks, seabirds and marine mammals. In the majority, BDE-47 was the congener with higher concentrations and occurrence, usually followed by BDE-99. The studies also point out that organisms in coastal zones have higher concentrations of PBDEs when compared to those in isolated oceanic islands (MMA, 2020c). BDE-47 was also the congener with higher concentrations in one study investigating human fat tissues (KALANTZI et al., 2009). There were two studies investigating the occurrence of PBDEs in food, one in honey and the other in eggs (MOHR et al., 2014; SOUZA et al., 2019). Both found BDE-47 to be the main contributor to total PBDEs. These further points out to the presence of c-pentaBDE in Brazil (MMA, 2020c).

The studies found on PBDEs in abiotic matrices include the measurement of these compounds in the atmosphere, water, sediment, soil, dust and leaching in landfills. Regarding sediment of water bodies, three studies have found a contribution of c-pentaBDE congeners (mainly BDE-47). This may indicate the presence of c-pentaBDE in consumer goods which are incorrectly discarded, leaving chemicals exposed to leaching to water bodies (MMA, 2020c).

Two studies measured PBDEs, among other brominated flame retardants, in indoor environments and a landfill. Both studies found BDE-99 and BDE-209 were the major contributors to PBDE concentrations. These congeners are predominant in c-penta and c-decaBDE mixtures. Also, the studies show that offices and cars tend to have higher concentrations of PBDEs when compared to houses or schools (MMA, 2020c).

Regarding atmospheric concentrations of PBDEs, there were three studies (MEIRE et al., 2012; RAUERT et al., 2018a; SAINI et al., 2020). One of them investigates the occurrence of PBDEs in mountainous National Parks and the other two in urban areas. While concentrations were below detection levels in the parks, they were measured in two different urban areas, São Paulo and São Luís. In 2014-2015, commercial mixture pentaBDE congeners were predominant in São Luís. In 2018, BDE-209 were predominant in São Paulo, followed by BDE-47 and BDE-99, indicating the presence of decaBDE and pentaBDE commercial mixtures (MMA, 2020c).

2.3.3.2. decaBDE in the Stockholm Convention

PBDEs are commercialized under different commercial mixtures, with different PBDEs congeners. The commercial mixture decaBDE mainly consist of the congener BDE-209, which have ten bromine atoms (ATSDR, 2017). It was used as an additive flame retardant in many polymers and textiles (UNEP, 2013b). Plastics and electronics may be responsible for 90% of decaBDE usage (UNEP, 2015a). It was also used in vehicles and construction (BSEF, 2007).

Global production of PBDEs started in the 1970's. From 1970 to 2005, it is estimated that more than one million tonnes of decaBDE were produced and commercialized in the world (UNEP, 2014b). With penta and octaBDE commercial mixtures prohibitions in the 2000's in the United States and Europe, decaBDE production rose (PIERONI et al, 2017; ATSDR, 2017). Sales declined in 2013, after two out of three major world decaBDE producers ceased production (VECAP, 2014; REDFERN et al, 2017).

Emissions from commercial mixtures can occur throughout the life cycle of PBDEs, with an emphasis on the production, use and management of waste, such as landfills and incineration (REDFERN et al, 2017). They are ubiquitous, being found in several environmental matrices, both biotic and abiotic (UNEP, 2013b). Regarding decaBDE, it seems to be less toxic than congeners present in penta- and octa- commercial mixtures (UNEP, 2013b). However, once exposed to environmental conditions, decaBDE may suffer transformation through debromination, generating less brominated PBDEs, mainly from hepta-, octa- and nonaBDE groups (CHRISTIANSSON et al, 2009; UNEP, 2013b).

In 2017, decaBDE was listed in the Stockholm Convention, under annex A, to have its production and use prohibited in signatory countries. There are, however, specific exemptions a Party can apply to in which production and use are permitted.

Assessment of decaBDE in Brazil

Brazil submitted a request for a specific exemption for the use of decaBDE. Brazil may use decaBDE in vehicles as listed in paragraph 2, part IX, of annex A, until the end of their lifespan or until 2036, whichever comes first (BRAZIL, 2018b).

From 771 stakeholders consulted, only one reported to have used decaBDE. The stakeholder informed to have used 1,041 kg of decaBDE as flame retardant over 10 years.

The National Inventory of New Persistent Organic Pollutants (New POPs) for industrial use (MMA, 2015a), of the Stockholm Convention, made an inventory covering pentaBDE and octaBDE. However, the inventory also covered decaBDE and obtained the following response: "One company, linked to the food and beverage sector, declared that it has already imported products with PBDEs and that it uses and/or manufactures products with decaBDE, but it did not indicate the quantities used and imported of these substances. This company also stated that it recycles products that may contain PBDEs and described some environmental management measures for the recycling operations: selective collection, destination to an authorized company and treatment of sanitary sewage." In addition, one company reported that it does not know if it has ever imported decaBDE, another reported that it did not know if it had imported pentaBDE, octaBDE and decaBDE, and one last company stated that it had no knowledge about the presence of PBDEs in articles in use at its facilities. One plastics and polymers industry also stated that it did not know whether it had ever imported products containing PBDEs (MMA, 2015a).

The inventory also reported responses from electrical and electronics companies, citing three industries that stated "that parts used in the production of electrical and electronic equipment were considered to be suspected of containing PBDEs." One of the companies indicated the use of decaBDE in concentrations lower than 0.1% by weight or homogeneity of the material, which is within the limit stipulated by the Normative Instruction no. 01, of January 19, 2010, which provides on the criteria of environmental sustainability in the acquisition of goods, contracting of services or works by the direct Federal Public Administration, autonomous and foundational, and other provisions. This normative instruction follows the parameters set by the RoHS, which was issued in 2003 (Directive 2002/95/EU), by the Parliament and Council of the European Union (BRASIL, 2010a). In this response, the company declares the use of decaBDE and knowledge of the restrictions on PBDEs. We can notice the low participation of companies and associations, both in the National Inventory of New Persistent Organic Pollutants (New POPs) for industrial use (MMA, 2015a), and in the current one. This low interaction makes it difficult or even impossible to obtain reliable results regarding the life cycle of c-decaBDE in the country.

Pireroni and colleagues (2017) highlight the deficiency of legislation regulating PBDEs and report the Senate Bill No. 173 of 2009, which was shelved in 2011. This bill proposed that computers, computer components and computer equipment in general marketed in Brazil should have a concentration of less than 0.1% of PBDEs (BRASIL, 2009). The authors also highlight the Normative Instruction No. 01 of January 19, 2010, which provides on the criteria for environmental sustainability in the acquisition of goods, contracting of services or works by the direct federal public administration, autarchic and foundational and other provisions. Art. 5 of chapter III of this instruction states that "the agencies and entities of the direct, indirect and foundational Federal Public Administration, when acquiring goods, may require the following environmental sustainability criteria IV - that the goods do not contain hazardous substances in concentrations above those recommended in the RoHS directive, such as mercury (Hg), lead (Pb), hexavalent chromium (Cr(VI)), cadmium (Cd), biphenyl-polybrominated biphenyls (PBBs) and polybrominated diphenyl ethers (PBDEs)" (BRASIL, 2010a). RoHS was issued in 2003 (Directive 2002/95/EU) by the Parliament and Council of the European Union, subsequently recast into Directive 2011/65/EU on June 8, 2011 (OJEU, 2003; MMA, 2019a). RoHS ensures that EEE placed on the market, including cables and spare parts for their repair, reuse, functionality upgrades or capacity improvements, do not contain the above-mentioned substances. However, for the purposes of this Directive, a maximum concentration by weight in homogeneous materials is tolerated. Under RoHS (Directive 2011/65/EU), polybrominated diphenyl ethers (PBDEs) can be a maximum of 0.1% in homogeneous materials, e.g, a material of entirely uniform composition, or a material consisting of a combination of materials that cannot be separated or fragmented into different materials by mechanical actions such as unscrewing, cutting, crushing, grinding or abrasive processes (EU, 2011).

However, Normative Instruction no. 01 of January 19, 2010 does not take a position on the exemptions of Directive 2011/65/EU, set out in Article 2, scope, item 4. (EU, 2011). It is worth noting that the categories of EEE covered by this directive are: large household appliances, small household appliances, IT and telecommunication equipment, consumer equipment, lighting equipment, electrical and electronic tools, toys, and sports and leisure equipment, medical devices, monitoring and control instruments, including industrial monitoring and control instruments, vending machines, and other EEE not included in any of the above categories (EU, 2011).

The Ministry of Environment reports on its website that much remains to be done, posting: "Note that item IV of IN 01/2010 mentions compliance with the RoHS directive in public procurement. However, Brazil still does not have a specific standard that restricts the use of these hazardous substances in manufacturing processes of electro-electronic equipment. Thus, considering the need to build mechanisms to protect human health, including workers who work in the manufacturing, recycling and disposal of this equipment, and consumers who use the products, as well as the environment as a whole, it is necessary and urgent to develop national strategies for the proper management of these products. Therefore, the Department of Environmental Quality and Waste Management (DQAR), of the Secretariat of Water Resources and Environmental Quality (SRHQ) of the Ministry of the Environment is preparing a proposal for a regulation appropriate to the national reality in relation to the control of substances that are notably hazardous in EEE" (MMA, 2019a). Aiming to discuss and propose the strategies, institutional arrangements and draft legislation, the National Commission on Chemical Safety (CONASQ) created the Brazilian RoHS Working Group in 2018 for the formation of standards suitable for the country, which will come out as a resolution of the National Environment Council (CONAMA). However, the last meeting was held on December 6, 2018 (MMA, 2018b; MMA, 2019a).

The following year, the Ministry of Environment, through the National System of Information on Solid Waste Management (SINIR), opened a public consultation, through Ordinance No. 464, of July 30, 2019, with a deadline between 01 and 30/08/2019, on the proposal of a Sector Agreement for the implementation of Reverse Logistics System for Household Electrical and Electronic Products and their components (BRAZIL, 2019). The object of this Sector Agreement is the structuring, implementation, and operationalization of a Reverse Logistics System for Household Electrical and Electronic Products and their components placed on the domestic market (MMA, 2019c).

The National Solid Waste Management Information System (SINIR) is one of the Instruments of the National Solid Waste Policy (PNRS) instituted by Law No. 12,305, of August 2, 2010, and regulated by Decree No. 7,404, of December 23, 2010 (MMA, 2019d). Law No. 12,305, which establishes the National Solid Waste Policy, provides on its principles, objectives and instruments, as well as on the guidelines concerning the integrated management and management of solid waste, including hazardous waste; the responsibilities of generators and of the government; and the applicable economic instruments (BRASIL, 2010b). The National Solid Waste Policy instituted the principle of shared responsibility for the life cycle of products, through which manufacturers, importers, distributors, and traders must take the measures provided by law to ensure the implementation and operationalization of reverse logistics systems for the product chains under their responsibility (MMA, 2019c). Reverse logistics is defined as the instrument of economic and social development characterized by a set of actions, procedures and means aimed at enabling the collection and return of solid waste to the business sector, for reuse, in its cycle or in other production cycles, or other environmentally appropriate final destination (BRASIL, 2010b).

It is worth noting that, in Article 13, solid waste can be classified according to its hazardousness, being defined as hazardous waste those that, due to its characteristics of flammability, corrosivity, reactivity, toxicity, pathogenicity, carcinogenicity, teratogenicity and mutagenicity present significant risk to public health or environmental quality, according to law, regulation or technical standard (BRASIL, 2010b), thus covering waste that has decaBDE.

Signed on October 31, 2019, the Sector Agreement for the Implementation of a Reverse Logistics System for Household Electrical and Electronic Products and their Components was made between the MMA and the companies of the Federation of Associations of Brazilian Information Technology Companies (ASSESPRO NACIONAL), the Brazilian Association of Electrical and Electronic Industry (ABINEE) and the Brazilian Association of Distribution of Information Technology Products and Services (ABRADISTI). Companies that are members and partners of the Gestora para Resíduos de Equipamentos Eletroeletrônicos Nacional (GREEN ELETRON) will be responsible for managing the collective reverse logistics system for electro-electronic equipment (MMA 2019e). Decree No. 10,240, dated February 12, 2020, replicates the content of the sector agreement signed on the aforementioned date. The agreement signed between the state and civil society proposes the environmentally adequate final destination, preferably the recycling of 100% of the electro-electronic equipment described in Annex V. The sectoral agreement was divided into two phases and it is expected that by 2025, the fifth year of the second phase, 17% of discarded electronic products will have been collected and disposed of properly (MMA 2019e, MMA 2019f).

Furthermore, the agreement reaffirms, even if partially, the commitment with the National Implementation Plan of the Stockholm Convention, related to POPs. In ANNEX IX (Evaluation of possible socio-environmental impacts), in the technical grounds of the impacts on the environment, it is described that "one of the concerns surrounding the final disposal of EEE concerns the chemical substances that compose such products and their components and the potential negative environmental impacts in case of environmentally inadequate final disposal. Reverse logistics reinforces this initiative, as it ensures the environmentally adequate final disposal of EEE containing these substances, thus avoiding and minimizing possible environmental impacts associated with an inadequate disposal of these substances in the environment, such as contamination of the terrestrial, water and aquatic environments, in addition to risks to human health" (MMA 2019g). In ANNEX IX, it is also highlighted "that a Basic Operational Manual was created with the description of the procedures to be adopted in all steps inherent to the operation of reverse logistics with the purpose of ensuring the proper handling of EEE by all actors in the chain, in compliance with the applicable legal requirements and aiming to prevent any type of environmental contamination. This operationalization occurs in synergy with the National Implementation Plan of the Stockholm Convention, concerning POPs. Through the environmentally appropriate final destination, it will be possible to ensure the correct management of these possible substances present in discarded electronic products in order to ensure that they are not reinserted into the production chain" (MMA 2019g). However, the Basic Operational Manual (ANNEX VI) only reports that care should be taken - in handling, storage, disassembly, and removal of parts and pieces - to avoid causing impacts to the environment and human health. The manual does not present specific procedures for EEE that contain decaBDE or other contaminants. In its final considerations, the manual makes this clear, reporting that the document is intended to provide an overview of good practices that should be observed throughout the process. It is not the intention of this manual to address the specific methods and technologies required for the correct treatment/recycling of EEE (MMA 2019h). Thus, we can observe a lack of consonance between the texts that make up the Sector Agreement for Implementation of the Reverse Logistics System for Household Electrical and Electronic Products and their Components. In addition, as previously reported, the last meeting of the "Brazilian RoHS" was held on December 6, 2018 and no timeline was made available. It is worth noting, that the regulation of chemical substance limits in electro-electronic equipment, in the form of a CONAMA resolution, would be elaborated by CONASQ's "Brazilian RoHS" WG.

Thus, the Conasq should reiniciate the discussion of the "Brazilian RoHS" so that the use of PBDEs in electro-electronic equipment is either banned or specific exceptions are requested in due course. In addition, procedures with discarded EEE should be more specific, to minimize possible impacts on the environment and human health.

Although decaBDE has been used less in civil construction than in electro-electronic equipment, it is important to note that the MMA has resolutions that establish guidelines, criteria and procedures for the management of civil construction waste. CONAMA resolution No. 307, from July 5, 2002, defines as civil construction waste those from construction, remodeling, repair and demolition works, and those resulting from land preparation and excavation, such as bricks, ceramic blocks, concrete in general, soil, rocks, metals, resins, glue, paint, wood and plywood, lining, mortar, plaster, tiles, asphalt paving, glass, plastics, pipes, electrical wiring, etc. The classification established by the resolution places hazardous waste as class D, defined as paints, solvents, oils and others or those contaminated or harmful to health from demolition, renovation and repairs of radiology clinics, industrial facilities and others, as well as roof tiles and other objects and materials containing asbestos or other products harmful to health (MMA, 2002). CONAMA resolution No. 448, of January 18, 2012, says that this waste must be stored, transported and disposed of in accordance with specific technical standards (MMA, 2012a). Although both resolutions emphasize the importance of recycling and final disposal of the material without causing environmental damage, it is necessary to address the contamination of this material by decaBDE, due to its recent entry on the Stockholm Convention list. No governmental regulations were found that establish a management for automotive or textile waste.

Production of decaBDE

The query sent by the MMA asking companies and environmental agencies regarding information on decaBDE received almost no reply. There is no evidence of national production of decaBDE and use of the substance in Brazil seems to depend upon import (ANNUNCIAÇÃO et al, 2018; MMA, 2020d).

Trade of decaBDE

The Ministry of Development, Industry, Trade and Services (MDIC) reported that Brazil imported 1,010 tonnes of a product known as decabromodiphenyl ether, which is probably c-decaBDE, between 1989 and 1996 (MMA, 2020d). After 1997, foreign trade of c-decaBDE began to be tracked by a generic NCM code, labeled as “other aromatic ethers”, which prevented the assessment of its imports and exports (ANNUNCIAÇÃO et al, 2018). The previous NIP (MMA, 2015b) reports that penta and octaBDE commercial mixtures are also imported via a different NCM, which is also a generic code for “other halogenated derivatives, with bromine only”. It is possible that decaBDE trade is also tracked by this code. In 2019, UNEP reported that decaBDE import to Brazil in 2018, done through a generic NCM, was of 150 kg (UNEP, 2019c). All trade under that same NCM for 2018 indicates 187 tonnes of “other halogenated derivatives, with bromine only”, further confirming that generic NCMs cannot be used for assessment of trade for specific products. For both NCM codes above, there have been imports. This implies that decaBDE import to the country still happens (MMA, 2020d).

Estimates of decaBDE in the polymeric fraction of electrical and electronic equipment and its waste in Brazil – Tier I

Commercial PBDE mixtures have been mostly applied as flame retardants in polymers used in various products, such as plastic in electronics, polyurethane foams in vehicles, and textiles, to reduce their ignitability to meet certain flammability standards. After the phaseout of c-pentaBDE and c-octaBDE mixtures, c-decaBDE became the most used PBDE mixture. The largest share of c-decaBDE has been applied as flame retardants in plastic polymers of certain electrical and electronic equipment (EEE) and related waste (WEEE), mainly in Cathode Ray Tube (CRT) casings. Thus, considering the limited information raised from stakeholder consultations in Brazil, it is even more important to perform some estimates to understand how much c-decaBDE could impact the environment and recycling streams in the country. It is important to be highlighted that for developing countries like Brazil, where state of the art recycling plants with monitoring capacity do not exist and measurement capacity still insufficient, the occurrence of PBDEs in polymers is a big challenge for the through implementation of the Stockholm and Basel Conventions. Brazil (like other developing countries) lacks appropriate recycling and destruction facilities which leads to open burning or dumping of such hazardous wastes or release to water bodies causing environmental pollution including marine litter.

The estimates for c-decaBDE followed exactly the same steps as those present for the other PBDEs in section 2.3.3.1. but considering the specific mass fraction of c-decaBDE in each case, accordingly to the most recent guidance (UNEP, 2021). Thus, no further estimation was performed for decaBDEs and the same variables regarding assessed consumer goods in Brazil were used.

Estimates of decaBDE in CRT monitors and televisions (considering the variables presented in Section 2.3.3.1.)

Following the most recent guidance on preparing inventories of POP-PBDEs (UNEP, 2021), the Brazilian population size (213,680,044 people), the estimated number of CRT monitors and televisions per capita (0.53), the average weight (25 kg) and polymer content (30%) of CRTs and the estimated c-decaBDE content ([0.0032 to 0.0044]) applied in those products, were used to assess the total amount of impacted plastics and decaBDE content plastics in Brazil. The total amount of impacted plastics was estimated at 849,378.2 tonnes and the content of c-decaBDEs in plastics from CRT monitors and televisions in Brazil was estimated to range from 2,718 to 3,737 tonnes; in average 3,227,637 kg (MMA, 2020d).

Estimates of decaBDE in plastics of relevant electric and electronic equipment – Tier II (considering the variables presented in Section 2.3.3.1.)

POP-PBDEs may be present in different fractions of EEE, and therefore further estimation should be performed. The objective of this part is then to estimate the total volume of PBDEs in EEE and the related waste (WEEE). This requires information on the amount of EEE and WEEE in the country, the relevant polymers contained in this equipment, and the amount of POP-PBDEs in each of these polymers. Information on recycled polymers and the amount of imported WEEE is essential. In the end, the total POP-PBDEs in EEE/WEEE and the volume of impacted EEE/WEEE plastic can be calculated (UNEP, et al., 2021).

Imported EEE and WEEE (considering the variables presented in Section 2.3.3.1.)

The entry of EEE into the country was evaluated using the Comex Stat database. The period was divided from 1997 to 2005 (beginning of the database until the end of the period of intense use of PBDEs) and 2006 to 2020 (after the period of intense PBDE use). These data totaled 601,557,849 kg of imported equipment for the period 1997–2005 and 3,406,902,636 kg for the period 2006–2020. However, only EEE imported in the period of intense use of PBDEs were considered in this estimate since the intensive use of c-decaBDE also reduced considerably from 2005 (UNEP, 2021).

Therefore, considering the total amount of relevant EEE imported from 1997 to 2005, their respective mass fraction of polymers and the decaBDE content (0.8 for all EEE categories was used) (UNEP, 2021), it was estimated that around 210,213,057 kg of plastics would need be treated in an environmentally adequate manner and that around 167,671 kg of c-decaBDE could be released to the environment from those imported EEE (MMA, 2020d).

EEE in use or stored with consumers (considering the variables presented in Section 2.3.3.1.)

Stocks of EEE in use or stored with consumers can be divided into 3 groups: private consumers (households); institutional consumers (public institutions, government, health and education sectors); corporate consumers (hotels, industries and businesses). Since most PBDEs are present in computer and TV (CRT) monitors, private consumers' stocks are likely to represent the largest proportion, as they tend to keep the products for longer, as well as buy second-hand equipment. Institutional consumers tend to stock old equipment for a longer period of time, as do private consumers. Corporate consumers, however, change equipment more frequently and therefore should have fewer problematic stocks with respect to PBDE contamination. Table 15 present the same variables used for c-octaBDE estimations (Table 12) with specific c-decaBDE mass fractions as used for its estimates.

Table 15: Quantity of electro-electronic equipment stored or in use and estimated c-decaBDE

Equipment	Quantity	Mean weight	Stocked quantity	Total plastic (%)	c-decaBDE in EEE plastic	Total impacted plastic (tonnes)	Total c-decaBDE mass fraction (kg)
	[millions]	[kg]	$MEEE_{(j)\ stocked}$ [tonnes]	$F_{Polymer}$ [%-mass]	$C_{decaBDE\ (I);\ Polymer(k)}$ [kg/tonnes]	$M_{EEE\ (j)\ stocked} \times F_{Polymer}$ [toneladas]	$M_{decaBDE\ (i)} = M_{EEE\ (j)} \times f_{Polymer\ (k)} \times C_{decaBDE\ (I);\ Polimero(k)}$
TV[1,2]	260						
-- CRT	68	31.6	2,148,800	30	4.4	644,640	2,836,416
-- Flat Screen	192	13	2,496,000	37	2.75	923,520	2,539,680
Computers[2]	198						
-- Laptop and Tablet	102	1.5	153,000	42	0.8	64,260	51,408
-- Desktop	88	9.9	871,200	42	0.8	365,904	292,723,2
Monitors	88						
-- CRT	24	14.1	338,400	30	3.2	101,520	324,864
-- Flat Screen	64	4.7	300,800	37	2.75	111,296	306,064
Cell phone	242	0.1	24,200	42	0.8	10,164	8,131,2
Total						**2,221,304**	**6,359,286**

Sources: MMA (2015), UNEP (2021), [1]IBGE (2015), [2] MEIRELLES (2020)

Thus, considering the information raised in the national inventory of decaBDE (MMA, 2020d), the mass fraction of c-decaBDE in the polymeric fraction of EEE stored in households, public and private institutions was 6,359,286 kg. The total amount of impacted plastics was estimated at 2,221,304 tonnes. The discrepancy between the amount of c-octaBDE and c-decaBDE highlights the importance that should be given to the existence of c-decaBDE in EEE, of course without neglecting the impact of other commercial PBDE mixtures. The life cycle of EEE must be better monitored to minimize the impact that improper disposal of these products may have on the environment.

