Sri Lanka PFAS Situation Report - 2019 -

Centre for Environmental Justice (CEJ)

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Background, usage and recommendations to manage PFAS in Sri Lanka

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Sri Lanka PFAS Situation Report

Summary

Per- and polyfluoroalkyl substances (PFAS) include a large number of fluorinated chemicals. These chemicals are persistent and have a variety of negative effects on human health and the environment. Some members of this group have been identified as persistent organic pollutants. Sri Lanka does not produce these substances, but they are in use. This report recommends further, research and action plans to manage this hazardous group of chemicals.

Key findings of this report include:

PFAS substances are poorly controlled in Sri Lanka
Sri Lanka became a Party to the Stockholm Convention in 2005 and the treaty added PFOS to its global restriction list in 2009. This amendment went into legal force in Sri Lanka in 2010. However, most PFAS not regulated. A newly formed national waste management policy in response to a case filed by CEJ (SCFR152/17) includes policies to manage all chemical wastes.

Firefighting foams are a likely major source of PFAS
According to the Revised National Implementation plan under the Stockholm Convention firefighting foams are the likely major source of PFOS in the country with 17,837 kg/ year as an upper estimate. According to the government inventory, the Sri Lankan Fire Brigade has a stockpile of around 50,000 liters of firefighting foams imported in the late 1980s – likely PFOS-containing foam. A major firefighting foam importer supplies PFAS-containing foams, but does not indicate the PFAS content in the documentation.

PFAS are found in tea workers
A 2005 study found PFOS, PFHxS, PFUnA, PFDA, PFNA, and PFOA, were detected in all sera samples. Relatively high levels were found and mean levels of PFOS and PFOA in conventional tea workers in the rural area (PFOS mean: 6.3 ng/mL; range: 1.8-17.5 ng/mL and PFOA mean: 9.06 ng/mL; range: 1.9-23.5 ng/mL) were similar to those in people living in the capital, Colombo. In contrast, organic agriculture tea workers had comparatively lower levels of accumulation than conventional tea workers. For example, PFOS levels in organic tea workers were 0.96 mg/ml compared to 6.3 ng/mL in conventional tea workers. Overall the PFAS with the highest concentration in sera was PFOA.

Fish, shellfish and water are contaminated with PFAS
A 2008 study found PFOS in fish up to 12.4 ng/g wet weight and PFOA up to 0.74 ng/g. PFAS in water included PFOS, PFOA, N-EtFOSAA, PFOSA, and THPFOS.

What are per- and polyfluoroalkyl substances (PFAS)?

PFAS is a large class of more than 4,500 fluorinated chemicals. Two widely-used members of this class have been perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA). As these two substances have come under regulatory pressure, the industry has shifted to other PFAS with similar properties.

Human exposure to PFAS is mainly by ingestion of contaminated food or water. These substances bind to proteins (not to fats) and persist in the body where they are mainly detected in blood, liver and kidneys. Studies indicate that PFOA and PFOS can cause reproductive and developmental, liver and kidney, and immunological effects in laboratory animals. Both chemicals cause tumors in animal studies along with a variety of other effects on infant birth weight, growth, learning, infant behavior, pregnancy, endocrine system, increased cholesterol, and thyroid function. Recent studies have linked a variety of PFAS substances to many human health effects: cardiovascular disease, markers of asthma, damage to semen quality, ovarian insufficiency, altered glucose metabolism, lower testosterone levels in male adolescents, association with shorter birth length in girls, elevated blood pressure, abnormal menstruation, lower birth weight in infants, possible increased risk of female infertility due to endometriosis, and decreased lung function in children with asthma.

The manufacture of PFAS and their use in a multitude of products has caused widespread pollution. For example, PFAS use in firefighting foams at military bases and airports is responsible for water pollution and contaminated communities in many countries, including Australia, Canada, China, Germany, Italy, Japan, Netherlands, New Zealand, South Korea, and Sweden.

Due to their unique lipid and water-repellent characteristics, PFAS substances have been used in a widespread variety of industrial and commercial products such as textiles and leather products, metal plating, the photolithography, photographic industry, semi-conductors, coating additives, paper and packaging, cleaning products and pesticides. Some PFAS can be formed by degradation or metabolism, necessitating the inclusion of precursors in any regulation.