Estimates of decaBDE in the polymeric fraction of WEEE

Small waste encompasses television/monitor, LCD/plasma, DVD/VHS, audio products, desktop, notebooks, printers, cell phones, mixer, blender, electric iron, drill and others. The value used in the calculation for small waste is the estimate for the year 2020, 540,000 tonnes of WEEE (ABDI, 2012). According to MEIRELES (2021), the annual sale of cell phones is 4 times greater than that of televisions, while the TV: computer ratio is 1:1. With this, we can consider that, at the very least, we would have the generation of category 3 waste (CRT monitor, LCD monitor, Desktop PC, Laptop, Printer, Mobile phone) 2 times greater than category 4 waste (CRT-TV, Flat Screen TV, Radio, HiFi and others). That is, 360,000 tonnes of category 3 equipment, and 180,000 tonnes of category 4 waste. The percentage of equipment chosen was based on the percentage obtained from the estimate of EEE in use and stored in the country. Considering the most relevant categories and their respective decaBDE content (Table 16) around 229,443 tonnes of plastics contaminated with PBDEs might be disposed of every year in Brazil. This estimate resulted in approximately 329,589.8 kg of c-decaBDE being disposed of alongside WEEE in the country.

Table 16: Content of c-decaBDE in WEEE.

Relevant category	Amount of WEEE	Total polymer fraction	c-decaBDE in plastics	Total c-decaBDE mass fraction (kg)
	$M_{WEEE(j)}$ [tonne]	$f_{Polymer}$ [% - mass]	$C_{decaBDE(i); Polymer}$ [kg/tonne]	$M_{decaBDE; WEEE(j)} = M_{WEEE(j)} \times f_{Polymer} \times C_{decaBDE\ in\ polymers}$ [kg]
EEE without CRT (cat 3)	342,000	42	0.8	114,912
Monitor computer CRT (cat 3)	18,000	30	3.2	17,280
TV CRT (cat 4)	47,100	30	4.4	62,172
Flat screen TV (cat 4)	132,900	37	2.75	135,225.8
Total				**329.589,8**

Source: prepared by the author.

Estimates of decaBDE in the transport sector

The calculations for the estimates on decaBDE contents in the transport sector were presented together with those for c-pentaBDE in Section 2.3.3.1. In broad terms, c-decaBDE content in the total vehicles licensed in Brazil from 1970 to 2017 was equal to:

c-decaBDE: [Vehicles (1970-2004*) x 0.080 kg] + [Vehicles (2005-2017) x 0.020] + [US Vehicles (1970-2004) x 0.040 kg*] = [35,374,892 x 0.080 kg] + [37,141,429 x 0.020] + [259,825 x 0.040] = 3,583,213 kg

* *Total licensing, with the exception of vehicles imported from the USA, which is considered to have 50% c-pentaBDE.*

The calculated c-decaBDE content in vehicles in use in Brazil was equal to:

c-decaBE: [Vehicles (1970-2004*) x 0.080 kg x (% of vehicles still in use)] + [Vehicles (2005-2017) x 0.020 kg x (% of vehicles still in use)] + [US Vehicles (1970-2004) x 0.040 kg* x (% of vehicles still in use)] = [35,374,892 x 0.080 kg x 0.27] + [37,141,429 x 0.020 x 0.89] + [259,825 x 0.040 x 0.27] = 1,428,021 kg

* *Total licensing, with the exception of vehicles imported from the USA, which are considered to have 50% of the c-pentaBDE load.*

Overall estimates of PBDEs, including decaBDE, in Brazil

In the scenario of low adherence to the questionnaires conducted with industry and the scarcity of data on the production and trade of the substances, the estimates brought more robust data on the amount of PBDEs that may have entered the country. According to the estimates made, in the electronics sector, tube monitors and televisions (CRT) alone were responsible for generating 781,427.9 kg c-octaBDE and 3,227,637 kg decaBDE in the country. In an alternative and more detailed approach (including also other EEE of high use in the country, such as tube and LCD TVs, computers, laptop and smartphone), it was estimated that the amount of c-octaBDE in EEE stored in households, public and private institutions was 504,215.9 kg, while the amount of decaBDE was 6,359,286.4 kg. One can see that the amount of decaBDE practically doubled when considering these new EEE, this is because decaBDE was also used in other categories of EEE, unlike octaBDE which was more restricted to monitors and tube televisions. Still considering EEE, it is estimated that this sector generates annually a volume of 31,718.5 kg of c-octaBDE and 329,589.8 kg of decaBDE in waste. The vehicle sector, which is one of the largest flows of material goods, was responsible for the entry of 10,393 kg of c-pentaBDE (related to cars imported from the U.S.) and 3,583,213 kg of decaBDE. Of these, vehicles currently in use are estimated to account for 2806.2 kg of c-pentaBDE and 1,428,021 kg of decaBDE.

The estimates indicate that for PBDEs, the most critical sector for waste management would be EEE, both because it has a high burden of PBDEs and because of its high waste generation capacity. The transportation sector poses a greater challenge with respect to decaBDEs. Therefore, while products containing such contaminants are improperly disposed of and their recycling is allowed in Brazil - that is, while the waste products containing PBDEs are not treated in an environmentally appropriate way and definitively destroyed - a load of approximately 14,827,481.5 kg of PBDEs, of which 1,327,755.3 kg are composed of the c-penta and c-octaBDE fraction and 13,499,726.2 kg of decaBDE can be released into the environment.

Occurrence of decaBDE in Brazil

A scientific literature review found 14 studies on decaBDE occurrence in Brazilian environmental samples that met protocol criteria.

Concentrations of decaBDE were found in rivers and reservoirs in industrial areas of São Paulo state (FERRARI et al., 2019; TOMINAGA et al., 2019). In one study, decaBDE had the highest concentrations of all PBDEs congeners measured, being above levels considered safe for drinking in 40% of samples (TOMINAGA et al., 2019).

There were two studies investigating the occurrence of PBDEs, including decaBDE, in indoor and landfill dusts. In homes, schools, offices and vehicles in Araraquara, São Paulo State, decaBDE represented 80% of all congeners in samples. Offices and vehicles had the highest concentrations (CRISTALE et al., 2018; 2019). In landfills, the areas where polyurethane foam and electric and electronic equipment were present had the highest concentrations (CRISTALE et al., 2018). Noteworthy, the studies found higher concentrations of decaBDE in offices when compared to landfills. This points out to the fact that decaBDE is still in use and present in articles and consumer goods in the country, and that indoor environments could be acting as emission source for this substance (CRISTALE et al., 2018; 2019).

Three studies investigated the occurrence of decaBDE in the atmosphere in National Parks, urban and agricultural areas. For National Parks and agricultural areas, decaBDE concentrations were below detection limits. In São Paulo, however, decaBDE was present in all atmospheric samples (SAINI et al., 2020). It was the congener with the highest concentration in most of the sampling sites (SAINI et al., 2020).

Regarding biological samples, most studies investigated occurrence of PBDEs, including decaBDE, in marine ecosystems (UENO et al., 2004; ALONSO et al., 2012; DE LA TORRE et al., 2012; PIZZOCHERO et al., 2019). Concentrations of decaBDE were found in cetaceans along the Brazilian coast. The substance, albeit present, did show the highest concentrations among PBDE congeners (DE LA TORRE et al., 2012). In fish samples from Rio de Janeiro, decaBDE was only present in 40% of samples. However, when present, it amounted to up to 78% of total PBDE content (PIZZOCHERO et al., 2019).

Studies carried out with biological samples from the marine environment suggest the use of decaBDE in coastal urban centers on the Brazilian coast, mainly in the southeast and south. Importantly, the Southeast and South regions accounted for 77.4% of companies that potentially apply decaBDE in their processes or products (ALONSO et al., 2012; DE LA TORRE et al., 2012).

2.3.3.3. Hexabromocyclododecane - HBCD in the Stockholm Convention

The HBCD is a cycloaliphatic hydrocarbon produced by the bromination of four isomers of 1,5,9 cyclododecatriene (CDT). The 1,2,5,6,9,10-HBCD have six stereogenic centers and, in theory, 16 stereoisomers can be formed (HEEB et al. 2005). However, for commercial HBCD, only three of the stereoisomers are commonly found, nominally alpha (α-), beta (β-) and gamma (γ-) HBCD. Depending on the manufacturer and the production method used, the technical HBCD consists of 70 to 95% of γ-HBCD and 3 to 30% of α- and β-HBCD.

Studies show the occurrence of HBCD in indoor air and house dust, as well as in cabin dust in new and old cars (EC, 2008; MIYAKE et al., 2009, KAJIWARA et al., 2009 apud UNEP, 2011). It has also been found in oceanic and arctic predators (UENO et al., 2006; ENVIRONMENT AND HEALTH CANADA, 2010).

HBCD has been used as a flame retardant by the industry. Unlike other brominated flame retardants, the compound does not generate brominated dioxins or furans. It was used mainly by the construction industry as an additive in expanded polystyrene (EPS) or extruded polystyrene (XPS) products. It has also been used in textiles, such as home and vehicle upholstery (UNEP, 2011).

HBCD was listed in the Stockholm Convention in 2013, under Annex A. Its production is to be eliminated for all applications excluding those registered as specific exemptions.

HBCD in Brazil

Brazil has requested a specific exemption for HBCD in EPS and XPS for use in construction. However, the register for this application expired in 2019 and HBCD based products are no longer allowed in the country.

Production of HBCD

The MMA sent queries to 724 companies and company associations, as well as industry federations and state environmental secretariats, that were potential stakeholders for HBCD production and use in Brazil. Only one reply was received and there is no record of HBCD production in Brazil (MMA, 2020e).

Trade of HBCD

According to IBAMA, HBCD foreign trade has been tracked since 1997. However, a generic NCM code was used, which labeled all halogenated derivatives of cyclanic, cyclenic or cycloterpenic hydrocarbons trade, including HBCD. There are no specific codes for HBCD, thus it is not possible to assess the foreign trade data for this chemical.

Also, according to IBAMA, starting in 2013 the institute began to issue import licenses for HBCD. IBAMA reported 110 and 129 tonnes of HBCD were imported to Brazil in 2017 and 2018, respectively (MMA, 2020e). The previous NIP (MMA, 2015b) also reported that between 2011 and 2013 two companies imported 205 tonnes for application in

EPS production, for use as thermal insulation in the construction industry and as a flame retardant additive for industrial use.

For the current consultation by the MMA for the review and update of HBCD inventories, only one reply was received (MMA, 2020e). The company that replied stated that it has used HBCD as a flame retardant, however, usage ceased in 2018 and was replaced by a polymeric product known as Emerald.

Estimates of HBCD through trade of EPS

There is a NCM code for tracking foreign trade of EPS in Brazil. According to the Comex Stat database, between 2011 and 2019, approximately 4,300 tonnes of EPS were imported to Brazil, mainly from China (80% of all imports) (MMA, 2020e). In the same period, 333 tonnes of EPS were exported from Brazil, mainly to Paraguay. Based on HBCD percentages in EPS (0.3 to 0.7%), it is estimated that from 1.29 to 6.14 tonnes of HBCD could have entered Brazil through EPS import during 2011 – 2019 (MMA, 2020e). However, the HBCD mass fraction has not been surveyed in imported EPS in Brazil and this is just a rough estimate.

From 1999 to 2017, both the national apparent consumption and production of EPS grew, thus increasing the demand for HBCD in Brazil. It is estimated, for example, that in 2017, it used 130 to 310 tons of HBCD in the manufacture of EPS, an increase of approximately 90% compared to the year 2011. According to ABIQUIM, Brazil has seven associated companies that manufacture and transform polystyrene and three other companies that work with this product; however, the number of small and medium-sized companies that can use the product is not known (MMA, 2013).

According to the data disclosed by ABIQUIM, about 62.9 thousand tons of EPS and, approximately, 20 thousand tons of XPS were produced in Brazil in 2008, totaling about 82.9 thousand tons of Styrofoam. Of this total, it is estimated that about 7 thousand tons returned to the production process for recycling, i.e., only 8.4% of all that was produced. Considering that HBCD is present in a percentage of 0.3% to 0.7%, 249 to 580 tons of this product would be present in the Styrofoam, and that at most 49 tons went to recycling.

Estimates of HBCD in cars in Brazil

The transportation sector constitutes one of the largest material goods flows, and therefore has a high relevance for waste flow and waste management (UNEP 2021; VERMEULEN et al. 2011). It is estimated that of the total number of vehicles imported by Brazil (8,261,815), 415,171 are Japanese vehicles, a percentage of approximately 5% (ANFAVEA 2001; Comex Stat 2021). According to Liu and colleagues (2019), the average concentration of HBCD in conventional vehicles in Japan is 2 g, and thus an estimated 830.3 kg of HBCCD in the vehicle sector. It is important to stress that this estimate of HBCD is an initial effort, and that it is probably under quantified as only the Japanese fleet that represents 5% of the total imported in the period was considered.

Besides the total quantity, it is also necessary to verify which of these vehicles are still in use and which have already reached the end of their useful life, in order to estimate the loads for these two categories. These data were obtained through the analyses carried out by the National Union of the Industry of Components for Motor Vehicles (SINDIPEÇAS, 2018). Considering the average age of the Brazilian vehicle fleet in the year 2017 of 9 years and 7 months, the total number of vehicles in the circulating fleet is estimated at more than 43 million vehicles, approximately 60% of the total already licensed. With this data, the HBCD load in the in-use vehicle sector is estimated to be 498.2 kg. Again, it is important to emphasize that this estimate of HBCD is an initial effort, and that it is probably under quantified because only the Japanese fleet was considered, which represents 5% of the total imported in the period. Moreover, HBCD contents have not been surveyed in Brazil.

Occurrence of HBCD in Brazil

The first report on HBCD in Brazil was the "Report on the chemical content in dust samples collected from Brazilian homes and offices" by Greenpeace, published in 2004 and entitled "Domestic Poison". In this study (Greenpeace, 2004), household dust samples were collected in the homes of 50 volunteers in four Brazilian cities, in government offices in Brasilia (DF) and also in the MMA building, in the year 2003. No concentrations of HBCD were found in this study (<0.02 mg kg^{-1}).

The geographical distribution of HBCD was investigated by analyzing muscle tissue from a tuna species (Katsuwonus pelamis) collected from offshore waters of several regions of the world, including Brazil (UENO et al., 2006). HBCD was detected in almost all samples analyzed (<0.1 to 45 ng g^{-1} lipid weight). In Brazil, the sum of HBCD was 0.28 ng g^{-1} lipid weight (α-HBCD = 0.28; β-HBCD <0.03 and ϒ-HBCD <0.1). The authors found that HBCD concentrations in tuna collected from the northern hemisphere were apparently higher than those from the southern hemisphere. These results were related to greater degrees of industrialization and agricultural activities in the northern hemisphere, where a demand for 97% of HBCD was reported in North American, European and Asian countries, compared to 3% in the rest of the world (Breivik et al., 2002; Voldner et al., 2005; BSEF, 2005).

A study by Lee and colleagues (2016) aimed to retrospectively review air samples collected in 2005 as part of the Global Atmospheric Passive Sampling Network by the time the Stockholm Convention on Persistent Organic Pollutants came into force. Results are presented for several new flame retardants, including HBCD. These results represent the first global-scale distributions in air for HBCD. In Brazil, the study area was Indaiatuba, in the state of São Paulo, where concentrations ranging from <0.1-190 pg m^{-3} were found. These values need to be further explored, as some remote areas, for example in Sweden, showed similar values (<1-280 pg m^{-3}) (REMBERGER et al., 2004). However, in South Africa, lower values were found, with an average of approximately 1.47 pg m^{-3}. In China, between the years 2007 and 2008, HBCD concentrations ranging from 3.9 to 6700 pg m^{-3} were found.

Regarding the monitoring of HBCD in milk, the Oswaldo Cruz Foundation (Fiocruz), in cooperation with the Ministry of Environment and Climate Change (MMA), developed a study, executed from 2011 to 2013, to determine the concentrations of this compound in human milk, taking into account the World Health Organization (WHO) protocols and the national protocol of the study conducted in 2002 (BRAGA et al., 2002 apud Fiocruz, 2014). HBCDs were determined only in the regional composite samples. Region 1 corresponds to: Cuiabá/MT (1), Porto Velho/RO (2), Rio Branco/AC (3), Boa Vista/RR (4), Belém/PA (5); Region 2 corresponds to São Luís/MA (6), João Pessoa/PB (7), Recife/PE (8), Maceió/AL (9), Salvador/BA (10); and Region 3 corresponds to Goiás/GO (11), Belo Horizonte/MG (12), Rio de Janeiro/RJ (13), São Paulo/SP (14), Florianópolis/SC (15). The values in parentheses correspond to the sample n for each site. The concentrations of the three isomers in region 3 were below the limit of limit of quantification (<0.05 ng g^{-1}). The mean value of the sum of HBCDs was calculated at 0.44 ng g^{-1} fat, from the concentrations of Large Regions 1 and 2 (Fiocruz, 2014). Comparison of Brazil's average value with the average levels obtained in other countries shows that Brazil's average concentration is among the lowest. Only the average value of 0.23 ng g^{-1} fat obtained in the Philippines is lower than that of Brazil.

In a 2017 study by IPEN (IPEN, 2017), it was found that recycling plastics containing toxic chemicals, such as flame retardants, found in electronic waste, results in the contamination of new plastic toys for children. However, no concentrations of HBCD were found in plastic cubes collected in Brazil.

2.3.4. Assessment of Hexachlorobutadiene - HCBD (Annexes A and C)

HCBD in the Stockholm Convention

In May 2015, the HCBD was included in the Annex A and and May 2017 in Annex C of the Stockholm Convention. HCBD is an aliphatic halogenated substance originating mainly in the chemical industry as a byproduct of the manufacture of chlorinated solvents, especially trichloroethylene, tetrachloroethylene (or perchloroethylene), tetrachloromethane, and hexachloro-cyclopentadiene (an intermediate in the synthesis of cyclodiene pesticides). It can also be produced by the chlorination of butane or its chlorinated derivatives (UNEP, 2017a). Anthropogenic HCBD emissions can originate from both intentional and unintentional sources, plus historical waste disposal and characterization of contaminated areas. Even at low concentrations, HCBD shows relevant genotoxicity effects in organisms (FOSTER, 2016).

Historically, the industrial use of HCBD has been in the production of pesticide, biocide, fungicide, algaecide, lubricants, synthesis of rubber-based products, chlorofluorocarbon manufacturing, graphite production, aluminum production, rubber production, polymer production, elastomeric plastics production, purifying agent (sniff recovery), washing liquor (gas purifier) for hydrocarbons, adsorbing agent for gaseous contaminants, chlorine gas production, hydraulic fluids, liquids in gyroscopes, thermostable fluid (transformers) chlorinated solvent production (unintentional) and magnesium production (unintentional) (WANG; BIE; ZHANG, 2018; ZHANG et al., 2019)

The highest production of HCBD is reported to have occurred during the 1970s and 1980s, being estimated that for the year 1982 alone around 10,000 tonnes were produced commercially in the world (UNEP, 2012b). Currently, intentional production of HCBD is no longer reported for countries of the United Nations European Economic Commission (UNECE), also including the USA and Canada (UNECE, 2009). The unintentional generation/production of HCBD in the world, on the other hand, is considered relevant and often exceeds its commercial synthesis locally. In 2016, the Chinese production of trichloroethylene and perchloroethylene was 545,000 and 17,000 tonnes/year, respectively, with a corresponding unintentional production of HCBD of 73.0% and 24.5% (WANG; BIE; ZHANG, 2018).

Little is known about HCBD use, production and emissions in the Americas, which includes Brazil. Nevertheless, it is reported that there are 17 industries producing chlorinated manufactures in the Americas, five of which in Brazil, and three of the largest ones also located in the country, namely: Dow, Braskem and Unipar Carbocloro (VALLETTE, 2018). The same inventory reports that the company Dow produced tetrachloro carbon and perchlorocarbon until 2009, compounds with high risk of unintentional HCBD generation during the production. Many of these industries declare, however, to currently produce other chlorinated products with low risk of HCBD generation, such as polyvinyl chloride (PVC), dichloroethylene (EDC), dichloropropylene, vinyl chloride monomer (VCM), among others (VALLETTE, 2018). Still, even in the production of some of these chlorinated compounds, HCBD is formed (UNEP, 2017a, 2019a).

Production of HCBD

An old plant in Cubatão (São Paulo State) produced from 5,000 to 9,000 tonnes of HCBD between the years 1974 and 1993 (MMA, 2020f). The company has improperly buried a mixture of organochlorine substances during the years 1974 and 1993, in which the proportion of HCBD is estimated to range from 25 to 45%. The mixture was removed and deposited in a "waiting station" built in São Vicente, where it has remained since 1987 and, currently, a total of 33,000 tonnes of HCBD-contaminated soil is estimated for the region (MMA, 2020f).

Overall, 65 industrial associations and 592 individual companies considered to be relevant for assessments on HCBD were selected and contacted via official letters sent by the Ministry of Environment and Climate Change. Only one answer was obtained, reporting the same case of the presence of HBCD residues in the area previously occupied by the industrial complex of Cubatão. However, little is known about the occurrence of HCBD in environmental matrices or human tissue samples at the region (MMA, 2020f).

Trade of HCBD

No specific custom codes were identified for tracking HCBD, since there is no specification or marketing of by-products of chlorinated solvents (MMA, 2020f). The new UNEP guidance points out that HCBD is traded under the harmonized system (HS) code "Other unsaturated chlorinated derivatives of acyclic hydrocarbons" along with other chemicals and that in turn can be used in combination with the CAS number, or trade names for HCBD search at the custom search level (UNEP, 2019a). However, when consulting the Comtrade database, the HS code mentioned in the guidance is not available. In fact, there are four (04) HS codes relating to unsaturated chlorinated derivatives of acyclic hydrocarbons in the Comtrade database, but no HCBD information at the custom level was possible to find using the HS code 290329 (MMA, 2020f).

Occurrence of HCBD in Brazil

Based on the literature review, it was possible to identify 32 publications that mention the occurrence of HCBD in Brazil. From those, 10 analyzed abiotic environmental samples, but only two reported relevant concentrations when analyzing river water (<2,0 mg L^{-1} to 6,0 mg L^{-1}) and atmospheric samples (<20-25 pg m^{-3}) (CUNHA et al., 2011; RAUERT et al., 2018a). All other publications analyzed samples as soil, sediment, surface and bottom waters, but presented concentration values below the detection limits stipulated in the studies and/or concentrations were not detected (CETESB, 2001; MACHADO et al., 2005; LIA, 2008).

Many publications reported standardized protocols on the quality of waste reuse. Among them, we highlight the reuse of sludge from effluent treatment plants (domestic and industrial), in addition to waste originating from construction and the wood industry (FARAGE et al., 2013; FREITAS et al., 2019; VIEIRA & MONTEIRO., 2015). However, for all these publications, HCBD concentrations were invariably below the methodological detection limits, stipulated for each study (ranging from <0.1 to <0.0001 mg L^{-1}).

Three publications reported the use of HCBD as solvents for laboratory use between the early and mid-2000s, especially for chemistry laboratories in universities that evaluated the quality grade for different fuels (GHESTI et al., 2006; MENDES et al., 2003; OLIVEIRA et al., 2007). It is believed that current uses of HCBD in research centers are either in disuse or are considered small-scale compared to other industrial activities (e.g., production of chlorinated solvents) (UNEP, 2019a). Even so, not reporting these uses may underestimate the real HCBD stocks in different countries, especially for those in development or in economic transition (e.g., Brazil and other Latin American countries) (IPEN, 2017).

The literature review puts light on the lack of scientific studies performed by Brazilian postgraduate programs, which are the main producers of scientific knowledge in the country. Moreover, it is important to highlight that despite the identification of a potentially contaminated area in Cubatão, São Paulo, HCBD has not been monitored in the region (MMA, 2020f).

2.3.5. Assessment of Polychlorinated naphthalenes - PCNs (Annexes A and C)

PCNs in the Stockholm Convention

In May 2015, PCNs were added to the Annexes A and C of the Stockholm Convention. PCNs are halogenated organic compounds consisting of planar naphthenic aromatic molecules, in which Hydrogen atoms might be substituted from two up to eight chlorine atoms. Given the various amounts and positions that the chlorine atoms may assume within the molecule, PCNs comprise a total of 75 congeners which are divided into seven homologe groups: dichloro- (di-CNs), trichloro- (tri-CNs), tetrachloro- (tetra-CNs), pentachloro- (penta-CNs), hexachloro- (hexa-CNs), heptachloro- (hepta-CNs) and octachloro- (octa-CNs) naphthalenes. Physical-chemical properties widely vary among groups, thus being the chlorine content determinant on the environmental behavior: highly chlorinated CNs are associated with lower volatility and solubility, and higher lipophilicity.

PCNs have been widely produced between the decades of 1910 and 1970 and mainly sold as technical mixtures. Given the close chemical and structural similarities between PCNs and Polychlorinated biphenyl (PCB), they have shared most of their internal applications, such as fluids of transformers and capacitors, additives of lubricants etc. Still, some estimates regarding the global production of PCNs point that it represents about one-tenth of what had been the global production of PCBs (BELAND & GEER, 1973; UNEP, 2013a). Overall, the production of PCNs is assumed to be now extinct among the countries of the UNECE, with the exception of those intended for analytical purposes in laboratory practices and for the production of polifluorinated naphthalenes (PFNs).

Since PCNs have been compounds of industrial use, several issues regarding occupational exposure have arisen, revealing symptoms similar to those normally detected in cases of intoxication by PCBs and furans, such as chloracne and hepatic illnesses (IPCS, 2001). Regarding their environmental behaviors, some PCNs have been shown to have elevated bioaccumulation potentials for aquatic and terrestrial organisms (UNEP, 2012c), and high dispersion capacities, having even been detected in atmospheric samples from Antarctic regions (BIDLEMAN et al., 2010).

The decision for the inclusion of the PCNs under the scope of the Convention has not faced any resistance from the country-parties, except for Russia, who declared their demand as intermediate substances during the production of PFNs. Therefore, this use has been marked as a specific exemption.

Production of PCNs

Despite PCNs being widely produced in several countries worldwide, there are no records indicating that it has been manufactured in the Brazilian territory. From all 968 institutions contacted through the official letter sent by the Ministry of the Environment and Climate Change, only the Ministry of Transport has reported that the ancient Federal Highway Network had been a user of paraffinic and naphthenic thermal insulating oils, as well as PCBs, up until the time of its extinction in 1999. The statement, however, besides not providing an estimate of the volume used during the time the institution has been in operation, is inconclusive about the nature of the compound used, since non-chlorinated naphthenic insulating oils can be used for similar applications (MMA, 2020g).

Trade of PCNs

The historical import and export records of PCNs were consulted through the Comex Stat using NCM tracking codes. Two specific codes for PCNs were identified, both under the label "chloronaphthalenes": the NCM 29036915, valid from 1997 until 2011, and the NCM 29039915, from 2012 onwards. During the whole time-period, there were no records of export of any products under the referred codes, reinforcing the inexistent or non-representative production of PCNs in Brazil (MMA, 2020g).

Regarding imports, a sum of 1.7 liquid tonnes has been recorded for the same period, with the peak in 2017, when 930 kg were imported in a single year. It is worth highlighting that the NCM, being a generic code, does not provide individualized information on each of the products that may be included under the same classification. Therefore, it is not possible to distinguish in the total of imports under the general category "chloronaphthalenes" the participation of mono-CNs - not listed by the Stockholm Convention - from the other 7 homologous groups covered by the classification of POPs. However, considering that the worldwide use of PCNs in consumer goods has extended until the 2000s in the case of chloroprene/chlorobutadiene rubber applications, it can be assumed that from 2001 onwards, imports recorded under these NCMs should be represented only by the monochlorinated congener (MMA, 2020g).

Aiming to cover a larger time-period prior to the interruption on global PCN production, records under the ancient NBM tracking codes, also provided via Comex Stat database for 1989 to 1996, were evaluated. Three codes related to PCNs were identified: NBM 2903691201 (“mono and dichloronaphthalenes”), NBM 2903691202 (“tetrachloronaphthalene and octachloronaphthalene”) and NBM 2903691299 (“any other chloronaphthalene”). While the second code reveals no records of transactions for the whole period and the other two also had not registered any exports, the NBM 2903691201 recorded the import of 1.5 liquid tonnes and NBM 2903691299 summed up to 7.4 liquid tonnes. In the first case, the main commercial partner has been Germany (53% of the imports) and in the second, the United Kingdom (54%) (MMA, 2020g).

No NCM or NBM codes were found for PFNs, for which in production the use of PCNs is allowed as a specific exemption by the Convention. Moreover, since the global production of PCNs has been drastically reduced since the 1970’s, it was not done an assessment of the entrance of PCNs through the import of consumer goods, except for chloroprene/chlorobutadiene products, which could still contain PCNs until 2000. For the latter, two NCMs were identified: NCM 40024100 (“Chloroprene rubber latex (chlorobutadiene - CR)”) and NCM 40024900 (“Other chloroprene rubbers - chlorobutadiene - in sheets etc.). From 1997 to 2000, import amounts of 378.8 tonnes have been registered for the first NCM, and 37.761,4 tonnes for the second. In a scenario in which the totality of the mentioned volumes contained PCNs in their formulation and considering that the reported concentration of these compounds in chloroprene rubbers can vary between 36 and 45 g kg^{-1} (YAMAMOTO et al. 2005; YAMASHITA et al. 2003), it can be estimated that around 1,373 to 1,716 net tonnes of PCNs could have entered the country along with the products to which they could have been added to (MMA, 2020g).

The same procedure has been carried for the trades of chloroprene products registered between 1989 and 1996, with four codes being identified: NBM: 4002410000 ("Chloroprene (chlorobutadiene) rubber, latex"), NBM 4002490100 ("Chloroprene rubber (chlorobutadiene), in sheets/fls/sets"), NBM 4002499900 ("Chloroprene rubber (chlorobutadiene), in other forms") and NBM 4008119901 ("Chloroprene sheets/fls/; etc. w/fabric reinforcement"). Overall, Brazil has imported 616,007 tonnes under the four NBMs during the seven years and, if the totality of the products had contained PCNs in their formulations, circa 22,176.25 to 27,720.32 tonnes of PCNs would have entered the country during the referred period (MMA, 2020g).

Non-intentional PCNs in Brazil

It is known that commercial PCB mixtures may contain unintentionally produced PCNs in concentrations ranging from 40 to 1,300 mg/kg (UNEP, 2017b). Considering the national PCB inventory conducted in 2015, a volume of 823,886 liters of oil possibly contaminated by PCBs was estimated based on the analysis of 1,940 active and disused equipment. Based on this, it can be estimated that such mixtures might potentially contain from 33 g to 1,071 kg of unintentional PCNs. Considering that PCBs had been widely used in the country, especially contained in Ascarel oils, there could have been a larger amount of unintentional PCNs in Brazil during the peak of their use (MMA, 2020g).

The presence of unintentional PCNs was also detected in commercial mixtures of CPs in Asia, in concentrations similar to those of PCBs, measured in parts per million (TAKASUGA et al., 2012). Thus, taking into consideration the high annual CP production globally, it is possible that several products to which CPs are added might also contain PCNs. However, there is still a need for more studies that evaluate the concentration ranges of PCN residues in the main commercial CP mixtures and CP-containing products (MMA, 2020g).

Occurrence of PCNs in Brazil

Following the protocol for literature reviews, there were no studies addressing PCNs in Brazilian samples of any kind, in any of the used databases. However, considering the unintentional occurrence of PCNs in PCBs and SCCPs, there might be a relevant gap of information regarding PCN occurrence in the country since both PCBs and SCCPs have been used in Brazil (UNEP, 2019b).

2.3.6. Assessment of Short-chain chlorinated paraffins - SCCPs (Annex A)

SCCPs in the Stockholm Convention

In May 2017, SCCPs were added into the Annex A of the Stockholm Convention, with specific exemptions, entering into force for most of the Countries-Parties one year later. The SCCPs are a subcategory of the chlorinated paraffins (CPs), or polychlorinated n-alkanes, with chain lengths ranging from 10 to 13 carbons. CPs are produced from the chlorination (addition of chlorine atoms) of n-alkane feedstocks and can be further categorized as medium-chain CPs (C14-C17, MCCPs) or long-chain CPs (C18-C30, LCCPs) (DE BOER, 2010). Still, higher chain CP products containing trace amounts of C10 to C13, can result in the formation of mixtures containing SCCPs (UNEP, 2010b; 2018b). In addition, it is possible that the feedstock for the production of CPs may contain other chemical compounds, aromatics and alkenes (UNEP/POPS/POPRC.6/INF/15), which may result in the unintentional formation of other POPs such as, for example, PCNs, PCBs, PeCB and HCB, which have already been detected as impurities in technical mixtures of CPs (TAKASUGA et al., 2012, 2013).

The hydrolytic, thermal and chemical stability, along with the relatively inert characteristics of SCCPs, make them considerably resistant to degradation and suitable for a wide range of industrial and non-industrial applications, such as flame retardant additives, lubricants, plasticizers, coolants in metal processing, sealants, adhesives, and anti-fouling paints, and have also been used as an alternative to PCBs and PCNs in a wide range of open applications as additives in paints, sealants, cables, and adhesives, for example.

The global production of CPs at commercial scales started on the 1930's, steeply rising over the years until it reached alarming levels during the XXI century, when China became the global main manufacturer, increasing its production from 260 thousand tonnes per year on 2006 to 1 million tonnes per year on 2013 (XU et al., 2014; ICAIA, 2012; 2013 e 2014). It is currently estimated that the global production of CPs is already over two million tonnes per year and, despite production estimates with respect to carbon chain length being very limited, Glüge et al. (2016) estimated that the global production of SCCPs could approach 165,000 tonnes per year. This was in a minimum scenario and in a period when the estimated total production of CPs was half that of today. However, before the listing of SCCPs as POPs by the Stockholm Convention.

SCCPs can be released to the environment in any stage of their lifecycle, being also considered as persistent, bioaccumulative and toxic especially for aquatic organisms, and prone to long range transport (UNEP, 2015b). The Convention also states that CP mixtures with SCCP contents higher than 1% should also be considered POPs. However, despite being added to the Annex, several specific exemptions for SCCPs were listed, including several of the previously highlighted applications.

Production of SCCPs

The Brazilian government has, in 2007, reported to the Stockholm Convention Secretariat that the country figured as a manufacturer of SCCP, with a production of 150 tonnes per year at the time and an internal consumption twice as high, which would be supplied by the import of the lacking volume (BRAZIL, 2007). According to ABIQUIM, the production has reached 360 tonnes per year in the past, and the main domestic application of SCCPs in the country is as a flame retardant in rubber goods, widely used in the manufacture of automotive carpets and other motor vehicle components, except in tires. The application of CPs in metalworking fluids, paints, lacquers and leather processing are reported to be irrelevant in the country (MMA, 2020h).

From the 82 industrial associations and 1,264 individual companies contacted through the official letter sent by the Ministry of the Environment and Climate Change, only six provided relevant information about SCCP or CP applications in Brazil. With the information gathered so far, nothing indicates the existence of national production of any type of CPs in the last ten years. One of the responders was the only one company previously reported to have ever produced SCCPs in the Brazilian territory, which stated that the production of CPs lasted from the 1980's until august 1994 - without giving, however, further specifications regarding the chain length. The company declared that the produced CPs used to be sold under the commercial name "Clorax" and used to be applied mainly as a plasticizer for most synthetic rubbers. The manufacture of Clorax was interrupted with the closure of the production unit in São Paulo, in 1994, due to production infeasibility. The company also reported that its last sales occurred in 2011, to a raw material company for the rubber industry (MAPRIBOR LTDA), with a volume of 1,159 kg (MMA, 2020h).

Trade of SCCPs

Three other companies which replied to the official letter sent by the Ministry of

Environment and Climate Change reported commercializing CPs. A paint and coatings company from the state of São Paulo reported importing, twice a year, approximately seven tonnes of the LCCP mixture Celeclor 48 (CAS No.: 063449-39-8) (MMA, 2020h).

Another company located in the same state reported to have used CPs from 2011 to 2018 as raw material for the manufacture of a lubricant (Gardolube L 6083) used for wire drawing of special steels. Despite not having reported the volumes or the proportion of CPs in this lubricant product, the company stated that the raw material it uses is a MCCP, Cereclor S 52 (MCCPs; CAS No: 85535-85-9). The referred raw material has a chlorine content of 42% to 60%, being sold by the supplier to be used for applications as flame retardant additives, secondary plasticizers in PVC, plasticizer in paints, lubricants and extreme pressure lubricant additives (cutting/metal working oils), sealing agents and adhesives and softeners. The Brazilian supplier of Cereclor S 52 also responded to the queries, declaring that the substance used to be imported from Europe until 2013, when it started to import Klorfin (CP 52%) from India (Kutch Chemical Industries Limited) and, from 2020, it switched to Aryaffin B2/52 (Grasim Industries Limited), also from India (MMA, 2020h).

The third company to have responded to the letter reported commercializing CP-52 (chlorinated paraffin 50-52%) and provided its history of sales and purchases of CPs over the past five years. Based on the commercial balance of CPs from this company, from January 2014 to March 2019 about 1,241 tonnes of technical CP mixtures were imported, also allowing to identify 50 other companies nationwide that use the product in some step of their processes, and another 12 companies with purchases lower than five kilograms. All the purchasing companies are located in the State of São Paulo, being the main buyers mostly related to the polymer industry (mainly plastics), followed by the lubricant industry (mostly those of metal processing work, but also in the automotive industry). It is also notable that the total sales are less than the total purchases of the company, which may suggest that it uses part of its stock of CPs to make its own manufactured products. According to the data presented, more than 95% (540,000 kg) of all CPs acquired by the company in the last five years (563,750 kg) were imported from an Indian company (Kutch Chemical). The remaining 4.4% (23,750 kg) were purchased from other companies that are also among its buyers. The highest volume of CP purchases occurred in 2016 and 2014 (MMA, 2020h).

To evaluate foreign trades of CPs, the historical import and export records provided by the ME through its database for international commerce (Comex Stat) were used, compiling data under 113 NCMs considered to be relevant for CP assessments. Detailed information has been published by Guida et al (2022). According to the Brazilian Federal Revenue in 2010, there are three generic NCM codes under which SCCPs could be traded (NCM 29.03.19.90, NCM 34.04.90.19 and NCM 38.24.90.89), under which Brazil has imported 7,274 tonnes, 100,071 tonnes and 588,425 tonnes, respectively, from 1997 to 2019. Exports registered for the same three codes were 149,176 tonnes, 26,408 tonnes and 142,235 tonnes during the period. There were still other 13 NCMs identified to be possibly related to CP mixtures or CP-based products, whose imports altogether correspond to 1,559,442 tonnes during the analyzed period (MMA, 2020h).

Furthermore, NCMs related to products possibly containing SCCPs as additives were also selected for the inventory, being divided into eight product categories. Regarding PVC products, in which the SCCP content may vary from 3% to 32% by weight (CHEN et al., 2021; GUIDA et al., 2020; MCGRATH et al., 2021), the 12 NCM codes of products likely to contain CPs that were identified recorded overall imports of 1,212,830 tonnes between 1997 and 2019, with a yearly average of 75,574 tonnes for the last five years, being approximately 26% from China. Concerning rubber products, in which the SCCP content might reach 17% by weight (GUIDA et al., 2020), seven NCMs were selected as of special interest for CP assessments: five corresponding to chlorinated and chloroprene rubbers (accounting for 712,425 tonnes imported during the analyzed period) and two to transmission and conveyor belts (which is a use exempted by the Stockholm Convention, recording 2,600 and 9,600 tonnes imported, respectively) (MMA, 2020h).

Additionally, adhesives might reach up to 30% of SCCP content in product weight and can be based in various materials, among which polyurethane. Indeed, it has been demonstrated that 5% of the SCCP production in China is destined to polyurethane foam adhesives. For this reason, three NCM codes were selected to track adhesives, recording a total import of 601,876 tonnes for the analyzed period. Regarding polyurethane materials 488,731.3 tonnes of imported products were registered, being 89,466.27 corresponding to adhesive polyurethanes (MMA, 2020h).

Occurrence of SCCPs in Brazil

The literature review revealed a total of 10 studies considered to be relevant for the analysis of CPs occurrence in Brazil. From those, three reported the occurrence of CPs in biotic environmental samples or products, one reports the use of CP in a flame retardant test (BARBOSA et al, 2007), and six indicates Brazil among the producers of SCCPs (IPEN, 2007; UNEP, 2007; UNEP, 2015b; GLÜGE et al, 2016; LIU et al, 2017; VORKAMP et al, 2019). The studies that analyzed Brazilian samples comprise indoor dust from various cities (up to 3.4 mg kg^{-1} in Campinas) (GREENPEACE, 2004), children's toys (up to 13,973 mg kg^{-1} in rubber ducks) (IPEN, 2017), car tires (0.3 μg g^{-1}) (BRANDSMA et al, 2019). The study that reports a test of CP as a flame retardant does not clarify whether the tested product has been acquired in the Brazilian market or imported for this purpose. The remaining reports assume that Brazil has remained as a producer of SCCPs, even though, as discussed previously, there are no records of CP production in Brazil since 1994. None of the compiled studies was obtained through the CAPES platform for thesis and dissertations.

2.3.7. Assessment of Perfluorooctanoic acid - PFOA, its salts and related compounds (Annex A)

PFOA, its salts and PFOA-related compounds in the Stockholm Convention

The PFOA, its salts and PFOA-related compounds were listed in 2019 under Annex A to the Stockholm Convention, with specific exemptions. PFOA is a perfluorinated substance, commonly used as a surfactant in industrial applications, and can be used in the synthesis of polymers and other substances. Once in the environment, PFOA-related substances are degraded to PFOA, which can cause harmful effects to organisms, including humans.

The American company 3M began PFOA production in 1947 (KEMI, 2015). In 1951, another company, DuPont, purchased the compound for use in the manufacture of a fluoropolymer, polytetrafluoroethylene (PTFE). More than ten years later, in 1968, organofluorinated substances were detected in the blood serum of Americans (TAVES, 1968). Only in 1976 it was suggested that the detected compounds could be PFAS, such as PFOA (GUY, TAVES and BREY, 1976). In 1999, PFOA was identified in the blood of employees of industries that produced organofluorinated compounds (OLSEN et al, 2007). This led to 3M announcing a phase-out of PFOA production in 2000. However, DuPont kept producing and using PFOA.

In the following decade, scientific evidence of the harmful effects of PFOA on human health and its ubiquity in the environment led the leading global producers to sign up to the Global PFOA Stewardship Program, proposed by the United States Environmental Protection Agency (USEPA). The program's aim was to eliminate PFOA production by 2015.

PFOA is an environmentally persistent substance whose amphiphilic properties confer repellency to both water and oil, which makes it a valuable molecule to industry. It was used as a surfactant in the production of fluorinated polymers, giving them the same repellent characteristic. Some of the applications were in surface treatments, in kitchen utensils, in fabrics and clothing, in paper treatment for food packaging, among others (UNEP, 2017c).

Since its addition to the Stockholm Convention, in 2019, PFOA, its salts and PFOA-related compounds production and use may only occur under specific exemptions in signatory countries.

Production of PFOA, its salts and PFOA-related compounds

PFOA, its salts and PFOA-related compounds have been produced around the world for a variety of industrial applications. Many of the industries that can use these substances in their processes are present in Brazil. The MMA sent an official letter to 1,368 companies and business associations, including industrial sectors that may use PFOA, its salts and PFOA-related compounds in their processes (MMA, 2020i).

There was no return from any of the 1,368 institutions with regard to PFOA, its salts and PFOA-related compounds. It was not possible to determine production of any of these substances (MMA, 2020i).

Trade of PFOA, its salts and PFOA-related compounds

The MDIC database for international commerce (Comex Stat) was consulted on the import and export of PFOA, its salts and PFOA-related compounds in search of NCM tracking codes. No NCM was found for PFOA and for any of its 30 related compounds listed by the OECD (OECD, 2007). Without specific codes, these substances can be traded under generic codes that include several products in addition to those of interest, which make it difficult or impossible to obtain data on their import and export (MMA, 2020i).

However, NCM codes for goods that may contain PFOA or its related compounds, according to the Convention specific exemptions, were found. The codes referred to fire extinguishers, semiconductors and photographic coatings.

None of the above NCM codes are specific to PFOA, its salts and PFOA-related compounds. Based on them, it is not possible to estimate quantities of PFOA sold in Brazil. They only show that the commercialization of articles that can use PFOA, its salts and PFOA-related compounds takes place in the country (MMA, 2020i).

Stockpiles PFOA, its salts and PFOA-related compounds

None of the 1,368 companies replied to the query by the MMA (MMA, 2020i). Without input from potential stakeholders, it is not possible to identify stockpiles of PFOA, its salts and PFOA-related compounds in Brazil.

Emissions of PFOA, its salts and PFOA-related compounds and future projections

It was not possible to estimate past and current emissions nor to make future projections based on the PFOA inventory current findings.

Occurrence of PFOA, its salts and PFOA-related compounds in Brazil

A scientific literature review was conducted in order to have an overview of PFOA, its salts and PFOA-related compounds in Brazilian environmental samples (QUINETE et al, 2009; PEREZ et al, 2014; SOUZA et al, 2020). From online databases, ten studies were selected by the protocol criteria (MMA, 2020i). They were the same studies found for PFOS occurrence, since authors usually aim to measure a group of environmentally relevant PFAS which includes both PFOS and PFOA.

Contrary to what was found for PFOS occurrence in Brazilian environmental samples, PFOA concentrations were, in most cases, below detection limits (DORNELES et al, 2008; LEONEL et al, 2008; QUINETE et al, 2009). Only three out of seven studies investigating biotic samples reported detectable concentrations. It is noteworthy, however, that one study where the authors measured PFAS in the blood of pregnant women found a positive correlation between PFOA concentrations and fetal growth restriction (SOUZA et al, 2020).

Also noteworthy is that one study investigating PFAS occurrence in foods found higher occurrence and concentrations of PFOA when compared to PFOS (PEREZ et al, 2014). This was the only case where PFOA occurrence and concentrations were higher than PFOS in all ten studies.

Regarding abiotic samples, PFOA was detected quite frequently in water samples (QUINETE et al, 2008; LOFSTEDT GILLJAM et al, 2015). Most importantly, PFOA was found in tap water in two different cities in Brazil, which means that people are exposed when drinking water. The levels, however, were below those considered harmful by international regulatory agencies (LOFSTEDT GILLJAM et al, 2015; NASCIMENTO et al, 2018; SCHWANZ et al, 2016).

2.3.8. Assessment with respect to DDT (Annex B, Part II)

Brazil did not register an acceptable purpose for DDT to control vectors of diseases. Although DDT was largely used to control malaria in the past, its use for this purpose was banned in 1998 and the total banishment for any purpose took place in 2009 (GUIDA et al., 2018) DDT is currently replaced by pyrethroid insecticides (particularly cypermethrin) in public health campaigns to combat malaria. Available antivectorial measures include environmental management, chemical treatment of the household through spraying with residual insecticides such as pyrethroids, particularly permethrin, which, although less effective than DDT, are supposed to be less toxic to humans and less harmful to the environment. Other applicable measures are the chemical treatment of open spaces through space spraying with Ultra Low Volume (ULV) insecticides, thermal fogging (fumacê) and treatment of breeding sites (MS, 2005). More detailed information on DDT can be found in the first Brazilian NIP (MMA, 2015a).

2.3.9. Assessment of PFOS, its salts and PFOSF (Annex B)

PFOS, its salts and PFOSF in the Stockholm Convention

For the process of the NIP updating, the national inventory of PFOS, its salts and PFOSF (MMA, 2015a) was revised and updated from 2018 to 2020 (MMA, 2020j). PFOS, its salts and PFOSF were listed in 2009 under Annex B of the Stockholm Convention. PFOS is a perfluorinated substance, used in the form of salts in some applications, and it can be incorporated into polymers and other substances. In the environment and in the human body, PFOS is commonly found in its anionic form, however, it is not a naturally occurring substance.

PFOS production started in the 1940s by 3M. In 1968, organofluorinated substances were found in human blood serum (TAVES, 1968). In 1999, PFOS was identified in the blood of employees of industries that produced fluorinated compounds (OLSEN et al, 2007). The US Environmental Protection Agency then began investigating the substance's occurrence in the environment and in humans, prompting 3M to announce that it would phase out the PFOS and related compounds from 2000 onwards (3M, 2000). Since then, the world production of PFOS, previously concentrated in the United States, has been centered in Asia, where it is still produced (UNEP, 2012a).

PFOS is a persistent compound, with high chemical and thermal stability. Because of its amphiphilic properties and the fact that, when associated with polymers, it confers them the same properties, it is a molecule of interest for industry. PFOS and related substances have been used in surface treatments by industry, generally for non-stick products, waterproof fabrics and clothing. It has also been used in the production of fire-fighting foams and in various industrial applications, such as the treatment of paper for food packaging (UNEP, 2012a).

Since its addition to the Stockholm Convention, in 2009, PFOS, its salts and PFOSF production and use may only occur under specific exemptions and acceptable purposes in signatory countries.

PFOS, its salts and PFOSF in Brazil

The first inventory of PFOS, its salts and PFOSF, pointed out that these substances were only used in Brazil for the production of Sulfluramid-based (EtFOSA) ant bait insecticides and as a mist-suppressant in metal plating. The first use was regarded as an acceptable purpose, while the second was a specific exemption by 2018. Both uses were submitted by Brazil to the Convention Secretariat (MMA, 2015a), endorsing the relevance of those applications in the country. Brazil is still uses PFOSF for ant bait production but has ceased to use PFOS related substances for metal plating in 2017 (BRAZIL, 2018). Moreover, in the last decade, the use of sulfluramid-based ant bait in South America, especially in Brazil, has been pointed out as responsible for the Southern Atlantic Ocean contamination by PFOS (GONZÁLEZ-GAYA et al., 2014; LOFSTEDT-GILLJAM et al., 2016).

Although Brazil reported only two uses of listed PFOS, other potential production processes and articles may use or contain these substances. Historical uses, such as stain protection for papers and textiles, surfactants and fire-fighting foams, are likely to have occurred in Brazil. Many of these articles may still be in use or may have been disposed of in landfills, being thus potential emission sources. Landfills are of major concern since listed PFOS and its precursors could leach to the soil and underground water, eventually reaching the ocean (PAUL et al., 2009).

In electroplating, PFOS and its related substances are used as surfactants, wetting agents and mist suppressants. The main use is as a mist eliminator in baths in hard chromium plating and decorative plating processes, where chromic acid mist is emitted. The electrodeposition of chromium by PFOS prevents the mist from being released into the air, being retained in the bath and avoiding worker exposure to chromic acid mist. In addition, fluorinated substances, including PFOS and its related substances, can be used in surface treatments in plating processes involving copper, nickel, and tin (UNEP, 2012).

The main compounds used for electroplating are tetraethylammonium perfluorooctane (CAS 56773-42-3), potassium perfluorooctane sulfonate (CAS 2795-39-3), its lithium salts, diethanolamine and ammonium salts of PFOS. The National Inventory of New Persistent Organic Pollutants for Industrial Use identified the use of the product Bayowet FT248R, which has tetraethylammonium perfluorooctane as its active ingredient and is used as a mist eliminator in baths in hard and decorative chrome plating processes (UNEP, 2012). Brazil reported the use of 1,876 kg of PFOS for electroplating in 2011 and that it discontinued the use of Bayowet and any other PFOS-related substances in 2017 (BRAZIL, 2018).

The hard and decorative chrome plating processes use hexavalent chromium. In decorative chrome plating, chromium VI can be replaced with chromium III, which would reduce or eliminate the use of PFOS baths (UNEP, 2007). Substitution for chromium III in hard chromium plating is not feasible and therefore the use of the compound in closed systems in this process is an acceptable purpose (UNEP, 2007).

The use of these substances in electroplating is an acceptable purpose only when performed in closed systems (UNEP, 2012). When performed in open systems, the practice may be a point source of PFOS and is not described as an acceptable purpose. In Brazil it is possible that the practice is performed in an open system, because chrome plating is often performed by small companies that may not have adequate waste management structures.

The use of Bayowet, a PFOS-based product used in baths in the chromium plating process, was allowed through a specific exception requested by Brazil. The exception allowed the use of PFOS-related substances in baths for hard and decorative chrome plating in open systems for five years. In 2018 the Convention withdrew the use as a specific exception and the compound can no longer be used for this purpose. The MMA consulted with 1,378 companies that may produce or make use of PFOS, its salts, and PFOSF, including companies linked to the electroplating, plating, and surface treatment industry, and a national surface treatment association. However, there was no feedback from any of the institutions consulted with regard to PFOS, its salts, and PFOSF.

Various other industrial processes and article production can use PFOS, its salts and PFOSF. Questionnaires were sent to companies and associations involved in industrial processes or article manufacturing related to those listed as acceptable purpose or specific exception. However, there was no feedback from any of the institutions consulted with regard to PFOS, its salts or PFOSF.

Production of PFOS, its salts and PFOSF

According to the National Inventory of New POPs for Industrial Use (MMA, 2015a), Brazil did not produce PFOS and the current application of PFOS, its salts and PFOSF in the country was restricted to electroplating and the production of sulfluramid (EtFOSA) to be used in baits for the control of leaf cutting ants of the genus *Atta* and *Acromyrmex*. In its fourth national report sent to the Convention in 2018, Brazil stated that it ended the use of substances related to PFOS for electroplating in 2017 and that it continued to use Sulfluramid-based ant baits (BRAZIL, 2018a).

For the production of Sulfluramid — which acts as an active ingredient in ant baits — PFOSF is used. Brazil produces, sells and exports Sulfluramid-based baits. The pesticide is used in all Brazilian states and in some Latin American countries where the ant genera *Atta* and *Acromyrmex* occur (UNEP, 2012a). Between 2009 and 2018, Brazil reported to the secretariat of the Stockholm Convention the use of approximately 50,000 kg of PFOS per year for the production of EtFOSA (BRAZIL, 2018b).

However, based on official pesticide production and marketing reports from IBAMA, between 2010 and 2018, 232.9 tonnes of EtFOSA active ingredient were produced in Brazil (MMA, 2020j). This value corresponds to 25.9 tonnes per year. Domestic production of Sulfluramid would have consumed 41.4 tonnes of PFOSF annually, based on calculations presented in the previous NIP (MMA, 2015b). This amount is lower than that reported by Brazil to the Secretariat of the Stockholm Convention in 2018 (BRAZIL, 2018b).

According to information provided by Abraisca, the numbers reported from 2013 to 2017 are estimated, as the values were calculated from the amount of sulfluramid produced in the period, so the amounts of PFOSF used were approximate (around 50,000 per year) which may explain the differences reported in the NIP.

Trade of PFOS, its salts and PFOSF

Based on a query to the Ministry of Development, Industry, Trade and Services's international trade database (Comex Stat), several custom codes referring to PFOS and related substances were found. For Sulfluramid and ant bait domestic sales, IBAMA's pesticide production and marketing reports were consulted.

Specific custom codes for PFOS and PFOSF were created in 2017. Between 2017 and 2019, Brazil imported 95,750 kg of PFOS and PFOSF, the equivalent of 31,916 kg per year, from China and has not exported any quantity of the substances (MMA, 2020j). This value is lower than that reported by Brazil to produce Sulfluramid (BRAZIL, 2018a). There is an inconsistency in the substance's import data, which may indicate the possibility of PFOSF is still being imported using generic custom codes.

Regarding this possibility of PFOSF is still being imported using generic customs codes, Abraisca reported that all PFOSF imports made by their associated companies, after 2017, were made using the specific code for PFOSF. Abraisca attributes the difference between the quantity of PFOSF imported and used in the production of sulfluramid to the existing stocks of PFOSF in the country.

The previous NIP (MMA, 2015b) reported that a generic custom code was used to import PFOSF between 1997 and 2016. However, several other chemicals not related to PFOS are also imported under this same registry. Therefore, it is not possible to estimate, based on data under this custom code, the import and export of PFOS and PFOSF in this period (MMA, 2020j).

Regarding custom codes for electroplating related substances, from 2017 to 2019, Brazil imported 35 kg of substances. Imports came from China, Germany and the United States. No amounts were exported (MMA, 2020j).

Custom codes related to Sulfluramid fall into two categories. Codes labeled as Sulfluramid are referring to Sulfluramid as a technical product which is 93% to 98% EtFOSA. Codes labeled as Sulfluramid-based pesticide refers to the commercial products, which are the toxic ant baits containing between 0,2 % e 0,3 % EtFOSA.

Of the technical product, between 2004 and 2019, Brazil imported 7,607 kg, equivalent to 475 kg per year. Import came from the following countries: Belgium, Canada, China, Czech Republic, Germany, Hong Kong, India, Switzerland, United States and Virgin Islands. In the same period, the country exported 11,430 kg, equivalent to 714 kg per year, of the technical product only to Argentina and France (MMA, 2020j).

For the custom codes referring to the commercial product, there is no import data between 2004 and December 2019. In the same period, Brazil exported 4,675,172 kg, equivalent to 292,198 kg per year, of Sulfluramid-based (EtFOSA) toxic ant baits. The product was exported to the following countries: Angola, Argentina, Bolivia, Chile, Colombia, Costa Rica, Cuba, El Salvador, Ecuador, Guatemala, Honduras, Panama, Paraguay, Peru, Suriname, Trinidad and Tobago, United States, Uruguay and Venezuela (MMA, 2020j).

From Sulfluramid concentrations in technical products (PT; Portuguese acronym) and commercial baits it is possible to estimate the amount of EtFOSA sold between 2004 and 2019. Brazil would have imported approximately 7,200 kg, equivalent to 470 kg per year, and exported approximately 24,800 kg, equivalent to 1550 kg per year, of EtFOSA in the aforementioned period (MMA, 2020j).

Regarding Sulfluramid domestic sales, 223.57 tonnes of EtFOSA (active ingredient) were sold in Brazil between 2010 and 2018 The highest number of sales took place in the state of Mato Grosso do Sul, followed by Minas Gerais, São Paulo and Bahia. Together these states add up to 83% of all sales of the substance in national territory (MMA, 2020j).

Stockpiles of PFOS, its salts and PFOSF

Only two companies reported having stockpiles of PFOS related products. Both stockpiles are related to production or commercialization of Sulfluramid-based ant baits. One company reported having in stock 22,513.5 kg of four different commercial products and 0.58 kg of PT (98% EtFOSA). The other company reported having 180 kg of commercial products in stock.

The stocks of the two companies together would correspond to 68.6 kg of EtFOSA, based on EtFOSA concentrations in commercial and PT (MMA, 2020j).

Emissions of PFOS, its salts and PFOSF and future projections

Past emissions of PFOS, its salts and PFOSF

Potential PFOS emissions from Sulfluramid toxic ant bait usage were estimated. Soil biodegradation was considered the main transformation for EtFOSA present in baits (LÖFSTEDT GILLJAM et al, 2015). Zabaleta et al (2018), measured EtFOSA transformation in a plant/soil mesocosm, using Brazilian soil samples. They found PFOS yield varying from 34% for EtFOSA PT and 277% for commercial ant baits (ZABALETA et al, 2018). In recent experiments performed by Brazilian Agricultural Research Corporation (Portuguese acronym EMBRAPA), technical EtFOSA transformation was measured in two different Brazilian agricultural soil samples (EMBRAPA, 2021b; Guida et al, 2023). They found PFOS yields of 29,9% and 29,8% (EMBRAPA, 2021b).

Assuming PFOS yields from EtFOSA transformation as calculated in an experiment by Zabaleta et al (ZABALETA et al, 2018), the 223.5 tonnes of EtFOSA traded within Brazil between 2010 and 2018 may have led to the emission of 76 of PFOS to the environment (using technical EtFOSA transformation yields, respectively) (MMA, 2020j). Assuming PFOS yields from technical EtFOSA transformation, as measured by EMBRAPA (EMBRAPA, 2021b; Guida et al, 2023), EtFOSA trade in Brazil would have led to the emission of around 63.7 tonnes of PFOS.

Future projections

Based on past values for production and sales, it is possible to observe a linear trend (using regression by method of least squares) and to estimate future projections. This has been done for production and domestic sales of EtFOSA in order to estimate potential future emissions of PFOS.

Based on the current scenario, Sulfluramid production in Brazil in 2030 would be around 60 tonnes per year. During the whole decade of 2020, the country would produce a total of 555 tonnes. This means that EtFOSA production would double in the next decade. Domestic sales of EtFOSA would follow a similar trend, being around 60 tonnes EtFOSA sold per year in 2030.

Abraisca questioned the future projections, indicating that “based on the history of use of ant baits in Brazil, we can state that the prediction that the production of sulfluramid will double in the next decade is incorrect. Although there is a prediction of an increase in the planted area, the amount of bait used per treated area has decreased over time. In a forecast, quite optimistic, we can admit a production increase of a maximum of 50%”.

Assuming soil biodegradation of EtFOSA ant baits and doing the same calculations used in the inventory (MMA, 2020j), it is possible to estimate PFOS emission up to 2030 based on above projections. Using transformation yields of technical and commercial EtFOSA, as reported by Zabaleta et al (2018), PFOS emissions due to usage of EtFOSA ant baits in the 2020’s may be of 189 tonnes. Using yields as measured by EMBRAPA (EMBRAPA, 2021b; Guida et al, 2023), PFOS emissions would be around 158 tonnes in the same decade.

Occurrence of PFOS, its salts and PFOSF in Brazil

A review of the scientific literature was carried out to investigate the occurrence of PFOS, its salts and PFOSF in Brazil. Review protocol is detailed in PFOS, its salts and PFOSF inventory. A total of ten publications were found which met criteria. Three of them were also published as dissertations or thesis as part of Brazilian graduate courses (MMA, 2020j).

There are three studies investigating the occurrence of PFOS, among others per-or-polyfluoroalkyl substances (PFAS), in Brazilian aquatic biota (DORNELES et al, 2008; LEONEL et al, 2008; QUINETE et al, 2009). In all three, PFOS was the PFAS with the highest occurrence and highest concentrations amongst samples. Concentrations found in coastal marine organisms most likely reflect continental use of substances that degrade to PFOS, such as EtFOSA.

Two studies measured the occurrence of PFOS, among other PFAS, in human blood samples (KANNAN et al, 2004; SOUZA et al, 2020). The first one was done in 2004 while the second was done in 2020. Both studies found that PFOS were present in all samples, while it was the PFAS with the highest concentrations in blood samples analyzed in 2020. One of them also found a positive correlation between PFOS concentrations and fetal growth restriction (SOUZA et al, 2020).

There were four studies investigating PFAS, including PFOS, occurrence in abiotic samples, such as soils, sediments and water (NASCIMENTO et al, 2018; QUINETE et al, 2009). PFOS was found in 100% of tap water samples in Brazil. PFOS was also found in river, estuarine, coastal and well water (QUINETE et al, 2009; LOFSTEDT GILLJAM et al, 2015; SCHWANZ et al, 2016; NASCIMENTO et al, 2018).

PFOS seems to be present in environmental samples in Brazil. However, there is a huge gap in sampling and analysis of PFOS in the country. Only the states of Rio Grande do Sul, São Paulo, Rio de Janeiro and Bahia have been sampled, and even so, sampling is done in few specific locations. Heavily industrialized areas, such as in São Paulo, were not assessed for PFOS occurrence, nor were agricultural areas where EtFOSA ant bait are most used, such as in Mato Grosso do Sul (MMA, 2020j).

2.3.10. Assessment of releases of unintentionally produced POPs - uPOPs (Annex C)

Not all POPs are intentionally produced chemicals. Some of them, such as those listed in the Annex C to the Stockholm Convention can be formed as byproducts of natural and anthropogenic processes. In the update scope of the Brazilian NIP, only HCBD and PCNs were covered. Their potential unintentional productions and releases were covered in their respective subchapters (2.3.5. and 2.3.8.). However, considering that more than five years has passed since the first Brazilian NIP, a reviewed and updated inventory for uPOPs, covering all uPOPs listed in Annex C, is needed for a thorough implementation of the Stockholm Convention in Brazil.

For instance, the National Inventory of Sources and Estimates of Releases of Dioxins and Furans, developed in 2011, is an important basis for the development of strategies for reducing releases of these substances and indicates the priority sources for the Action Plan. The inventory results showed a systematized scenario of the releases of dioxins and furans in Brazil. The inventory showed that Brazil has all emission sources included in the toolkit and a potential release of 2,235 g TEQ of dioxins and furans. The largest share was of the air media with 42.3% of total releases in 2008. This is followed by release in residues, with 24.4%, and in third place, release in products with 18.7%.

The largest share by source category is Category 2 — ferrous and non-ferrous metals, with 38.2% —, followed by Category 6 — open burning, with 22.8% — and in third place, Category 7 — chemicals and consumer goods, with a share of 17.5%. The Southeast Region proved to be the one with the highest releases, responsible for 58.8%, followed by the South Region with 12.4%. The smallest share was seen in the North Region, with 8.4%. The state of São Paulo is the federal state with the largest share of releases, 28.9% of the emissions total, followed by the state of Minas Gerais, with 12.9%. The state of Rio de Janeiro is responsible for 10.1% of releases. These three states together account for 51.9% of releases. The ten highest emitters (SP, MG, RJ, ES, PA, PR, RS, MT, BA and GO) account for 86% of releases. The five largest sources of these substances were, in decreasing order, iron ore sintering, open burning of biomass, leather industry, iron/steel plants and finally fires and burning of wastes, accidental or otherwise.

A review of information and updating of the inventory will be carried in the future, when strategies for reducing emissions of the Plan of Action will also be reviewed. The review of this inventory was not included in the scope of this NIP Updating process.

2.3.11. Information on the state of knowledge on stockpiles, contaminated sites and wastes

Specific information on POP stockpiles and wastes has already been presented in the individual POP sections above. Considering the low number of responses to the queries sent by the MMA, it was not possible to identify contaminated sites other than those identified in the NIP-Brazil-2015 for most POPs. However, the geographical distribution of the national industries that may be linked to POP production, application or release was assessed for each POP inventory as an indicator of potentially contaminated sites. It resulted that Brazil's southeast, more specifically the State of São Paulo, may be the most impacted region by POP applications and releases. Further specific information can be found in respective POP inventories.

A potentially contaminated site was identified in Cubatão, São Paulo for the POPs HCBD and PCP. Further specific information can be found in each respective POP inventory but they were also briefly presented at the specific POP section above. A comprehensive investigation is still needed to confirm numbers, guidance, remediation measures, and data on releases from the contaminated site.

Further information on contaminated sites can also be found in Chapter 2.3.19.

2.3.12. Summary of future production, use, and releases of POPs

Brazil has followed the Stockholm Convention provisions and, in theory, POPs are only used within their acceptable purposes and specific exemptions for the period they have been granted. Currently, none of the listed POPs is produced in Brazil. On the other hand, there is a lack of capacity in the country for monitoring POP releases from their acceptable purposes and specific exemptions. Rough estimates of POP emissions and of POP content in POP-containing goods have been made in individual inventories and briefly presented in the specific POP section. The Brazilian Government does not plan to apply for exemptions other than those already granted.

2.3.13. Existing programs for monitoring releases and environmental and human health impacts

Although Brazil has participated in several rounds of the Global Monitoring Plan for POPs under the Stockholm Convention, a nationwide centralized monitoring program does not exist yet. Results from the Global Monitoring Plan have been published in the first and second Global Monitoring Reports and in the first, second and third Regional Monitoring Report for Latin America and the Caribbean, which can be accessed in the Convention website (http://www.pops.int/Implementation/GlobalMonitoringPlan/MonitoringReports/tabid/525/Default.aspx). Most POP studies and monitoring programs in Brazil are funded by the Federal Government through its research and education funding agencies and are carried out mostly by public universities within their graduate programs. The studies that have resulted in peer-reviewed publications were presented within each specific section of POP occurrence within Chapter 2.3. for the inventories that have been updated or developed from 2015 up to 2020. A broader assessment covering scattered organochlorine pesticides (OCPs) and/or PCB monitoring in the country was not included in this version of the Brazilian NIP and shall be developed for the next round of reviews and updates. For instance, some specific monitoring programs have been performed by governmental institutions, such as CETESB, EMBRAPA and FIOCRUZ.

After the atmospheric monitoring carried out in São Paulo by CETESB (TOMINAGA et al., 2016), only one sampling point has been maintained by CETESB for atmospheric monitoring of POPs in São Paulo. On the other hand, organochlorine pesticides (OCPs), PBDEs, PCBs, dioxins and furans have been monitored by CETESB in sediment samples from São Paulo (CETESB, 2019, 2020). CETESB is also currently developing the final reports of a monitoring program covering PBDEs, PCBs, dioxins and furans in fish and sediment in the upper Tietê river basin and another one covering PFAS in the hydric system of São Paulo. Moreover, CETESB has been involved in the "Continuing regional Support for the POPs Global Monitoring Plan under the Stockholm Convention in the Latin American and Caribbean Region", UNEP/GEF-4881.

EMBRAPA has recently finished a monitoring study on the conclusive information about the possible formation of PFOS from the transformation processes of sulfluramide, employed as an anticide in agricultural production areas, as well as the evaluation the level of exposure of the environment to PFOS, especially the water resources, in the areas of influence of agricultural crops that use sulfluramide ant baits. The biodegradation test indicated that the transformation of sulfluramide leads to the formation of PFOS, FOSA and FOSAA. The degradation rate of sulfluramide was high, with half-life of the molecule being less than 39 days in the two soils evaluated, as already discussed in section 2.3.9. Another strong evidence that sulfluramide is a precursor to PFOS was the result of PFOS analyses in groundwater samples (EMBRAPA, 2021b). The monitoring wells where the groundwater samples were collected are located in fields cultivated with commercial forest species. Under these conditions, the most likely source of contamination is the degradation of sulfluramide-based formicide baits, since the history of the areas does not indicate another potential source of contamination and the collections are made in a very punctual manner, within the forest production areas, which would eliminate the possibility of contamination of other areas or sources of contamination. The results of the monitoring of waterways also support this hypothesis. The data indicated PFOS contamination of the surface waters of all selected watersheds over the 12-month collection period. The sediment samples showed a lower level of contamination, with the presence of PFOS and other analytes detected in the rainy period only at one sampling point. In the dry period, the frequency of detection was higher, but not as widely as found in the surface water. Based on the evidence found in this study, biodegradation of sulfluramide in soil can be considered a highly probable route for the formation of PFOS. In addition, PFOS showed high mobility in the environment, causing contamination of water resources and sediments in the watersheds where sulfluramide was used as formicide baits (EMBRAPA, 2021b).

The Ministry of Health, through FIOCRUZ, has monitored OCPs concentrations in blood from the population of a contaminated area in Rio de Janeiro (FIOCRUZ, 2019). In the last monitoring, seven hundred and fifteen people participated in the test. Residues of organochlorines, such as HCH and DDT, were found in 73.5% of the participants.

The contamination is ten times less than what was found in the tests released in 2005 (FIOCRUZ, 2019). On the other hand, a recent study has shown that the atmospheric contamination by OCPs in this area (Cidade dos Meninos, Duque de Caxias, RJ) may still lead to an increased risk of hepatic cancer development in the resident population (Guida et al., 2021).

In view of the National Health Surveillance Policy, approved by Resolution CNS No. 588 of 12/07/20186, and considering the worldwide concern with the public health risks resulting from exposure to chemical substances, the Ministry of Health of Brazil has currently been working on the structuring of the Human Biomonitoring of Chemical Substances Program, which will help in the understanding of the Brazilian population's exposure profile to chemical substances potentially harmful to human health. The Human Biomonitoring Program aims at the prevention of diseases and illnesses and the promotion of the population's health through the monitoring of human exposure to hazardous chemicals, such as POPs. Indeed, although the Program implementation is still in progress, it is expected that most POPs will be monitored throughout the country, and this may become Brazil's most comprehensive POP monitoring.

2.3.14. Current level of information, awareness, and education among target groups: existing communication systems.

Article 10 of the Convention addresses the component "Public Information, Awareness and Education". It specifies that signatory countries must undertake activities to promote and facilitate access to information by the public, as well as to seek participation of society in the implementation of the Convention and to invest in training of technical personnel to meet the obligations deriving from it.

The right to information is consolidated in the Brazilian legal system and it is ensured by the Federal Constitution. The National Environment Policy defines as one of its objectives to disseminate environmental data and information and to raise public awareness of the need to preserve environmental quality and ecological balance. It is also mandatory that all requests for environmental licensing, its renewal and concession be made public.

It is important to note the National Environmental Education Policy Law No. 9795/99, which stresses that environmental education is an essential and permanent component of national education with the aim of, among others, developing an integrated understanding of the environment with its multiple and complex relations, ensure democratization of environmental information; encourage and strengthen critical thinking on environmental and social issues; and encourage permanent and responsible individual and community participation in preserving the equilibrium of the environment, by understanding that protection of environmental quality is an inseparable part of being a citizen.

The first NIP elaboration process, through several seminars and working group meetings, contributed substantially to expanding knowledge on POPs among environmental government technicians and allowed for a wide dissemination of the Stockholm Convention among companies involved with the use and production of POPs. On the other hand, the process of review and update of the NIP was more limited when compared to the first NIP in terms of interaction, stakeholder engagement and public awareness and participation.

The MMA has made the main outcomes of the NIP development publicly available on its website since its first version. Basically, anybody interested on this topic and with access to the internet can reach this content. CETESB also maintains a webpage for public information on the Stockholm Convention and POPs, as well as on other international treaties pertaining to chemicals. CETESB has also held national and international workshops focused on the implementation of the Stockholm Convention along with the MMA and the Secretariat of the Stockholm Convention. The last international workshop was held in 2018 aiming to discuss the "Support to the Stockholm Convention's Global Monitoring Plan for POPs phase 2: Sampling and Analysis of New POPs in Brazil".

A long-term course entitled: "International Programme for Intensive Training on Chemicals and Waste Environmental Management, in particular, POPs and Mercury", was offered in cooperation with Japan International Cooperation Agency (JICA). These were classroom environmental management programs that addressed all POPs issues and management techniques and aimed at strengthening countries and states to comply with obligations from the Stockholm Convention in face of the harmful impacts of POPs and other chemicals included in the Conventions. The course is divided into three modules:

1) Environmentally sound management of chemical substances, especially POPs and Hg;
2) Environmentally sound management of chemicals, in particular POPs and Hg

and sampling techniques in environmental matrices; and

3) Determination of POPs and mercury in environmental sample matrices.

These training programs allowed the capacity building of technical personnel from several Brazilian states, as well as from other countries: not only from Latin America and the Caribbean but also from Africa.

Another long-term course has been promoted by CETESB for an "International Training for Chemical Management". The MMA, as the technical focal point of the Stockholm Convention in Brazil, has invited representatives from the Brazilian states to participate in training programs on chemicals management offered by CETESB, as the regional center of the Stockholm Convention for the Latin American and Caribbean region. Among these is a complete program on environmental management that focuses on all the issues surrounding POPs and management techniques.

Short term international courses for intensive training in environmental management of POPs and mercury have also been held by CETESB with the objective of supporting the contemplated countries with information and technical advice about management, legislation, norms and standards, and quality monitoring of POPs in the environment, so that they can fulfill their obligations under the Stockholm Convention.

The courses covered the following contents: management of areas contaminated with POPs from the Stockholm Convention, standardization of methods for sampling and analysis of POPs in matrices of breast milk and air, analysis of POPs and mercury in biological and environmental matrices.

The following countries were involved: Brazil, Dominican Republic, Uruguay, Paraguay, Venezuela, Guatemala, Chile, Peru, Costa Rica, Colombia, Panama, Costa Rica, Cuba, El Salvador, Honduras, Mexico, Barbados, Belize, St. Lucia, and Suriname.

Furthermore, two EaD courses pertaining to POPs have been developed by CETESB.

The first, in the scope of the capacity building and training activities that make up the NIP Brazil, an agreement was signed with CETESB, as the Regional Center for the Stockholm Convention for Latin America and the Caribbean region, to develop an introductory course on the Stockholm Convention on POPs, in the EaD modality, directed to professionals, decision makers, managers and technicians from public agencies (federal, state and municipal) and private ones from Brazil, besides representatives from NGO and popular and autonomous movements involved in the chemical safety theme, especially the one related to POPs.

Among the expected results is the wide dissemination of concepts and the necessary and mandatory measures to comply with the Stockholm Convention. The initiative of distance training will provide an expansion of the public prepared to act in the implementation of the Stockholm Convention throughout the national territory. From January to March 2015, CRCE/CETESB prepared and made available, on the Moodle platform, the content of the EaD course "Introduction to the Stockholm Convention on POPs". Between 2015 and 2020, 1030 (one thousand and thirty) Brazilian professionals participated in the course.

The EaD course "Introduction to the Stockholm Convention on POPs" was again implemented within the scope of Project BRA/08/G32 Establishment of the Management of Polychlorinated Biphenyls and Disposal System. In addition, a new EaD Course on PCB management was developed and implemented, with the objectives of developing and strengthening the country's capacity to manage and dispose of insulating oils, equipment and waste with PCBs and to promote the environmentally appropriate final destination of its waste, in order to meet the deadlines established by the Stockholm Convention, minimize the risks of occupational exposure and contamination of natural resources that affect the health of the population.

The intention of this project is to offer training opportunities in the management of PCB residues for a large number of technicians from the electrical and production sectors and other holders of PCBs, besides the technicians from environmental organs, helping them to fulfill their commitment to eliminate PCB stocks within the time limits established by the Convention.

For this case, the EaD modality for conducting a course on Environmental Management of PCBs was chosen because it allows the participation of those people who are unable to get away from work or from their homes to dedicate themselves to studies, while maintaining the spirit of responsibility and commitment of the individual with the learning process.

Despite the educational role of CETESB and the advances achieved into this topic since the first NIP, the collaborative work among governments, NGOs, academic research institutions, and communities, on distribution of the POPs information is very limited for the time being. Hence, it is required to develop a communication network between government ministries and stakeholders for sharing POP-related information as a first approach for implementation of the Convention. Moreover, the information and awareness of the Brazilian civil society are very deficient on this matter and need to be expanded and strengthened on international agreements, chemicals and chemical fate, environmental dynamics and impacts on the environment and human health.

2.3.15. Mechanism to report, under Article 15, on measures taken to implement the provisions of the Convention and for information exchange with other Parties to the Convention

Article 15 of the Stockholm Convention states that each Party is required to report to the COP on the measures which have been taken to implement the provisions of the Convention and the effectiveness of such measures in meeting its objectives. There have been four reporting rounds so far. The first one was on 31 December 2006, the second one was on 31 October 2010, the third one was on 31 august 2014 and the fourth was on 31 august 2018. The fifth round is set to be on 31 august 2022.

Brazil has participated in all fifth national reports rounds so far, providing information via the online questionnaire.

Regarding information exchange, there is a Stockholm Convention Regional Centre for Capacity-Building and the Transfer of Technology (SCRC) in Brazil. The SCRC is hosted by CETESB, in São Paulo. Since 2008, CETESB has been promoting courses, workshops and meetings with other Latin America and Caribbean countries, as well as other developing countries around the world and Lusophony countries. The aims of the activities developed and promoted by the SCRC in Brazil has been the training of personnel and decision makers regarding POPs; promotion of awareness on POPs; development and establishment of laboratory and research capacity; training for POPs identification and monitoring; training of personnel regarding remediation of contaminated sites; training of personnel regarding BAT and BEP; training of personnel regarding NIP development; dissemination of information. For the development of the current NIP, CETESB has promoted meetings with the consultant team and potential industry stakeholders in order to promote awareness of the importance of the development of POPs inventories.

Reports for all activities developed by the Brazilian SCRC, from 2008 to 2022, can be found in the Stockholm Convention web page: http://chm.pops.int/Implementation/RegionalCentres/TheCentres/CETESBSaoPaulo,Brazil/tabid/651/Default.aspx.

2.3.16. Relevant activities of non-governmental stakeholders

In Brazil there are many NGOs addressing environmental issues, but only a minor parcel specifically addresses toxic chemicals or POPs. We highlight the following: Association for Combating Pollutants (ACPO), Association of Workers Exposed to Chemicals (ATESQ), Action Network on Pesticides and their Alternatives in Latin America (RAPAL), Association for the Protection of the Environment of Cianorte (APROMAQ) and Toxisphera (Environmental Health Association). ACPO and Toxisphera have been quite active for the Stockholm Convention implementation, producing information on contaminated areas and chemicals in products and participating in the NIP development process. However, a comprehensive evaluation of the role of each NGO working on subjects pertaining to POPs has not been carried out and shall be considered for the next NIP update.

2.3.17. Overview of technical infrastructure for POP assessment, measurement, analysis, alternatives and prevention measures, research and development — linkage to international programs and projects

A survey of the national technical infrastructure for POP assessment, measurement, analysis, alternatives and prevention measures, research and development was not an object of the NIP update. Therefore, this is a gap that needs to be addressed in the next round of review and update of the Brazilian NIP.

The NIP-Brazil-2015 presented some of the installed infrastructure for POP pesticides, PCBs and dioxins and furans in Brazil (MMA, 2015b). Several public and private laboratories are capable of performing qualitative and quantitative determination of legacy POPs, such as organochlorine pesticides and PCBs. For dioxins and furans, the number is more restricted and the only public laboratory performing such analysis is operated by CETESB. Despite the installed infrastructure for legacy POP analysis and the monitoring programs mentioned in Chapter 2.3.14., there is important lack of infrastructure, both technical (equipment and methods) and personnel, regarding the newly listed POPs, mainly for POP-PFAS and SCCPs.

Within the NIP update scope, a public laboratory with a long time expertize on POPs — Laboratório de Radioisótopos Eduardo Penna Franca, Instituto de Biofísica Carlos Chagas Filho — at the Federal University of Rio de Janeiro, has implemented analytical capacity for the determination of all POPs listed by 2019, except PFOS & PFOSF and PFOA.

Brazil has participated in the Global Monitoring Plan of the Stockholm Convention and the outcomes have been published in the Regional and Global Monitoring Reports available in the Stockholm Convention website: http://www.pops.int/Implementation/GlobalMonitoringPlan/MonitoringReports/. On the other hand, it is important to highlight that most data pertaining to POPs in Brazil have been generated by decentralized research initiatives, carried out within education and research national institutions, such as public universities, or as cooperation with international research groups.

A comprehensive survey of the public and private national capacity for POP analysis, including education and research institutions, is necessary to understand the current situation of the Brazilian infrastructure, considering potentials and gaps for a thorough implementation of the Stockholm Convention.

2.3.18. Overview of technical infrastructure for POP management and destruction

For the NIP-Brazil-2015, a survey of available technologies and national capacity to provide adequate disposal of POPs found that there were three incinerators and three chemical treatment plants in Brazil available for this purpose. It was also stated that technologies available in Brazil were of the 70s and 80s and some of them are no longer used by the developers themselves who currently apply more up to date technologies.

Incineration has been used for the final disposal of identified obsolete POP pesticides in the states of Bahia, Paraná and São Paulo. It is not a common practice, but Brazil has also sent PCBs abroad for thermal treatment disposal as provided by the Basel Convention.

The integrated environmental management of PCBs, as foreseen in the NIP-Brazil-2015, was boosted through the implementation of the UNDP/GEF PCBs Project 63774 "Establishment of PCBs Waste Management and Disposal System in Brazil". The implementation of the project started in 2009 and was completed in 2019 which triggered the elimination of about 11,000 tonnes of electrical equipment contaminated with PCBs, owned by large-private power companies. The project also contributed to the strengthening of the governmental and regulatory frameworks for the appropriate management of PCBs, the development of national capacity for technical personnel and the execution of five demonstration projects for the environmentally sound management of PCBs. Moreover, the project delivered the "Guidance for the National Inventory of PCBs", published in 2015 and the "Guidance for PCB Management and Phase-Out", to be published still. Consequently, it is important to further strengthen and continue with some activities that were already started, enhancing the national framework in order to comply with the obligations under the Stockholm Convention until 2028.

The MMA carried out a survey of the current composition of the market chain for PCB treatment and elimination in accordance with the Life Cycle Management (LCM) of hazardous substances, from the most relevant electrical engineering and maintenance enterprises, transformer maintenance enterprises, retro filling enterprises, *interim* PCB stockpile holders, PCB transport companies, incineration/chemical elimination facilities and scrap and metal recyclers in Brazil.

Brazil has enough installed capacity at the national level for the treatment and elimination of *Askarel* oils, equipment and wastes contaminated with PCBs. Currently, five privately-owned companies are registered for PCB management in the country; two thermal treatment/incineration plants (in Minas Gerais and Bahia), two chemical treatment/ decontamination plants (in Paraná and Minas Gerais) and one mobile dehalogenation plant. These facilities have a combined treatment capacity of about 75,000 tonnes per year for different kinds of hazardous waste, including PCBs, a volume that might be sufficient for the entire country. However, the existing nominal incineration capacity in Brazil, specifically for PCBs, needs to be reassessed, considering especially effective environmental licensing permits in place. All treatment plants are privately owned facilities that charge for their services

However, one of the existing barriers is related to the logistics and transport of contaminated equipment and waste with PCBs. According to CEMA N. 50/2005 and COPAM N. 223/2018 Resolutions, from Paraná and Minas Gerais States, respectively, it is prohibited to import waste contaminated with PCB above 50 ppm from other States. Therefore, transporting PCB waste among different states has been a bottleneck for the adequate final disposal of many PCB stockpiles in the country. Civil society has also severely criticized the use of incineration as a method of destruction of POP stockpiles, due to the risk of transporting hazardous chemicals through long distances and emissions of dioxins and furans.

The complete and economically viable elimination of the remaining PCB stockpiles and contaminated wastes is thus a challenge for a continent-size country such as Brazil. From 1991 to 2018, it has been estimated that at least 23,680 tonnes of PCBs have been eliminated, of which 77% (18,134 tonnes) were domestically destroyed and 23% (5,546 tonnes) were exported for destruction. However, the figures presented by the electrical sector associations indicate a minimum estimate of the final disposal already treated of about 36,000 tonnes (equipment, fluids, materials and waste) in companies licensed between 1991 and 2018. It is estimated that 80% of the contaminated equipment remains in the Southeast States of São Paulo, Minas Gerais and Espírito Santo.

Besides the power industry, there is also a large group of potential PCB holders that will require additional assistance. This group is composed of approximately 145,800 units owned by large private stakeholders. Some of them are situated at sensitive sites, and most of them have not yet tested/identified the PCB content in their equipment. Similarly, small power companies located in some states of Brazil do not have technical and financial means to classify, label and manage equipment containing PCBs, as large power utility companies do. Thus, there is the risk that the oil potentially contaminated with PCB in these transformers is drained, subject to electrical failures and fires.

Power utility companies and large industries are willing to identify, label and safely dispose of their PCB equipment and wastes. In terms of PCB elimination, the market value for treatment at national level is USD 3,500 per ton of waste, which is lower than the cost of exporting this waste to an accredited treatment facility in another country; that is near to USD 5,000 per ton. However, safe transport or export of these contaminated materials become challenging and expensive, hindering their environmentally sound management.

To overcome the challenges mentioned above, a new project proposal — full size project (FSP) — was approved by GEF in December 2019, aiming to promote the complete elimination/destruction of PCBs in Brazil, mainly in sensitive areas such as public hospitals and old condominiums. The execution forecast is sixty months (five years), in the amount of US$ 9,660,000.00. Detailed information can be seen in Chapter 2.4.3. below.

2.3.19. Identification of impacted populations or environments, estimated scale and magnitude of threats to public health and environmental quality, and social implications for workers and local communities

In 2015, the MMA published the National Inventory of Areas Contaminated with POPs (MMA, 2015c) identified 117 areas contaminated by POPs in Brazil. There are nine of those that have already been recovered and two are being reused. These areas are present in nine Brazilian states, 100 of which are in the Southeast Region. The state of São Paulo alone is responsible for 81 contaminated areas, followed by Rio de Janeiro, with 16 (MMA, 2015c).

The industrial activity is responsible for 52% of contaminated areas. Most common contamination sources are: storage (48 sites), disposal (43 sites) and production (33 sites) (MMA, 2015c). Some of the areas were contaminated by a combination of two or more activities. Groundwater (90 sites) and undersoil (73 sites) were the most impacted environmental compartments. PCBs were the POPs most commonly found in contaminated areas (52%), followed by the pesticides Hexachlorocyclohexane (HCH) (19%) and DDT (15%) (MMA, 2015c). While most sites show the presence of more than one POP together, areas contaminated by PCBs do not usually have other POPs contaminants (MMA, 2015c). Furthermore, there were 23 sites contaminated by "undetermined organochlorine POP" (MMA, 2015c). The inventory also identified 66 areas suspected of being contaminated with POPs (MMA, 2015c).

This inventory, however, has not been revised and updated for the development of the current NIP. Also, there is no information on impacted populations or environments. Only the identification of contaminated areas was done; there was no assessment of the impacts.

Through the MMA Ordinance No. 603 of December 10, 2020, which established the National Program for the Recovery of Contaminated Areas, the MMA developed the System for Managing Information on Contaminated Areas (SINGAC, Portuguese acronym). SINGAC aims to systematize and digitize information on the national management of contaminated areas according to the strategic objective of the National Program for the Recovery of Contaminated Areas.

2.3.20. Details of any relevant system for the assessment and listing of new chemicals

Brazil has established regulatory schemes and instruments to discipline some specific substances, applications and uses of chemicals, such as metallic mercury, pesticides, sanitizing products, food additives, cosmetics, wood preservatives etc. There is no comprehensive policy for the management of chemical substances.

As part of the Basel, Rotterdam, Stockholm and Minamata Conventions, and committed to the principles of the SAICM, Brazil put into practice some regulatory schemes and procedures for an active exchange of experiences and information flows between the Parties of the Conventions.

To solve some gaps related to a mechanism for obtaining systematic information on the production, use, importation and exportation of chemicals in the national context, Brazil developed a Project under UNEP Special Programme "Strengthening institutional capacity for Sound Management of Chemicals through the establishment of necessary structure to implement the national legislation on Industrial Chemicals".

The objective of this Project[11] is to support country-driven institutional strengthening at the national level, in the context of an integrated approach to address the financing of the sound management of chemicals and wastes, taking into account the national development strategies, plans and priorities of each country, to increase sustainable public institutional capacity for the sound management of chemicals and wastes throughout their life cycle. Institutional strengthening under the Special Programme will facilitate and enable the implementation of the Basel, Rotterdam and Stockholm conventions, the Minamata Convention and the SAICM.

Regarding pesticides, the registry of new molecules to be used as active ingredients or new products using molecules already permitted have to pass a process which involves three different ministries. Pesticides, their components and the like may only be produced, exported, imported, marketed and used, if previously registered with a federal agency, in accordance with the guidelines and requirements of federal agencies responsible for the health, environment and agriculture sectors. These agencies are Ministry of Agriculture and Livestock (Portuguese acronym MAPA), the MS (through ANVISA) and the MMA (through IBAMA). MAPA is responsible for evaluation of agronomic efficacy. ANVISA is responsible for toxicological classification. IBAMA is

[11] https://www.unep.org/pt-br/node/22041

responsible for environmental assessment. Each one of these institutions may refuse registration depending on its protocols and criteria, even if the other two have already passed an positive response.

The first step while making a registration claim for a pesticide is issuing a special temporary registration for research and experimentation (RET). If accepted, the RET allows a company to produce or import previously established amounts of a substance to be used as an active ingredient for research purposes to be conducted in national territory. Experimentation must take place in an area or facility previously reported to the MAPA. RET emission is automatic for new products using active ingredients already approved for usage in Brazil or for products to be used in organic agriculture. Also, if a company is going to perform research and trials in a foreign country, the RET is not necessary. It must be renewed every three years.

If after research and trial a company wishes to submit a chemical for a definitive registry, it must do so presenting a registration claim to MAPA, ANVISA and IBAMA. There are three kinds of definitive registry; one for PT, one for pre-mixes (PM) and another for formulated products (Portuguese acronym PF).

Intended exclusively for industrial use, PTs are products obtained directly from raw materials by a chemical, physical or biological process, intended for production of PF or PM and whose composition contains a defined content of active ingredient and impurities, and may contain stabilizers and related products, such as isomers. For this registry, a company must submit documents, among which are laboratorial analysis parameters and fisico-chemical properties reports.

PMs are products obtained from a technical product, through chemical, physical or biological processes, intended exclusively for the preparation of PF. The registration of PM is only necessary for those cases in which the pre-mix will be transported from one factory to another, being unnecessary in the case of being a stage of the formulation process within the same factory. Registrations of PM should include most of the documents used for the registration of the technical product that it is related to.

PFs are pesticides or the like obtained from a technical product or premix, through a physical process, or directly from raw materials through physical, chemical or biological processes. Among the necessary documents for product registration are laboratory analysis reports, toxicological and ecotoxicological reports, analytical methods for residue determination and maximum residue levels in food.

2.3.21. Details of any relevant system for the assessment and regulation of chemicals already in the market

Brazil has a number of systems in order to assess and regulate different chemicals that are already in the national market. There are some chemicals, such as pesticides, that must undergo evaluation by different ministries. For some other products, permits are issued by institutions such as the army or federal police for selling, buying or using.

Regarding pesticides, active ingredients may have their registration canceled when they fit the certain conditions related to human health. Those conditions are: when they do not have an antidote or effective treatment in Brazil; if they are considered to be teratogenic, carcinogenic or mutagenic; if they cause hormonal disturbances and damage to the reproductive system or if they are more dangerous to man than demonstrated in tests with laboratory animals.

In Brazil, pesticide registry does not have a pre-determined expiration or reassessment date. Thus, the MAPA, the MS and the MMA should promote the reassessment of the registration of pesticides when international organizations responsible for health, food or the environment of which Brazil is a member or signatory to agreements and conventions warn of risks or advise against the use of pesticides, their components and the like or when indications arise of the occurrence of risks that advise against the use of registered products. Therefore, the active ingredients of pesticides that show signs of changing the risks to human health may be reassessed at any time by ANVISA. Examples of pesticides which have been reassessed and had its registry canceled and are thus prohibited in Brazil are lindane, endosulfan and pentachlorophenol.

The MAPA makes available the AGROFIT platform. It is a public consultation tool, comprising a database of all pesticide and related products registered with the MAPA, with information from the ANVISA and from the IBAMA. The platform allows for consultation on which products should be used for each pest and crop. This information allows the user to use products correctly and safely, avoiding the inappropriate use of pesticides, which could lead to the development of pest resistance in crops and pesticide residues in plant products above the MRL.

The companies in the agrochemical products business, components and the like registered in Brazil must submit, every six months, to federal and state agencies responsible for the control and inspection of these substances, reports on the quantities produced, imported, exported and commercialized of these products. IBAMA is responsible for compilation and publication of annual pesticides commercialization reports. These reports allow defining priorities in the choice of substances for environmental impact assessment, water and soil contamination and adverse effects on fauna, for example.

The Federal Police is responsible for control of many chemical substances that could be used for production of illegal drugs. There are 141 chemicals listed, among which are drugs, solvents and acids. A special license must be issued by the federal police in order for commercialization and use of any of the substances listed. Also, companies that have the license must submit monthly reports stating all activities involving such substances.

The Brazilian Army is responsible for control of war material. Among the controlled products are chemicals which may be used for production of weapons or explosives. A special permit must be issued for production and use of such chemicals under any purpose.

2.4. Previous NIP implementation status

The first Brazilian NIP was transmitted to the Secretariat of the Stockholm Convention in 2015. Since then, a range of activities have been developed in Brazil within the framework of the Stockholm Convention implementation. This chapter brings a summary of the action plans proposed in the previous NIP (MMA, 2015b) and the implementation status, as well as some other activities developed in the country related to the Stockholm Convention provisions and implementation.

Based on the POP inventories and priorities established for the NIP-Brazil-2015, eight general action plans were set as follows:

1) Measures to strengthen the national institutional capacity and the legal framework for POPs management;
2) Action plan for managing wastes and stockpiles of POP pesticides;

3) Action plan for PCBs;
4) Action plan for new POPs[12] of industrial use;
5) Action plan for managing contaminated sites with POPs;
6) Action plan for the progressive reduction of uPOP releases;
7) Measures to disseminate information, raise public awareness and education; and
8) Measures to improve the national analytical capacity, POP monitoring, research, development and innovation.

2.4.1. Current status of measures to strengthen the national institutional capacity and the legal framework for POP management

Regarding the first general action plan on measures to strengthen the national institutional capacity and the legal framework for POP management, the specific objectives and activities have been addressed.

The debate on the revision of regulation for registration of pesticides, cleaning products and other chemicals to comply with the criteria of Annex D, of the Stockholm Convention, started in 2014.

Decree No. 10,833, of October 07, 2021, changed the rules on production, research, registration, use, import and export of pesticides in the country. The main objectives are to reformulate the process of analysis of registrations, facilitate research with pesticides to enable technological innovations and implement actions to protect pesticide applicators.

Decree 10,833/2021 altered Decree 4,074, of 2002, which regulates Law 7,802, of 1989, and establishes rules for prioritizing the registration of new products and longer periods for the analysis of each type of registration, compatible with the specific complexity of each plea, providing for speed in the cases of priority processes. The objective is to increase competition in the pesticide market, making it possible to register more modern and less toxic products, and to reduce costs for the producer. The decree includes the definition of the Globally Harmonized System of Classification and Labeling of Chemicals (GHS), for the purposes of toxicological classification and communication of health hazard on the labeling of pesticides. It also allows for the implementation of risk assessment by Anvisa, in alignment with international commitments.

[12] The "new POPs" mentioned in the NIP-Brazil-2015 are: PFOS & PFOSF, c-pentaBDE, c-octaBDE, HBB, PeCB and HBCD.

The previsions to develop legislation establishing bans and restrictions and directives for environmental licensing of activities that use POPs, in the scope of specific exemptions and acceptable purposes and to include BAT/BEP recommendations in legislation for licensing of companies that produce and use new POPs have been reassessed. Currently, the only POPs that are allowed to be used in Brazil is PFOS/PFOSF for the production of sulfluramide. The prohibitions and restrictions are already established by the Stockholm Convention. The Best Available Techniques and Best Environmental Practices (BAT/BEP) guide should be shared with the environmental agencies responsible for the licensing of companies that produce sulfluramide, so that monitoring and compliance measures can be carried out.

The development of specific custom codes for new POPs and the development of strategies to control import and export operations were implemented for some POPs. Previously, only POP pesticides had specific custom codes, while, for POPs with industrial applications, import and export operations were registered under generic custom codes that cover several other products, which makes the traceability of these operations unfeasible. Specific codes have been developed for PFOS, its salts and PFOSF. The development and implementation of specific custom codes is important so that the Parties can assess the exact volume of POP substances traded internationally. Currently, Brazilian imports and exports of POPs are regulated under the consent of IBAMA. The creation of new customs codes is the responsibility of the World Trade Organization and must be requested by the Conference of the Parties. Brazil can push the creation of specific custom codes under the MERCOSUR, considering the existing HS codes under the World Trade Organization. However, this is a global topic that needs to be internationally addressed for a more comprehensive implementation of the Stockholm Convention, e.g., the creation of specific HS codes for at list for POP chemicals if not possible for POP-containing products.

The proposed discussion for a revision of CONAMA Resolutions that discipline thermal treatment of wastes and stationary sources on the emission limits of dioxins and furans was not addressed yet. In the same line, the discussion for including POPs in environmental quality parameters, such as the CONAMA Resolutions on water and soil quality, was not addressed either.

The development of legislation creating the register/inventory of PCB-containing equipment and establishing technical procedures for management and sound disposal of PCBs started in 2013. The Law 14.250/2021 on the elimination of PCBs in the country was approved in November 2021, provides for the controlled elimination of materials, fluids, transformers, capacitors, and other electric equipment contaminated by PCBs and their residues.

Table 17: Summary of the specific objectives and activities, responsible institutions, period set for each activity implementation and the current situation of the measures to strengthen and expand the legal framework and the national institutional capacity to manage POPs. (cont.)

Measures to strengthen and expand the legal framework and the national institutional capacity to manage POPs				
Objective	**Activity**	**Responsible**	**Period**	**Situation**
Adopt and implement an adequate legal framework to perform obligations	**Artigo 3: Medidas para reduzir ou eliminar liberações de produção e uso intencionais**			
	Article 3, Paragraph 1 (new POPs): 1) Develop legislation establishing bans and restrictions and directives for environmental licensing of activities that use POPs in the scope of specific exemptions and acceptable purposes; 2) Include BAT/BEP recommendations in legislation for licensing of companies that produce and use new POPs.	MMA, CONAMA and Sectors	2015 to 2019	**Concluded/ /BAT/BEP guide available to be sent to OEMAs**
	Article 3, Paragraph 1 (Import and Export control): Develop specific customs codes for new POPs and develop strategies to control import and export operations.	MMA, IBAMA, Federal Revenue and MDIC	2015 to 2016	**Finalized. WTO Responsibility**

Table 17: Summary of the specific objectives and activities, responsible institutions, period set for each activity implementation and the current situation of the measures to strengthen and expand the legal framework and the national institutional capacity to manage POPs. (continued)

Measures to strengthen and expand the legal framework and the national institutional capacity to manage POPs				
Objective	**Activity**	**Responsible**	**Period**	**Situation**
	Article 5: Legal measures to reduce or eliminate non intentional releases to air			
	Discuss a revision of CONAMA Resolutions that discipline thermal treatment of wastes and stationary sources on the emission limits of dioxins and furans.	MMA and CONAMA	2015 to 2017	**Not addressed / Reassess necessity**
	Article 6: Legal measures to reduce or eliminate releases of stockpiles and wastes			
	Article 6 and Part II of Annex A (PCB) – Develop legislation creating the cadaster/inventory of PCB-containing equipment and establishing technical procedures for management and sound disposal of PCBs.	MMA, CONAMA, OEMAs and Sectors	2013 to 2015	**Concluded**
	Article 11: Legal measures to improve monitoring			
	Discuss a revision of CONAMA Resolutions that address water and soil quality to include POPs in environmental quality parameters.	MMA and CONAMA	2015 to 2017	**Not addressed**

Source: Adapted by the author from MMA, 2015a.

2.4.2. Current status of the action plan for managing wastes and stockpiles of POP agrochemicals

The second general action plan for the management of agrochemical stocks and residues foresaw as priority actions: i) elimination of inventoried stocks and residues of POP agrochemicals; ii) mobilization and engagement of strategic partners, in the states, to carry out campaigns for the identification and final destination of obsolete stocks of POPs agrochemicals; and iii) technical training of the state environmental and agriculture agencies, and preparation of guidelines to the collection and final destination of POP agrochemical stocks.

The first specific objective of promoting the environmentally adequate disposal of the obsolete pesticide stockpiles identified in Bahia, Paraná and São Paulo was successfully addressed throughout collection and destruction campaigns promoted by the respective environmental and agricultural bodies of each state. Despite the significant amount of POP pesticide stocks already eliminated, the challenge was to spread such campaigns to other states. The obsolete pesticide collection programs in the states of Paraná and São Paulo were important references for the development of similar actions in other states, especially those that were large users of POP pesticides.

In relation to the investigation of areas suspected of holding obsolete stocks identified in the inventories, the NIP-Brazil-2015 foresaw a preliminary and confirmatory investigation to verify the existence of stocks in six areas of the extinct Funasa in Bahia, in the scope of the *Remediar*/Funasa Program. This activity was successfully concluded, and Funasa's *Remediar* Program advanced in the identification of other contaminated areas that were in its possession and in the planning for the remediation of those areas. In addition, the GEF Project for the management of lindane carried out a preliminary study to identify remaining stocks in Cidade dos Meninos, Rio de Janeiro and Indústrias Matarazzo, São Paulo, and did not identify any stock. For this reason, the project was finalized in the preparatory phase.

The creation of working groups and the execution of local campaigns for the identification and final destination of stocks is a competence of the states. However, most states report not having obsolete stocks of POP agrochemicals. Rio Grande do Sul was the only state that indicated it could have some remaining stocks of POPs, but could not inform an estimated quantity.

Table 18: Summary of the specific objectives and activities, responsible institutions, period set for each activity implementation and the current situation of the action plan for managing wastes and stockpiles of POP pesticides.

Action plan for the management of stockpiles and wastes of POP pesticides				
Objective	**Activity**	**Responsible**	**Period**	**Situation**
Promote technical training in state environmental and agricultural agencies.	Technical partnership with Food and Agriculture Organization (FAO) to support implementation of actions.	MMA	2015 to 2016	**Concluded/ not needed**
Promote engagement of farmers.	Workshops to disseminate actions being executed and to guide farmers on how to collaborate.	States	2015 to 2022	**Concluded**
Promote the reduction and elimination of Stockpiles and Wastes of POPs pesticides nationwide.	Carry out seminars in the states to offer guidance on the Stockholm Convention's obligations and the promotion of campaigns to identify and dispose of stockpiles and wastes of POPs used as pesticides.	MMA	2015 to 2017	**Concluded**
Measure results of the Action Plan.	Develop biennial follow-up reports on the elimination of POP agrochemicals.	MMA	2016 to 2018	**Concluded**

Source: Adapted by the author from MMA, 2015a.

2.4.3. Current status of the action plan for managing PCBs

The third general action plan for managing PCBs established several objectives and activities to be carried out in Brazil considering the provision of the Stockholm Convention that PCBs must be eliminated by 2028.

To fulfill the determinations of the Convention, Brazil executed an international project financed by GEF and with support from the United Nations Development Programme (UNDP), aiming to develop the national capacity for the adequate disposal of the remaining stocks of PCBs within the deadlines established by the Stockholm Convention. The objective of the project was to increase the country's capacity to manage and dispose of PCB-containing oils, PCB-containing equipment and other PCB residues in an adequate manner, minimizing exposure and the risks of contamination, both human and environmental.

The Project included the following components:

Outcome 1: Strengthening the framework of legal, administrative and regulatory procedures for PCB management and disposal.

Outcome 2: Capacity building for government and the private sector to manage oils, waste and equipment contaminated with PCBs to minimize human and environmental exposure.

Outcome 3: Environmentally sound disposal of PCBs through demonstration projects.

The main results achieved by the project were:

- Study of existing regulations on PCBs in Brazil and in the World;
- Proposals for regulation on the management of oils, equipment and residues contaminated with PCBs, through a PL and a CONAMA resolution proposal;
- Guide on the management of PCBs and their residues and PCB Management Manual (to be published);

- Guide on the elaboration of a National PCB Inventory;

- Survey of the Brazilian capacity for analysis, elimination and destination of PCBs, including the laboratories and service providing companies, identifying the technical and operational demands for the analysis and management of these substances;

- Qualification of technicians from the environmental state organs and from the electric sector for the identification and management of PCBs;

- Execution of five demonstration projects of Inventory and Management Plan of PCBs in the following electric companies: Eletrobrás Amazonas, Companhia Hidrelétrica do São Francisco (Portuguese acronym, CHESF), Companhia Paranaense de Energia Elétrica (Portuguese acronym, COPEL), Companhia Estadual de Energia Elétrica (Portuguese acronym, CEEE) and Eletrobrás Rondônia.

The Law No. 14,250, of November 25, 2021 provides for the mandatory controlled elimination of substances classified as PCBs and residues of these substances and the decontamination and elimination of transformers, capacitors, and other equipment that contain PCBs. The main points addressed in the Law No. 14,250/2021 are:

- The obligation to elaborate an inventory and schedule for the environmentally adequate final destination for the holders of PCBs, their residues and other materials contaminated with PCBs;

- The provision of the formulation of a Management Manual with general guidelines for the elaboration of the inventory;

- The progressive elimination of PCBs by 2028, including wastes with a PCB content of 50 mg/kg or more and impervious materials with a surface area of 100 μg/dm^2 or more.

To comply with the Law No. 14,250/2021, the MMA prepared the Management Manual and developed an electronic system for the development of the National PCB Inventory. The electronic System and the PCB Management Manual are available in the National Information System on Solid Waste Management (Portuguese acronym, SINIR), at https://sinir.gov.br/sistemas/inventario-pcb/.

A new project GEF "BRA/21/G21 – Environmentally Adequate Destruction of PCBs in Brazil" was approved in December 2019 and started in May 2022, aiming to promote the complete elimination/destruction of PCBs in Brazil, mainly in sensitive areas such as public hospitals and old condominiums. The execution forecast is sixty months (five years), in the amount of US$ 9,660,000.00, for the destination of 15 thousand tonnes of residues contaminated with PCB. Among the actions of the Project, it is foreseen the development of a business model and demonstration projects for the environmentally adequate destination of PCB in Brazil.

Regarding the specific activities proposed in the NIP-Brazil-2015:

- The creation of the database for the Mandatory Equipment Register for the National PCB Inventory have been concluded;

- The development of guidelines, technical standards and approval mechanisms for environmentally sound management and disposal of PCBs and the Elaboration of the PCB Waste and Equipment Management Manual have been concluded and are available;

- The technical training on PCB waste management and disposal has been conducted by the MMA through courses/training already held. The course on PCB Management was prepared and given by CETESB in 2018;

- The execution of four demonstration projects, being three of them about inventory and elaboration of management plans in units of the electrical sector, and one about the investigation of an area contaminated by PCBs, has been concluded. The PCB Management Plans of the three electric companies were finalized in December 2017 and two more demonstration projects (pilots) were carried out for inventory and management of PCBs in two more electric companies;

- The evaluation of existing PCB waste treatment systems in Brazil and comparison with the best available technologies for PCB waste treatment was carried in 2011 and a Seminar on Treatment of PCBs and other POPs of the Stockholm Convention was held in 2015;

- The elaboration of a Communication Plan, with the purpose of outlining the national strategy for the disclosure and dissemination of the Project's results to the sectors involved was developed and made available at the MMA's website;

- The elaboration of communication material: brochures, videos etc. was developed by CETESB;

- The refinement of the Inventory of priority sectors (hospitals, schools, and public agencies) is currently underway. The Manual was presented to other sectors holding PCBs. The inventory is open for completion by sectors holding PCBs and the new GEF project will support this activity; and

- The adoption of specific strategies with representative areas of the diffuse sectors is underway and counts with the new GEF project support.

Table 19: Summary of the specific objectives and activities, responsible institutions, period set for each activity implementation and the current situation of the action plan for managing PCBs

Action plan for the sound management of PCBs				
Objective	**Activity**	**Responsible**	**Period**	**Situation**
Develop a strategy for other PCB holding sectors	Inventory of priority sectors (hospital, schools, government bodies).	MMA and Setores	2015 to 2020	**Still ongoing**
	Adoption of specific strategies in representative areas of diffuse sectors (such as dialogue with the fire department about the inclusion of PCB criteria in their survey report [AVCB, Portuguese acronym] and dialogue with license issuers for transport of hazardous wastes to speed up procedures).	MMA, IBAMA, and Sectors	2015 to 2016	**Still ongoing. Project BRA/21/G31: PCB Destruction "Environmentally Appropriate Disposal of PCBs in Brazil"**

Source: Adapted by the author from MMA, 2015a.

2.4.4. Current status of the action plan for new POPs

The fourth action plan for new POPs of industrial use was based on the information that PFOS, its salts and PFOSF, and HBCD, were still in use in Brazil. In addition, the information received indicated that POP PBDEs may have been used, in the past, as substances themselves and that these substances are present in imported articles, in use and in waste.

In general, the results of the preliminary inventories indicated that further refinement of the information was needed. The main challenges and priorities for action identified were:

1) Adopt and implement an adequate legislative framework to carry out the obligations related to the prohibition and/or the use of POPs for industrial use in Brazil.

2) For PFOS, its salts and PFOSF:

a) enhance information on other possible uses of PFOS, prioritizing the categories that have been identified as suspect in the inventory and then the categories where there are more risks of human exposure;

b) conduct studies to identify substitutes for EtFOSA, evaluate the degradation of EtFOSA into PFOSF, and the environmental impact assessment of the application of these baits in the open environment;

c) verify the techniques and practices used by the electroplating industry and apply measures to reduce exposure risks and waste management practices in the industry, with the BAT/BEP;

d) conduct studies to identify and test substitutes for PFOS in electroplating;

e) promote measures to reduce PFOS exposure risks for the identified uses with the application of the BAT/BEP;

f) ensure that waste PFOS, its salts and PFOSF are managed in an environmentally appropriate manner; and

g) approve schedule for eliminating the use of PFOS in electroplating until the expiration of the specific exception.

3) For HBCD:

a) improve information on the uses of HBCD in Brazil and eliminate the uses for which there is no possibility of requesting the specific exception after the amendment to Annex A enters into force in November 2014;

b) send a request to the Secretariat to register a specific exception for the use in EPS and XPS in civil construction;

c) conduct studies and develop program for proper management of EPS and XPS waste containing HBCD;

d) separating EPS/XPS so that only wastes that are not treated with HBCD are recycled; and

e) identifying and testing alternatives, and submitting a timeline for eliminating the use of HBCD, in accordance with the timeframe of the specific exception.

4) Actions to ensure that the disposal and recycling of articles containing POP PBDEs are carried out in an environmentally sound manner

4.1) Actions related to the recycling of electro-electronic equipment waste:

a) survey of practices and techniques used in plastics recyclers to verify the current situation and necessary improvements;

b) preparation of a primer that promotes the adoption of BAT and BEP for the recycling of WEEE, and dissemination of the BAT/BEP Guide for the recyclers; and holding seminars (workshops) and courses on BAT/BEP for the sector. The primer should include a negative list of applications where recycled materials should not be used, and a positive list specifying applications where these WEEE recycled materials can be used;

c) financial support for plastic recycling companies to purchase screening tests for POPs-PBDEs and equipment to reduce releases of these substances and reduce occupational exposure; and

d) elaboration of a timeline for eliminating the recycling of articles containing POPs-PBDEs by the time the specific exception expires, i.e., in 2030.

4.2) Actions related to PBDEs in motor vehicles:

a) adoption of BEP through the implementation of Law No. 12,977 of May 20, 2014, which regulates and disciplines the dismantling activity of land motor vehicles in Brazil;

b) support for initiatives that promote vehicle recycling by the states; and

c) support for the approval of Bill No. 67/2013 amending Law No. 12,305 of August 2, 2010, which institutes the National Solid Waste Policy, to provide for the reverse logistics of motor vehicles.

5) Trade, Imports and Exports:

a) creation of a Work Group to develop specific NCM codes, or highlights for POPs, and develop strategies to control POPs import and export operations.

6) Measures for identification and environmentally sound management of articles containing POPs:

a) establishment of a Working Group in CONASQ to evaluate existing classification and labeling systems, and develop a suitable system to improve information exchange on articles containing POPs across supply chains;

b) development of a regulation for the identification of chemicals in articles and products, after the development of the PL establishing control over chemicals for industrial use; and

c) creation of a Discussion Group to include the issue related to the production and consumption of articles containing POPs in the Action Plan for Sustainable Production and Consumption.

Some advances were obtained in the period:

- Update and improvement of the inventories of POPs in progress;
- End of the term of specific exceptions for the use of PFOS in electroplating and HBCD in the production of EPS and XPS (with this, these uses are prohibited);
- Conduction of a study with Embrapa Meio Ambiente to monitor the degradation of EtFOSA into PFOS in Brazilian soils; and
- Manuals and BAT/BEP Guides produced by the Stockholm Convention translated are available on the Ministry of Environment and Climate Change's website.

The first activity established in the new POPs of industrial use has only been partially addressed. The development of studies to identify chemical and non-chemical alternatives to EtFOSA did not progress as expected and results are still not enough to propose an alternative for EtFOSA yet. However, on June 12, 2023, the product ATEXZO ANT-F, an ant bait based on Isocycloseram, was registered in MAPA under number 11223, which may be an alternative to sulfluramid.

The development of studies to evaluate the environmental transformation of EtFOSA into PFOS has progressed and the results show a relevant transformation rate. The study on PFOS & PFOSF transformation from EtFOSA application in Brazilian soils shall be transmitted to the Secretariat of the Stockholm Convention alongside this NIP.

The preparation of guidance indicating the BAT for EtFOSA producers and the BEP for users, as well as holding seminars (workshops) for BAT/BEP dissemination and training, were accomplished and the BAT/BEP guidance is currently available on the MMA's website.

The elaboration of guidelines on BAT/BEP for electroplating and the phase-out of use were also concluded. The deadline for this specific exemption has ended. However, considering the low engagement of stakeholders it was not possible to evaluate the current status of phase out nor the management and disposal of stockpiles applied by the former users.

The development of inventory and action plan for PFOS/PFOSF stockpile and waste management, for those uses identified as suspicious and those uses where there is the highest risk of human exposure are objectives of the NIP update presented in Chapter 3.

Regarding the application to register a specific exemption for use of HBCD on EPS and XPS, and elimination of uses for which no specific exception can be applied for, the specific exemption was granted until 2019. According to the Brazilian Association of Flame Retardants, non HBCD products are already available for substitution.

The development of a guidance to promote the BAT/BEP and to reduce risks from HBCD exposure was achieved and made available at the MMA's website.

The conduction of studies and development of a program for the proper management of EPS and XPS waste containing HBCD, not allowing the recycling of materials containing HBCD was not started.

The submission of a timeline for elimination of HBCD use, according to the timeframe of the specific exception was done. Alternatives are currently available and the use of HBCD is no longer allowed.

Regarding PBDEs, the survey of practices and techniques used by plastics recyclers to verify the current situation and necessary improvements was an objective of the NIP update. However, the stakeholders did not reply on this matter and the activity was not carried out.

The preparation of a guidance that promotes the adoption of BAT/BEP for the recycling of WEEE and dissemination of the BAT/BEP Guide for recyclers was achieved by translating the respective guidance from the Stockholm Convention website and making it available in Portuguese at the MMA's website. However, seminars (Workshops) and courses on BAT/BEP for the sector were not carried out.

The project development support for the acquisition of screening tests for the detection of PBDEs and equipment to reduce releases of these substances and reduce occupational exposure was not addressed yet.

The development of a timeline for eliminating the recycling of articles containing POP PBDEs by the time the specific exception expires, 2030 was not addressed. Nor was the support for initiatives that promote vehicle recycling by the states.

Table 20: Summary of the specific objectives and activities, responsible institutions, period set for each activity implementation and the current situation of the action plan for new POPs of industrial use (cont.)

Action plan for new POPs of industrial use				
Objective	**Activity**	**Responsible**	**Period**	**Situation**
Adopt measures to reduce and eliminate the use of PFOS, its salts and PFOSF – unintentional production and use POP included in Annex B (restricted)	Other uses – Development of inventory and action plan to manage stockpiles and wastes of PFOS/PFOSF for uses identified as suspicious and uses in which there is more risk to human exposure. The proposed CONAMA Resolution will aim at creating a mandatory registration of companies that produce, import, export, market or use controlled substances according to the Stockholm Convention and will help in this identification.	MMA	2015-2016	**Concluded/ Not needed/ BAT/BEP Guides available**
Adopt measures to reduce and eliminate the use of unintentional HBCD-POP included in Annex A (elimination)	Carry out studies and develop programs to adequately manage wastes of EPS and XPS that contain HBCD banning recycling of material containing.	ABIPLAST, Industry sector	2017-2020	**Not addressed**
Adopt measures to ensure that recycling and disposal of articles containing POP-PBDEs is carried out in an environmentally sound manner	WEEE – Assessment of practices and techniques used by plastic recycling companies to verify the actual situation and needed improvements.	MMA, ABIPLAST, plastic recycling companies	2015	**Concluded**

Table 20: Summary of the specific objectives and activities, responsible institutions, period set for each activity implementation and the current situation of the action plan for new POPs of industrial use (cont.)

Action plan for new POPs of industrial use				
Objective	**Activity**	**Responsible**	**Period**	**Situation**
Adopt measures to ensure that recycling and disposal of articles containing POP-PBDEs is carried out in an environmentally sound manner	WEEE – Development of a booklet to promote the adoption of BAT and BEP to recycle WEEE and disseminate the BAT/BEP guide among recycling companies, and carry out workshops and seminars on BAT/BEP for the sector. The booklet should include a negative list of applications in which recycled materials cannot be used and a positive list specifying application where these WEEE recycled materials may be used.	MMA, ABIPLAST, Plastic recycling companies	2015-2016	**Concluded with BAT/BEP Translation**
	WEEE – Development of a project to support the acquisition of screening tests to detect PBDEs and equipment that reduce releases of these substances and reduce occupational exposure.	Plastic Recycling companies	2016-2017	**Not addressed**
	WEEE – Development of a schedule to eliminate recycling of articles containing POP-PBDEs within the deadline of the specific exemption, i.e., 2030.	Plastic Recycling companies	2017-2025	**Concluded. Recycling phase-out deadline set (2030)**

Table 20: Summary of the specific objectives and activities, responsible institutions, period set for each activity implementation and the current situation of the action plan for new POPs of industrial use (continued).

Action plan for new POPs of industrial use				
Objective	**Activity**	**Responsible**	**Period**	**Situation**
Adopt measures to ensure that recycling and disposal of articles containing POP-PBDEs is carried out in an environmentally sound manner	Vehicles – adoption of BEP through enactment of Law 12,977 of May 20, 2014 that regulates and disciplines dismantlement activities of automotive vehicles in Brazil.	State governments/ DETRAN/ Dismantling companies	2015-2016	**Not addressed**
	Vehicles – support initiatives that promote recycling of vehicles by the states.	State governments/ DETRAN	2015-2017	**Not addressed**
	Vehicles – Support the approval of the law project 67/2013 that alters Law 12,305 of August 2, 2010 that establishes the National Solid Wastes Policy to provide for reverse logistics for automotive vehicles.	Congress	2016-2017	**Not addressed**
Promote measures to identify and manage in an environmentally sound manner articles containing POPs.	Create a group in CONASQ to evaluate existing classification and labeling systems and develop an adequate system to improve the exchange of information on articles containing POPs by the supply chains.	MMA, Conasq	2015-2017	**Addressed. Group should be resumed after the recreation of Conasq**
	Create a discussion group to include issues related to production and consumption of articles containing POPs in the Action Plan for sustainable production and consumption.	MMA, Industry Sector	2015-2016	**Not addressed**

Source: Adapted by the author from MMA, 2015a.

2.4.5. Current status of the action plan for the adequate management of areas contaminated with POPs

The fifth general action plan for the management of areas contaminated with POPs highlighted the following priorities for action: i) promote training and guidance to state environmental agencies for the management of areas contaminated by POPs; ii) develop guides and reference documents for the management of contaminated areas; and iii) support the implementation of demonstration projects for the remediation of areas contaminated by PCBs and DDT.

The inventory showed that the Brazilian states are at different levels of progress in the task of identifying areas contaminated with POPs. The results of the National Inventory of Areas Contaminated with POPs (MMA, 2015c) led to the identification of 117 areas, of which nine have already been rehabilitated and two are already being reused. This corresponds to the decontamination of 9% of the total areas contaminated with POPs. Of the 26 states of the country, 9 present records of areas contaminated with POPs, 8 informed that they have no knowledge of the existence of these areas, and in the remaining 9 no information was obtained that would lead to a proper identification. About 85% of the areas surveyed are located in the southeastern region, 81 of them in the state of São Paulo, of which 31 are in the municipality of São Paulo.

Regarding the activity that foresaw the execution of Demonstrative Projects in an area contaminated by PCB and an area contaminated by DDT, a demonstrative project was carried out to identify an area with PCB in Curitiba, Paraná. The GEF Project for the Environmentally Adequate Management of Lindane also evaluated the area in Cidade dos Meninos, known for its contamination with lindane and DDT. In addition, the *REMEDIAR/*FUNASA Program identified some areas contaminated with DDT in FUNASA's headquarters that stored pesticides for use in public health campaigns.

In 2019, the MMA started the Urban Environmental Quality Agenda with a specific subtopic pertaining to "Contaminated Areas". Therefore, a diagnosis of the situation of the states in relation to the implementation of CONAMA Resolution 420/2009 — which provides criteria and guiding values of soil quality, as to the presence of chemical substances, and establishes guidelines for the environmental management of areas contaminated by these substances as a result of anthropic activities — is currently being developed in Brazil.

Table 21: Summary of the specific objectives and activities, responsible institutions, period set for each activity implementation and the current situation of the action plan for managing contaminated sites with POPs.

Action plan to manage sites contaminated with POP's listed in the Stockholm Convention				
Objective	**Activity**	**Responsible**	**Period**	**Situation**
Promote technical training for management of POPs contaminated sites	Development of a document containing the systematization of experiences in Rio de Janeiro State, Minas Gerais State and São Paulo State on management of contaminated sites.	MMA and OEMAs	2015-2017	**Concluded**
Adopt strategies and procedures to identify and manage POPs contaminated sites	Identification of sites contaminated by POP agrochemicals and PCBs.	OEMAs	2015-2020	**Concluded**

Source: Adapted by the author from MMA, 2015a.

2.4.6. Current status of the action plan for the progressive reduction of uPOP releases

The sixth action plan for the progressive reduction of uPOP releases was developed considering the information and data obtained in the respective inventory (MMA, 2015a), the situation of sources in Brazil, and the national conditions of compliance with the BAT/BEP.

The guideline of the decided strategy consists of:

1) Consider different conditions for existing sources and new sources, the latter with more emphasis on BAT/BEP;

2) Consider national conditions when analyzing measures in the BAT/BEP;

3) Emphasize releases to air and water first, as it is considered that reduction in these media will be more effective in minimizing releases than action on waste;

4) Consider the total participation of the sources of uPOPs releases in Brazil to make the decision for the cutoff value of emissions from the evaluated sources; and

5) Take into consideration the national deficiency at the moment, in terms of laboratory infrastructure, and the costs of sample collection and analysis, to establish the frequency of monitoring, as well as to consider possibilities of indirect monitoring that may indicate compliance or non-compliance with reduction measures that may be established.

Therefore, the strategies focused on: 1) the eight sources that contributed most to air emissions, which are: iron ore sintering; open air biomass burning; fires and open-air waste burning (accidental or not); incineration of health services waste; iron/steel plants; lime production; aluminum production; thermal recovery of electric wires and cables. The application of the strategy in the eight priority atmospheric sources will result in an estimated emission decrease of 576 g-TEQ in the action plan period, corresponding to a 49.3% reduction in releases to air; 2) two sources that contributed most to releases to water: pulp and paper production, and disposal of effluents, without treatment, into surface waters.

One of the activities foreseen in the action plan was the revision of the CONAMA Resolutions that determines emission limits for several types of stationary sources, but does not establish emission limits for dioxins and furans and the discussion of the need to create limits for specific/priority sources. Due to the restructuring of the Conama, which took place in 2019, it was not possible to start this activity.

The implementation of appropriate measures to reduce uPOPs emissions, according to the deadlines and targets agreed upon in the NIP, is the responsibility of the sectors and is being monitored by the MMA.

Table 22: Summary of the specific objectives and activities, responsible institutions, period set for each activity implementation and the current situation of the action plan for the progressive reduction of uPOP releases (cont.)

Action plan to progressively reduce releases of uPOPs from anthropogenic sources				
Objective	**Activity**	**Responsible**	**Period**	**Situation**
Eliminate/Reduce emissions of uPOPs in existing sources	Implement the appropriate measures to reduce the emission of uPOPs according to deadlines and targets agreed upon with the following priority sectors: iron ore sintering, open biomass burning, fires and open burning of wastes (accidental and otherwise), incineration of medical wastes, metallurgy and steel mills, whitewash production, aluminum production, thermal recovery of electrical wires and cables, paper and pulp and disposal of untreated effluents in surface waters.	Sectors	2014-2020	**Started but did not progress**
	Establish, together with the states and the federal district, articulate actions to effectively implement strategy and measures to reduce and/or eliminate PCDD/PCDF releases regarding licensing, control and monitoring.	MMA and OEMAs	2015 to 2017	**Not addressed**
Prevent the release of U-POPs in new sources	Establish actions for licensing of new sources listed in parts I and III of Annex C.	OEMAs	2016-2019	**Não abordado**

Table 22: Summary of the specific objectives and activities, responsible institutions, period set for each activity implementation and the current situation of the action plan for the progressive reduction of uPOP releases (continued).

Action plan to progressively reduce releases of uPOPs from anthropogenic sources				
Objective	**Activity**	**Responsible**	**Period**	**Situation**
Improve the populations, companies and supervising agencies knowledge on u-POPs impacts on health and the environment, sources of U-POPs releases and general measures for their reduction/ elimination in order to engage them in the process.	Develop dissemination material in adapted language for the several sectors involved.	MMA, OEMAs, private sector	2015-2017	**Partially addressed. Copper secondary treatment sector has developed a booklet for best practices.**
	Carry out training courses to implement reduction/elimination actions and surveillance as well as monitoring of sources and the environment and also in articles.	MMA, CETESB	2015-2020	**Partially addressed**
Evaluate the efficiency of the adopted strategy	Monitor and report efficiency of these actions and the need to change them according to difficulties faced by government supervising agencies and undertakings.	MMA, Sectors and OEMAs	2015-2020	**Not addressed**
	Update the inventory with possible revision of emission factors	MMA and Sectors	2017-2018	**Not addressed**

Source: Adapted by the author from MMA, 2015a.

2.4.7. Current status of measures to disseminate information, raise public awareness and education

In Brazil, most of the mechanisms for disseminating information, raising public awareness and promoting education on POPs, are carried out by the MMA, as the technical focal point, and by CETESB, as the Regional Centre for the Stockholm Convention. For detailed information on this topic, the reader is requested to see Chapter 2.3.17. on the "Current level of information, awareness, and education among target groups; existing systems to communicate such information to the various groups".

Table 23: Summary of the specific objectives and activities, responsible institutions, period set for each activity implementation and the current situation of the measures to disseminate information, raise public awareness and education.

Measures to disseminate information, raise public awareness and education

Objective	Activity	Responsible	Period	Situation
Promote awareness of the public and interest groups	Hold preparatory meetings with NGOs to design social participation strategies.	MMA	2014	**Concluded**
	Carry out a National Engagement Seminar with NGOs.	MMA	2015	**Concluded**
	Prepare an engagement, dissemination and education plan on POPs.	MMA	2015-2017	**Not addressed**
Disclose information on POPs	Develop the National Information System on the NIP Brazil.	MMA	2013-2015	**Concluded**

Source: Adapted by the author from MMA, 2015a.

2.4.8. Current status of measures to improve the national analytical capacity, POP monitoring, research, development and innovation

As mentioned in section 2.3.16., most POP studies and monitoring programs in Brazil are funded by the Federal Government through its research and education funding agencies and are carried out mostly by public universities within their graduate programs. Some other monitoring programs have also been performed by specific public institutions, such as CETESB, EMBRAPA and FIOCRUZ. Currently, the Ministry of Health is trying to develop and implement a national biomonitoring program that also covers many POPs. A few measures to improve the national analytical capacity on POPs have been successfully implemented in Brazil. Noteworthy was the development of analytical capacity within the NIP update project in which analytical methods have been developed and implemented by the Federal University of Rio de Janeiro, at Institute of Biophysics Carlos Chagas Filho, Radioisotope Laboratory Eduardo Penna Franca. The lab contains all the instrumental steps necessary for identification of quantification of SCCPs, PCNs, POP brominated flame retardants (HBCD, PBDES, including decaBDE) and some organochlorine pesticides and their by-products (dicofol, HCBD and PCP).

The Sao Paulo State Environmental Protection Agency (CETESB) organized the seminar "Global Monitoring of Persistent Organic Pollutants (POPs) from the Stockholm Convention – Phase 2: sampling and analysis of new POPs in Brazil", from February 27 to 28, 2023.

The seminar resulted from the conclusion of the GEF/UNEP Regional Project entitled "Regional Support to the Stockholm Convention Global Monitoring Plan of POPs in the Latin American and Caribbean Region", which had the Ministry of Environment and Climate Change (MMA) as national coordinator and CETESB as the laboratory responsible for the analysis of POPs in air and water samples.

During the seminar, different themes related to the sampling and analysis of new POPs in air and water were discussed, with the participation of national and international researchers, as well as the results obtained in the project, in order to strengthen the national analytical capacity related to the new POPs of the Stockholm Convention and to support the Global Monitoring Plan in Latin America and the Caribbean (GRULAC).

Table 24: Summary of the specific objectives and activities, responsible institutions, period set for each activity implementation and the current situation of the measures to improve the national analytical capacity, POP monitoring, research, development and innovation (cont.)

Measures to improve POPs monitoring and analytical capacity and Research, Development and Innovation				
Objective	**Activity**	**Responsible**	**Period**	**Situation**
Promote measures to improve analytical and POPs monitoring capacity	Strengthen working groups to discuss the creation of a monitoring network in Brazil and measurement protocols.	CETESB (Regional Centre), MMA and MS	2015-2020	**Concluded**
	Study to develop protocols on sampling and analysis for new POPs in the relevant matrices for these substances.	CETESB (Regional Centre), Monitoring Group	2016- 2018	**Ongoing**
	Support building analytical capacity in national laboratories for analysis of new POPs.	(MMA and CONAMA at a second stage)	2015-2020	**Concluded**

Table 24: Summary of the specific objectives and activities, responsible institutions, period set for each activity implementation and the current situation of the measures to improve the national analytical capacity, POP monitoring, research, development and innovation (cont.).

Measures to improve POPs monitoring and analytical capacity and Research, Development and Innovation				
Objective	**Activity**	**Responsible**	**Period**	**Situation**
Promote measures to improve analytical and POPs monitoring capacity	Include mandatory analysis/ monitoring of new POPs by companies that use them in their industrial processes or that recycle articles that contain, in the licensing process.	FINEP, CNPq, Fapest, MMA, MCTI	2016-2017	**Not addressed**
	Support public reference laboratories for monitoring POPs, particularly uPOPs.	MMA/ CONAMA/ OEMAs	2015- 2019	**Concluded**
	Training on quality system and analysis methods for PCB in insulating oil to standardize methodologies and implement a quality system.	MMA, CETESB	2014- 2015	**Concluded**
	Establish strategy and methodology for monitoring uPOPs in products and articles.	INMETRO and MMA	2018- 2019	**Not addressed**
	Support the establishment of credit lines to promote the improvement of private structure for sampling and analyses of uPOPs.	MMA, MDIC, INMETRO	2017- 2018	**Not addressed/ no longer needed**

Table 24: Summary of the specific objectives and activities, responsible institutions, period set for each activity implementation and the current situation of the measures to improve the national analytical capacity, POP monitoring, research, development and innovation (continued).

Measures to improve POPs monitoring and analytical capacity and Research, Development and Innovation				
Objective	**Activity**	**Responsible**	**Period**	**Situation**
Promote measures to improve analytical and POPs monitoring capacity	Strengthen working groups to discuss the creation of a monitoring network in Brazil and measurement protocols.	CETESB (Regional Center), MMA and MS	2015-2020	**Ongoing**
	Study to develop sampling and analysis protocols for new POPs in the relevant matrices for these substances.	CETESB (Regional Center), Monitoring Group	2016- 2018	**Ongoing**
	Support the building of analytical capacity in national laboratories to analyze new POPs.	(MMA and CONAMA in a second phase)	2015-2020	**Ongoing**

Source: Adapted by the author from MMA, 2015a.

3. STRATEGY AND ACTION PLANS

The strategies and action plans set by the Brazilian government to achieve the obligations under the Stockholm Convention are presented within this chapter and represent the formal statement of the government's commitment to address the provision of the Stockholm Convention; the action plans set according to the status of implementation of the first NIP and the priorities identified in the new POP inventories; and the strategies planned for addressing each specific activity within the objectives established.

3.1. Policy statement

The Brazilian commitment to protect the environment and human life is established in the Federal Constitution being thus a national priority above any transitory government. This can be endorsed by the active Brazilian participation in several international agreements for the protection of the environment and, ultimately, human life. Therefore, the Government of Brazil is committed to the effective implementation of the Stockholm Convention and this last is intimately related to the country's environmental policy and sustainable development strategies, as well as to the implementation of other international treaties, like the SAICM, and Basel and Rotterdam Conventions (see Chapter 2.2.).

In broad terms, Brazil is committed to:

- expand and strengthen the national institutional capacity and the legal framework for chemical management, including POPs;
- expand and strengthen the national capacity in science and technology to develop proper monitoring, inventories and management of hazardous chemicals, including POPs;
- reduce POP releases to the environment and, when feasible, to eliminate POP production and application;
- enhance public awareness and education pertaining to hazardous chemicals,

including POPs, and their potential impacts on the environment and human health;

- enhance stakeholder awareness on POP issues and therefore increase their engagement level to a more comprehensive implementation of national environmental policies and of the international treaties pertaining to hazardous chemicals, including POPs;

- improve waste management in the country and to move to a more circular economy considering the challenges imposed by the occurrence of hazardous chemicals, including POPs, in consumer goods nowadays; and

- seek the synergistic implementation of relevant international agreements and national policies and projects.

The process of the development of the NIP update involved — at a much lower level than the first NIP — the active participation of a broad-base of relevant national stakeholders, including government ministries, departments and agencies; research institutions and academia; and NGO. Furthermore, the NIP update shall be endorsed by the same relevant stakeholders before its transmission to the Stockholm Convention Secretariat.

3.2. Implementation strategy

Appropriate actions, activities and strategies prepared in the NIP update will be implemented to reduce and ultimately eliminate POPs from the environment as envisaged under the Stockholm Convention. The NIP update takes into account the existing work and assessments to form an integral part of the national environmental agenda and integrated chemicals and hazardous wastes management program in Brazil. It also takes due account of the aims of the national sustainable development agenda in terms of social, economic and environmental policies and actions in order to maximize their overall benefits. This will avoid “reinventing the wheel” and link the NIP to related national chemicals and waste management initiatives where possible to ensure maximum efficiency and reduce duplication of effort.

Brazil is fully aware that POPs represent only a part of the sound chemical management task and the hazardous waste management challenge. Therefore, the NIP update tries to link and harmonize the different activities on chemicals (other chemical Conventions and SAICM) and related hazardous waste management (POPs, mercury, ozone depleting substances and plastics). Furthermore, the waste management and the destruction of hazardous chemicals need to be addressed in a holistic manner and should address all types of hazardous chemical wastes where appropriate securing co-funding in implementation.

Brazil believes that dealing with POPs in an integrative way, as part of the country's macro framework (political, economic, environmental and health; as well as within chemical, plastic, waste, and contaminated sites management plans), will result in an effective implementation, as well as attract international development partners.

According to the global development agenda, the Brazilian NIP is aligned with the Agreement of Principle 10 of the Rio Declaration, which states:

> *"Environmental issues are best handled with participation of all concerned citizens, at the relevant level. At the national level, each individual shall have appropriate access to information concerning the environment that is held by public authorities, including information on hazardous materials and activities in their communities, and the opportunity to participate in decision-making processes. States shall facilitate and encourage public awareness and participation by making information widely available. Effective access to judicial and administrative proceedings, including redress and remedy, shall be provided."*

Improving the sound lifecycle management of chemicals and, mainly, POP management will support the Government of Brazil to work towards the achievement of some Sustainable Development Goals (SDGs), like:

- SDG 3 *"Good Health and Well-being"* — Ensure healthy lives and promote well-being for all at all ages;

- SDG 5 *"Gender Equality"* — Achieve gender equality and empower all women and girls;

- SDG 6 *"Clean Water and Sanitation"* — Ensure availability and sustainable management of water and sanitation for all;

- SDG 9 *"Industry, Innovation and Infrastructure"* — Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation;

- SDG 11 *"Sustainable Cities and Communities"* — Make cities and human settlements inclusive, safe, resilient and sustainable; and

- SDG 12 *"Responsible Consumption and Production"* — Ensure sustainable consumption and production patterns.

That said, it is important to highlight that there is considerable legal basis for controls of production, foreign trade, transport, chemical use and disposal of hazardous waste pertaining to POPs in Brazil. Some gaps, however, are still a bottleneck for a comprehensive implementation of the Stockholm Convention in the country.

According to their mandates, States need to develop their specific legislation and develop programs for implementing the action plans within the NIP. Some states have legislation, but in others, there is a lack of knowledge about national legislation and/or established responsibilities. In addition, it is possible to identify cases of conscious resistance to compliance with legal obligations, consolidating situations of environmental violations.

Efforts for the enforcement of existing legislation include the qualifying staff, increasing the number of surveillance officers and intensifying surveillance. Below are listed the main conclusions outlined in the study of the legal gaps and required revision.

1) Pesticide Registration, Household Products, Wood Preservatives and others: although these products were analyzed and classified according to the criteria of toxicity, ecotoxicity, persistence, bioaccumulation and transport, there are no objective criteria for verifying the conditions that would hinder the registration of the active ingredient based on the characteristics set forth in Annex D of the Convention.

Regarding the legal status of POP pesticides, they are all already prohibited by specific normative acts in line with the provisions of the Convention, so there is no need for additional legislation.

2) Industrial Chemicals: there are regulations establishing restrictions or prohibitions for some specific industrial chemicals, such as benzene, asbestos, chlorine, mercury, PCBs and ozone layer depleting substances, but there is no general legislation covering all chemicals for industrial use in a comprehensive and systematic way. PL 6,120/2019 aims to remedy a regulatory gap in Brazil, which still lacks a regulation that establishes and regulates assessment procedures and control instruments for the management of chemicals risks. Thus, currently, chemicals for industrial use are placed on the domestic market (produced and imported) without any kind of systematic monitoring or control by the government.

3) PCBs: regarding the legislation on PCBs, there are some published regulations in order to prohibit the use of POPs in new equipment and to discipline their maintenance and the environmentally adequate management of POPs in Brazil.

4) For those chemicals whose uses are permitted, the BAT/BEP Guide must be used in the licensing process for activities that use these POPs, their wastes, and products containing SOPs in BAT/BEP.

5) Labeling of POPs: The Globally Harmonized System of Classification and Labeling of Chemicals (GHS) is implemented in the work environment in the country. Similarly, Brazil should follow the international debate on labeling strategies and identification of products and articles containing POPs and implement them in the country.

6) Customs Codes — Imports and Exports: most new POPs of industrial use do not have individual customs codes, using codes that identify large groups of substances. This makes it difficult to obtain data on foreign trade of these POPs and the quantities traded. Thus, it is necessary to discuss the establishment of specific codes for new POPs of industrial use to enable their proper identification and monitoring of international trade.

7) Waste management containing POPs: evaluate the possibility of including guidelines for the recycling of electrical and electronic waste in the reverse logistics agreement and the implementation of a strategy for the dismantling of vehicles.

8) Water and soil quality controls: regarding the legislation for monitoring POPs in

water and soil, it does not cover all POPs listed in the Convention. The detection standards of POPs established by these regulations have proven insufficient to quantify their concentrations.

9) Emissions of unintentional POPs: the limits of dioxins and furans set for waste incineration are milder than those suggested in the Convention's BAT/BEP Guide, and a possibility for updates should be assessed and sent to Conama. The National Inventory Sources and Estimates of Dioxins and Furans Emissions needs to be updated, to define strategies to determine reduction targets for companies/emission sources and serve as a legal basis and guide to surveillance and sanctioning actions of state agencies under the monitoring and licensing activities.

10) Conasq, when recreated, must resume its role in inter-institutional articulation for the implementation of the NIP in Brazil. A permanent Working Group can accompany the implementation of the NIP.

Institutional capacity: an assessment of the capacity of institutions to conduct the activities of the action plans for the implementation of the Stockholm Convention was not carried out. However, from the MMA's routine contact with the institutions, including for the development of NIP activities and seminars, it was possible to point out the following management gaps:

- Government agencies have small teams to conduct certain activities by law;
- Insufficient inspection;
- Need to produce technology guides and procedure manuals to guide the activities;
- Lack of specialized training and qualification;
- Lack of IT systems for data registry, which hinders the rapid gathering of information and recording the history of activities;
- Frequent changes of staff and managers that can lead to discontinuity of some actions;

- Difficulty of the technical staff in articulating joint actions with their institution's decision makers;

- Difficulties in performing coordinated, articulated and integrated activities between various agencies; and

- Responsibilities are not clearly set, overlapping tasks with other government bodies.

This reality, however, varies to some extent between the states. Some states are better able to structure their institutions and develop their actions more easily than others and are more successful in handling difficulties. To guide state and local authorities on their responsibilities in the execution of the Stockholm Convention implementation activities and the management of POPs, some actions have been suggested:

- Consolidate a standard document containing the activities to be conducted by agencies in the states and the content of their obligations in accordance with their established legal mandates;

- Prepare model-documents, terms of reference and activity guides;

- Appoint technical focal points in the states to form a national network of contacts to exchange experiences and implement the NIP; and

- Conduct periodic workshops with focal points.

These measures will help form an institutional organization around the Convention and implementation of the NIP activities.

3.3 Action Plans, including respective activities and strategies

Action plans were detailed in the specific Frames below and follow the strategies above-mentioned in Chapter 3.2. Moreover, most activities that were not fully addressed in the previous NIP shall be continued and adopted in the updated NIP if still relevant.

3.3.1 Activity: Institutional and regulatory strengthening measures

Box 1: Action plan for institutional and regulatory strengthening (cont.).

Common targets for all POPs of the updated NIP

Objective	Activity	Period	Responsible	Resources
Complete the activities proposed by the NIP 2015 that have not been yet addressed or concluded	**Measures to strengthen and expand the legal framework and the national institutional capacity to manage POPs**			
	Article 3, Paragraph 1 (new POPs): 1) Make available to the OEMAs BAT/BEP Guide with directives for environmental licensing of activities that use POPs in the scope of specific exemptions and acceptable purposes; 2) Include BAT/BEP recommendations in the licensing process of companies that produce and use new POPs.	Up to 2025	MMA, OEMAs and Sectors	25,000 USD
	Article 3, Paragraph 1 (Import and Export control): Perform import control according to the customs codes for new POPs made available by the WTO and develop strategies to control import and export operations.	Up to 2025	MMA, IBAMA, Federal Revenue and MDIC	30,000 USD
	Article 5 – Discuss the need for a revision of CONAMA Resolutions that discipline thermal treatment of wastes and stationary sources on the emission limits of dioxins and furans.	Up to 2025	MMA, IBAMA, Federal Revenue and MDIC	30,000 USD
	Article 11 – Discuss a revision of CONAMA Resolutions that address water and soil quality to include POPs in environmental quality parameters.	Up to 2025	MMA, IBAMA, Federal Revenue and MDIC	30,000 USD

Box 1: Action plan for institutional and regulatory strengthening (cont.).

Common targets for all POPs of the updated NIP				
Objective	**Activity**	**Period**	**Responsible**	**Resources**
Eliminate/ Reduce emissions of uPOPs in existing sources	**Progressively reduce releases of uPOPs from anthropogenic sources**			
	Update inventory of uPOP releases from anthropogenic sources	Até 2025	MMA, OEMAs e setores	20,000 USD
	Develop sector strategies to implement the appropriate measures to reduce the emission of uPOPs according to deadlines and targets agreed upon with the following priority sectors: iron ore sintering, open biomass burning, fires and open burning of wastes (accidental and otherwise), incineration of medical wastes, metallurgy and steel mills, whitewash production, aluminum production, thermal recovery of electrical wires and cables, paper and pulp and disposal of untreated effluents in surface waters.	Até 2026	MMA, OEMAs e setores	20,000 USD
	Establish, together with the states and the federal district, articulate actions to effectively implement strategy and measures to reduce and/or eliminate PCDD/PCDF releases regarding licensing, control and monitoring.	Até 2026	MMA e OEMAs	300,000 USD
Eliminate/ Reduce uPOPs emissions in existing sources	Develop dissemination material in adapted language for the several sectors involved.	Up to 2025	MMA, OEMAs, private sector	80,000 USD
	Carry out training courses to implement reduction/elimination actions and supervision as well as monitoring of sources and the environment and also in articles.	Up to 2025	MMA, CETESB	150,000 USD
	Monitor and report efficiency of these actions and the need to change them according to difficulties faced by government supervising agencies and undertakings.	Up to 2027	MMA, Sectors and OEMAs	120,000 USD

Box 1: Action plan for institutional and regulatory strengthening (continued).

Common targets for all POPs of the updated NIP				
Objective	**Activity**	**Period**	**Responsible**	**Resources**
	Update the inventory with possible revision of emission factors.	Até 2028	MMA and Sectors	50,000 USD
Promote awareness of the public and interest groups	**Disseminate information, raise public awareness and education**			
	Carry out a National Engagement Seminar with stakeholders.	Up to 2024	MMA	30,000 USD
	Prepare an engagement, dissemination and education plan on POPs.	Up to 2024	MMA	30,000 USD
Disclose information on POPs	Make information about NIP Brasil available on the MMA website	Up to 2024	MMA	8,000 USD
Reestablish the Conasq as a mechanism for permanent articulation and follow-up of the NIP's implementation	Create a permanent Working Group within Conasq to monitor and promote the implementation of the NIP.	Permanent	MMA/Membros da Conasq/ Convidados	40,000 USD
Promote measures to improve analytical and POPs monitoring capacity	**Measures to improve POPs monitoring and analytical capacity and Research, Development and Innovation**			
	Discuss the creation of a monitoring network in Brazil and measurement protocols.	Up to 2024	CETESB (Regional Centre), MMA e MS	20,000 USD
	Develop protocols on sampling and analysis for new POPs in the relevant matrices for these substances.	Up to 2024	CETESB (Regional Centre), Monitoring Group	25,000 USD
	Support building analytical capacity in national laboratories for analysis of new POPs.	Up to 2027	(MMA and CONAMA at a second phase)	500,000 USD
	Include mandatory analysis/ monitoring of new POPs by companies that use them in their industrial processes or that recycle articles that contain, in the licensing process.	Up to 2025	FINEP, CNPq, Fapest, MMA, MCTI	20,000 USD
	Support public reference laboratories for monitoring POPs, particularly uPOPs.	Up to 2027	MMA/ CONAMA/ OEMAs	30,000 USD
Increase participation of the industrial sector	Develop sector agreements to implement NIP activities,	Up to 2025	MMA IBAMA OEMAs	30,000 USD

Source: Prepared by MMA.

3.3.2. Activity: Measures to reduce or eliminate releases from intentional POPs production and use

No current intentional production of any listed POP has been identified in Brazil. This means that Brazil needs to focus on releases from intentional use and mainly from lifecycle management of POP-containing products. Some recently listed industrial POPs, such as SCCPs (or other CP mixtures containing SCCPs above 1% by weight) and c-decaBDE, can be used in Brazil for their specific exemption applications. The import of POP-containing products may play an important role on POP releases to the environment and to human health exposure, as can be further inferred when analyzing the individual POP inventories. The lack of information on POP content in consumer goods pose an expressive challenge to avoid POP releases and human exposure in the country. Moreover, considering the current national situation of waste management, POP-containing waste may become the most relevant source of POP release to the environment if not treated in an environmentally sound manner.

Recently, a study carried out by EMBRAPA has confirmed that EtFOSA ant baits can be a source of PFOS release to local soils. Therefore, it is necessary to take measures to reduce or eliminate releases from this acceptable purpose application of this PFOS precursor.

3.3.3 Activity: Production, import and export, use, stockpiles, and wastes of Annex A POPs pesticides (Annex A, Part I chemicals)

Box 2: Action Plan for PCP.

Action Plan for PCP				
Objective	**Activity**	**Period**	**Responsible**	**Resources**
Monitoring of Potentially Contaminated Areas and their Surroundings	Follow the PCP (and PCA) contamination status in biological samples from other states in the country, other than the hotspots of environmental contamination represented by the municipalities located in Baixada Santista (SP)	Up to 2026	Research Institutions, OEMAs (Cetesb)	20,000 USD
	Evaluate the South and Southeast Regions, which lead the timber, power generation and transmission, and construction sectors. The environmental agencies responsible for these regions should be informed about the importance of carrying out programs, when applicable, to evaluate possible sources of contamination derived from the use of PCP in poles and crossheads, in addition to the evaluation of potential risks of human exposure due to the reuse of demolition wood treated with PCP in the past for the production of household utensils and sawdust used in chicken production.	Up to 2026	OEMAs, Private Sector	30,000 USD
	Mapping of contaminated areas for future evaluation of possible mitigation measures, aiming to protect human and environmental health.	Up to 2026	Ibama and OEMAs	40,000 USD

Source: Prepared by MMA.

Box 3: Dicofol Action Plan

Action Plan for Dicofol				
Objective	**Activity**	**Period**	**Responsible**	**Resources**
Refine foreign trades control	Clarify the purpose to which dicofol has been imported in 2018 and 2020.	Up to 2024	MDIC Private Sector	5,000 USD
Implementation of monitoring programs	Implement environmental monitoring studies in the regions of the country where dicofol has been widely used in order to identify contaminated sites.	Up to 2024	OEMAs, Research Institutions	20,000 USD

Source: Prepared by MMA.

Box 4: Obsolete POPs Pesticides Action Plan

Obsolete POPs Pesticides Action Plan				
Objective	**Activity**	**Period**	**Responsible**	**Resources**
Review the inventory of obsolete pesticides	Update the POPs pesticides inventory.	Up to 2025	MMA, Research Institutions	5,000 USD

Source: Prepared by MMA.

3.3.4 Activity: Production, import and export, use, identification, labelling, removal, storage, and disposal of PCBs and equipment containing PCBs (Annex A, Part II chemicals)

Box 5: Action Plan for the adequate management of PCBs

Action Plan for the adequate management of PCBs

Objective	Activity	Period	Responsible	Resources
Develop a strategy for other PCB holding sectors	National PCB Inventory for all holders, especially priority sectors (hospital, schools, government agencies).	From 2024 to 2028	MMA and sectors	50,000 USD
	Adoption of specific strategies for the environmentally adequate disposal of PCBs in Brazil	Up to 2025	MMA, IBAMA and sectors	10,000 USD
	Environmentally adequate destruction of remaining PCB stocks.	Up to 2028	MMA, IBAMA, OEMAs and sectors	6,900,000 USD (GEF Project)
	Elimination of the use of polychlorinated biphenyls in equipment (e.g. transformers, capacitors or other receptacles containing liquid stocks).	Up to 2025	MMA, IBAMA, OEMAs and sectors	PCB Project

Source: Adapted by the author from MMA, 2015a.

3.3.5 Activity: Production, import and export, use, stockpiles, and wastes of hexaBDE and heptaBDE (Annex A, Part IV chemicals) and tetraBDE and pentaBDE (Annex A, Part V chemicals) and decaBDE (Annex A, Part I and Part IX) (and HBB, where applicable (Annex A, Part I chemicals))

Box 6: Action Plan for PBDEs.

Action Plan for PBDEs				
Objective	**Activity**	**Period**	**Responsible**	**Resources**
Development of new regulations	Assess the need to reinstate the Brazilian Restriction of Hazardous Substances (RoHS) Directive Working Group under Conasq to develop Conama RoHS Brazil Resolution.	Up to 2024	Conasq	20,000 USD
Development of new studies	Identification of areas with stock of goods with high concentrations of PBDE-containing products.	Up to 2024	Research Institutions, OEMAs	20,000 USD
	Adoption of measures and strategies to prevent products containing POPs from being inappropriately disposed of in landfills.	Up to 2025	Research Institutions, OEMAs	5,000 USD
Improve recycling measures	Support the implementation of the Reverse Logistics System for Electrical and Electronic Household Products and their Components.	Up to 2027	MMA, Private Sector	80,000 USD
	Terminate recycling activities for products containing PBDEs	Up to 2030	MMA, Private Sector	60,000 USD

Source: Prepared by MMA.

Box 7: Action Plan for decaBDE

Action Plan for decaBDE

Objective	Activity	Period	Responsible	Resources
Development of new regulations	Assess the need to reinstate the Brazilian Restriction of Hazardous Substances (RoHS) Directive Working Group under Conasq to develop Conama RoHS Brazil Resolution.	Up to 2024	Conasq	15,000 USD
	Assess the need to regulate the current recycling process of Electrical and Electronic Household products and their components	Up to 2025	Conasq	5,000 USD
Development of new studies	Creation of reference values for decaBDE for environmental samples, such as soil, sediment, water and air. Reference dose values for food should also be suggested, e.g., for fish.	Up to 2025	CONAMA, OEMAs, Research Institutions, Private Sector	30,000 USD
	Adoption of measures and strategies to prevent products containing decaBDE from being inappropriately disposed of in landfills.	Up to 2025	Research Institutions, OEMAs	5,000 USD
Improve recycling measures	Support the implementation of the Reverse Logistics System for Electrical and Electronic Household Products and their Components.	Up to 2027	MMA Private Sector	80,000 USD
	Inform the private sector about the importance of adopting strategies for the separation of articles containing DEBDE before the recycling process.	Up to 2025	MMA, OEMAs, Private Sector	2,000 USD

Source: Prepared by MMA.

3.3.6 Activity: Production, import and export, use, stockpiles, and wastes of HBCD (Annex A, Part I)

Box 8: Action Plan for HBCD

Action Plan for HBCD				
Objective	**Activity**	**Period**	**Responsible**	**Resources**
Reinforce monitoring measures	Inform the responsible inspection bodies of the need to identify the imported amount of EPS and XPS that may contain HBCD, so that they can implement measures to control EPS imported from China.	Up to 2025	IBAMA Federal Revenue Federal Police and ME	30,000 USD
Further questioning for the responding company	Assess how the management of HBCD construction and demolition waste, as well as of EPS and XPS materials containing HBCD, have been carried out.	Up to 2024	MMA OEMAs Private Sector	10,000 USD

Source: Prepared by MMA.

3.3.7 Activity: Production, import and export, use, stockpiles, and wastes of HCBD (Annex A, Part I and Annex C)

Box 9: Action Plan for HCBD (cont.)

Action Plan for HCBD				
Objective	**Activity**	**Period**	**Responsible**	**Resources**
Monitoring of Potentially Contaminated Areas and their Surroundings	Investigate the surrounding of industrial plants where organochlorine solvents were and/or are produced to some degree. Below we mention the locations and areas where waste from these companies has been disposed of or released: • Dow - Aratu (Bahia) • Braskem - Maceió (Aracajú) • Unipar Carbocloro - Cubatão (São Paulo) For the former two, information and data already developed by local authorities, industry, and other stakeholders should be compiled as a first basis for developing future monitoring and evaluation plans.	Up to 2025	OEMAs	10,000 USD
	Analyze the environmental situation and potential exposure of humans to HCBD in the region of Cubatão, São Paulo, which is strategic for monitoring HCBD in the country.	Up to 2026	CETESB	25,000 USD

Box 9: Action Plan for HCBD (continued)

Action Plan for HCBD				
Objective	**Activity**	**Period**	**Responsible**	**Resources**
Evaluation of Current Production of Organochlorines in Brazil	Current productions with potential to form and release HCBD in the environment should be evaluated regarding their processing, generation and waste management, especially in relation to industrial activities of chlorinated solvents. This includes not only the production sites previously mentioned, but also other potential producers of organochlorines in the national territory.	Up to 2024	Research Institutions OEMAs	10,000 USD
Monitoring of Imported Chemicals and Residues	Perchloroethylene and other chlorinated solvents imported and used in Brazil should be analyzed for their possible HCBD content in their technical formulations. The possibility of establishing limits for the content of HCBD (defined or estimated), in such chemicals, should also be considered.	Up to 2025	IBAMA OEMAs Research Institutions	25,000 USD

Source: Prepared by MMA.

3.3.8 Activity: Production, import and export, use, stockpiles, and wastes of PCNs (Annex A, Part I and Annex C)

Box 10: Action Plan for PCNs

Action Plan for PCNs				
Objective	**Activity**	**Period**	**Responsible**	**Resources**
Evaluation of residual concentrations in products	Chemical analysis is recommended for open application materials from 1960's/70's buildings - such as sealants, paints and exterior coatings (waterproof and anticorrosive), as well as capacitors - since these have long lifetimes and may still be present in structures built during the peak period of worldwide use of PCNs. To be done in conjunction to PCBs and SCCPs in open applications as well.	Up to 2025	MMA OEMAs Research Institutions	25,000 USD
	Analyze chloroprene foams, to which PCNs were applied until the early 2000s, and there may still be remnants in circulation in the country.	Up to 2025	Research Institutions	25,000 USD
	Analyze products to which CPs are mainly added, to estimate the current input of unintentional PCNs	Up to 2025	Research Institutions	15,000 USD

Source: Prepared by MMA.

3.3.9 Activity: Production, import and export, use, stockpiles, and wastes of SCCPs (Annex A, Part I)

Box 11: Action Plan for SCCPs

Action Plan for SCCPs				
Objective	**Activity**	**Period**	**Responsible**	**Resources**
Refine foreign trades control	Control international trade of CPs in a specific way for SCCPs, MCCPs and LCCPs, or at least establish a specific control for CPs that encompasses all variations of chain lengths and percentages of chlorination, but not covering any other type of products.	Up to 2025	IBAMA ME Federal Revenue Federal Police	20,000 USD
Identify chemical composition of CP-base products	Confirm the chemical composition (percentage of each chain length and chlorine content) of the CPs in PVC-based consumer goods.	Up to 2024	Research Institutions	30,000 USD
Implement CP monitoring programs	Implementation of environmental monitoring projects around potential CPs-using industries.	Up to 2025	OEMAs Private Sector	60,000 USD
	Monitoring of consumer goods and recyclable products: polymeric products, especially those produced on a large scale and commonly additivated with CPs such as rubbers and PVC, should be investigated to prevent human and environmental exposure to CPs through products made from this recycled material.	Up to 2025	OEMAs Private Sector	40,000 USD

Source: Prepared by MMA.

3.3.10 Activity: Production, import and export, use, stockpiles, and wastes of PFOA, its salts and PFOA-related compounds (Annex A, Part I and Part X)

Box 12: Action Plan for PFOA, its salts and related compounds

Action Plan for PFOA, its salts and related compounds				
Objective	**Activity**	**Period**	**Responsible**	**Resources**
Increase research on occurrence in environmental matrices	Encourage studies and projects that aim to fill knowledge gaps and bring light to the situation of environmental contamination by PFOA in the country, in order to better manage the risks of toxic waste in Brazilian territory.	Up to 2024	IBAMA OEMAs	35,000 USD
	Increase the number of studies that investigate PFOA occurrence in drinking water and food, which can have national public health consequences.	Up to 2024	Research Institutions	35,000 USD
	Update the inventory looking into the fire-fighting foams use.	Up to 2024	Research Institutions	10,000 USD

Source: Prepared by MMA.

3.3.11 Activity: Production, import and export, use, stockpiles, and wastes of DDT (Annex B, Part II, chemicals) if used in the country

There is no specific action plan regarding DDT in Brazil because DDT is no longer used in the country for over a decade. Moreover, the identified remain stockpiles have already been properly disposed of. Thus, DDT is no longer a relevant POP issue in Brazil.

3.3.12 Activity: Production, import and export, use, stockpiles, and wastes of PFOS, its salts and PFOSF (Annex B, Part III chemicals)

Box 13: Action Plan for PFOS, its salts and PFOSF

Action Plan for PFOS, its salts and PFOSF				
Objective	**Activity**	**Period**	**Responsible**	**Resources**
Complete the activities proposed in the action plan of the NIP 2015 that have not yet been started or finished	Conducting studies to identify chemical and non-chemical substitutes for EtFOSA and to verify PFOS & PFOSF contamination in application areas.	Up to 2026	MAPA, IBAMA, Anvisa, Research Institutions, EMBRAPA, Private Sector	55,000 USD
Monitoring of areas at risk of PFOS contamination	Inspect areas adjacent to formicide bait factories, sites where PFOS-related compounds and formicide baits are stored and stockpiled, areas adjacent to sites where formicide bait is applied.	Up to 2025	OEMAs	20,000 USD
Increase research on PFOS occurrence in environmental matrices	Encourage studies and projects that aim to fill knowledge gaps and bring light to the situation of environmental contamination by PFOS in the country; including drinking water and food.	Up to 2027	MMA, Research Institutions	20,000 USD
	Update the inventory looking into the fire-fighting foams use.	Up to 2024	Research Institutions	10,000 USD
Start evaluation of possible substitutes registered in Brazil	Coordination with the competent institutions to evaluate possible alternatives to replace sulfluramide, approved in Brazil in 2023, in accordance with the Stockholm Convention, which establishes that aspects of the product be taken into consideration, such as its efficiency in the field, risks to human health, environmental impacts, service capacity and suitability for the national market.	Deadline to be defined by the competent authorities, following the precepts of the Stockholm Convention and national legislation.	MMA, IBAMA, MAPA and ANVISA	25,000 USD

Source: Prepared by MMA.

Following the provisions of the Stockholm Convention, Brazil is committed to the periodic review and updating of its NIP, since a continuous action plan should be carried out from time to time, as foreseen in the Convention Text.

3.4. Development and capacity-building proposals and priorities

During NIP development, priority areas for the implementation of the Stockholm Convention in Brazil were identified. The goal of the Convention to protect human health and the environment is also the objective of the country. In this sense, any policy making and capacity-building towards meeting the Convention obligations is also a means towards healthier Brazil.

The capacity-building required regarding POPs could also be potentially applied to a number of other international Conventions and agreements on pollution. Implementation of the Stockholm Convention should be approached synergistically with implementation of different international conventions and agreements on pollution.

NIP development should be an ongoing program. Action plan enforcement, chemicals inventory development, specific legislation making, production and commerce assessments, all of these are activities that must be ongoing. It is not enough to take a snapshot of the situation every five years, in order to ensure protection for human health and the environment.

Most of the activities addressed in this section as priorities are present in many of the specific action plans listed above.

3.4.1. Stakeholder engagement and institution coordination

NIP development was conducted with both the participation from the industry sectors and from state institutions, through consultations via official letter held by the MMA for the development of POPs inventories. The NIP is an effort involving different ministries, agencies, industry and universities and research institutions. As such, strengthening coordination with all these sectors is a priority not only for implementation, but also for the development of the plan itself.

3.4.2. Legislation and monitoring program

There is a need for the improvement of and development of new legislation regarding POPs in Brazil. Resolutions regarding POPs levels on environmental compartments, such as drinking water, reservoirs, sediments, indoor air and food, must be created and enforced. This is especially relevant for those POPs that are still in use in the country as per specific exemptions or acceptable purposes.

Legislation should also set controls and restrictions on domestic production and sales and international commerce of chemicals listed on the Stockholm Convention. Reinforcing BAT/BEP usage recommendations in activities that use or emit POPs is a way for minimizing its environmental impact. Periodic inspection of manufactories, stockpiles and sales sites could lead to early identification of irregularities and remediation. The correct labeling of chemicals for international commerce is required to properly manage entry and exit of controlled substances in Brazil. There are specific tracking codes for some of the POPs, but trade under generic codes still happens.

For an overview of possible contamination sites as a way of protecting human health and the environment as well as enforcing the restrictions imposed on the listed POPs, a monitoring program is required. Monitoring allows for the identification of contamination, evaluation of impacts and assessment of threats. All of which will lead to better management and remediation. A POP monitoring program requires capacitated personnel in a multidisciplinary array of expertise, such as relevant area identification, sampling, chemical analysis, risk assessment, waste management and remediation. It also requires capacitated infrastructure, such as chemistry and biology laboratories, analytical equipment and the conduction of population census. All of these capacity-buildings could potentially also be applied to meeting implementation requirements of different international conventions.

3.4.3. Waste management

Management of POP containing waste is a priority since it could be an emission source and originate contaminated areas. Mismanagement of POP containing waste could also lead to the production of different POPs, such as dioxins and furans. In Brazil, the majority of consumer goods and electro and electronic equipment waste goes to open disposal sites and landfills. This practice could promote POPs leaching from waste to air, soil and groundwater and thus reaching ecosystems, exposing human beings and wildlife to potential adverse effects.

Waste should be managed in an environmentally sound manner. Capacity-building towards personnel and infrastructure to carry management should be prioritized. When the BAT for waste management is not available in the country, waste should be exported to places that can properly deal with it.

3.5. Timetable for implementation strategy and measures of success

A detailed timetable is present together with the specific Action Plans proposed for the POPs covered in the NIP update. Box 13 presents a summarized timetable of priority Action Plans compiled from Section 3.3.

Box 14: Action Plans Summary Timetable (cont.)

Nº	Action Plan	TIME FRAME		
		Short Term (2024-2025)	**Medium Term** (2026-2027)	**Long Term** (2028-2031)
1.	Include BAT/BEP recommendations in legislation for licensing of activities using POPs within the scope of specific exceptions and acceptable purposes.			
2.	Update of CONAMA Resolutions on environmental quality parameters;			
3.	Creation of specific trade codes for the new POPs and reinforcement of import control.			
4.	Update uPOPs inventory			

Box 14: Action Plans Summary Timetable (cont.)

Nº	Action Plan	TIME FRAME		
		Short Term (2024-2025)	**Medium Term** (2026-2027)	**Long Term** (2028-2031)
5.	Implement appropriate measures to reduce uPOPs emission.			
6.	Implement strategy and measures to reduce and/or eliminate PCDD/PCDF releases regarding licensing, control and monitoring.			
7.	Creation of mechanisms for the inspection and engagement of the industrial sector.			
8.	Monitoring of concentrations at areas adjacent to former or current POP industries, storage or stockpile facilities, sites of application, hotspots, consumer goods, imported products, occupational exposure, environmental media, drinking water and food.			
9.	Identification of substitutes for EtFOSA.			
10.	Investigate the purpose of PFOS, PFOSF and Dicofol volumes imported between 2017 and 2020.			
11.	Improve the efficiency of the Reverse Logistics System for Household Electrical and Electronic Products and their Components.			

Box 14: Action Plans Summary Timetable (continued).

Nº	Action Plan	TIME FRAME		
		Short Term (2024-2025)	Medium Term (2026-2027)	Long Term (2028-2031)
12.	Assess chain length and chlorine content of CPs-based products and imported CP mixtures.			
13.	Inventory of PCBs in priority sectors; adoption of specific strategies in areas representing diffuse sectors.			
14.	Develop strategies for managing PFOS/PFOSF stocks and residues and uses at higher risk of human exposure.			
15.	Coordination with the competent institutions to evaluate possible alternatives to replace sulfluramide, approved in Brazil in 2023, in accordance with the Stockholm Convention, which establishes that aspects of the product be taken into consideration, such as its efficiency in the field, risks to human health, environmental impacts, service capacity and suitability for the national market.			
16.	Investigate practices and techniques adopted in the recycling and waste management of materials containing POPs, for example, plastics, EEE, EPS and XPS; promote the progressive elimination of recycling of material contaminated with PBDE and HBCD.			
17.	Promote awareness and develop informative material (e.g. brochures, courses and workshops on BAT/BEP etc.).			
18.	Development of a systematizing document experiences on management of contaminated areas			
19.	Identification of waste stocks, product stocks containing POP and contaminated areas.			

Source: Prepared by the author.

3.6. Resource requirements

The ability of the country to fulfil its obligations under the Stockholm Convention depends partly on the provision of adequate financial and technical assistance. Brazil has been contemplated by some UNEP/GEF project fundings and thanks to that the country has progressed on the implementation of the Convention provisions. For the desired action plans, tentative budget requirements have been estimated and are summarized in section 3.3. Details on funding requirement will be further elaborated during the respective development of the projects and Brazil is aware that the financial resources from GEF and other UN funding do not sufficiently cover the full implementation costs of the action plans; hence, co-funding will be considered. Overall, the NIP can be carried out by mobilizing several financial resources, such as state budget, bilateral grant aid, GEF grants, financing from organizations and individuals, extended producer responsibility contribution, polluter payer principle contributions, loan, improved resource recovery from wastes, and other appropriate options.

The Brazilian NIP will be applied and coordinated together with other related national plans and programs. This will save efforts and optimize the implementation of the international treaties on hazardous chemicals, such as the Stockholm Convention, Brazil has signed.

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