Safer cost competitive non-fluorinated alternatives for PFAS use in firefighting foams have been adopted by an increasing number of major airports, including Auckland, Copenhagen, Dubai, Dortmund, Stuttgart, London Heathrow, Manchester, and all 27 major airports in Australia. Increasing awareness about the negative characteristics of PFAS has driven efforts to identify and market safer substitutes for other uses. Due to the complexity and negative characteristics of PFAS, there is increasing interest in regulating PFAS as a class rather than as individual substances.

PFOS

PFOS and its related substances have been used in a variety of products and processes including firefighting foams, carpets, leather goods, upholstery, packaging, industrial and household cleaning products, pesticides, photographic applications, semiconductor manufacturing, hydraulic fluids, catheters and metal plating. PFOS has been used to manufacture aqueous film forming foam (AFFF) used to extinguish flammable liquid fires (for example, hydro carbon fueled), such as fires involving gas tankers and oil refineries. PFOS is extremely persistent and has shown no degradation under any environmental condition that has been tested. It is toxic to mammals and high concentrations have been found in Arctic animals, far from anthropogenic sources. PFOS is regularly detected in human blood and breast milk. For example, in one study of 299 infants, PFOS was found in the blood of 297 of them and PFOA was found in all of them.

PFOA

PFOA has been used to make non-stick pans, and is found in textiles, fire-fighting foams, and medical devices, and is used in many other products and processes. In 2017, the Stockholm Convention POPs Review Committee noted the link between PFOA and serious illnesses in humans, including diagnosed high cholesterol, ulcerative colitis, thyroid disease, testicular cancer, kidney cancer and pregnancy-induced hypertension. PFOA has contaminated the global environment, including wildlife and people of remote regions such as the Arctic and Antarctic.

For more information about recent research on the impacts of PFAS, including fluorinated substitutes for PFOS and PFOA, please see Annex 1. Information about the high cost of PFAS pollution clean up is available in Annex 2. Global regulation of PFAS through the Stockholm Convention and evaluations of its expert committee is discussed in Annex 3.

PFAS production, use, and waste management

Import of PFAS

Sri Lanka does not manufacture PFOS, PFOA or other PFAS substances. However, these substances or products containing them are likely imported. According to the Revised National Implementation plan under the Stockholm Convention on Persistent Organic Pollutants in Sri Lanka of 2015, PFOS is imported in articles and products to the country. The Ministry of Mahaweli Development and Environment has developed an inventory based on 14 such categories. These categories comprise thirteen subdivisions plus the pure chemical form used in the laboratory. Calculations of quantities were done based on Stockholm Convention guidance for the inventory of PFOS published in 2012 (Table 1). According to the data, firefighting foams are the likely major source of PFOS in the country with 17,837 kg/ year as an upper estimate. The second major PFOS source is coating and impregnations for synthetic carpets with 12,886 kg/ year as an upper estimate. Coatings and impregnations for textiles were third with an upper estimate value of 5711 kg/year. These estimates do not include PFOA as the substance has not yet been listed in the Stockholm Convention.

According to the UNEP-POPs factsheet on “Pentadecafluorooctanoic acid (PFOA, perfluorooctanoic acid), its salts and PFOA-related compounds”, PFOA is found in items such as non–stick kitchen ware, food processing equipment, surfactants and surface treatment agents in textiles, paper and paints, firefighting foams, stain resistant carpets, carpet cleaning liquids, house dust, microwave popcorn bags, water, food, and Teflon. PFOA has also been detected in industrial waste. Unintentional formation of PFOA can occur as a result of incomplete combustion of fluoropolymers during incineration or open burning facilities at moderate temperatures.[1] Although there is no inventory on applications and use of PFOA in Sri Lanka, it is possible that items containing it have been imported and disposed of over the years.

Table 1:Estimated amount of PFOS imported in year 2013. Source: Preliminary Inventory of Perfluorooctane Sulfonate (PFOS) and its salts in Sri Lanka- 2015.

Category of article or preparation	Process or sub application	PFOS content approximate values (mg PFOS/ kg article or preparation)	Estimated PFOS quantity (kg per year)
Photographic sector	• Surfactant • Electrostatic charge control agent • Friction control agent • Dirt repellent agent • Adhesion control agent	100	44
Semiconductor sector	• Etching agent • Photoresist substance • Photo-acid generator • Surfactant • Anti-reflective coating agent	200 - 1000	Nil
Electronics sector	• Etching agent • Dispersion agent • De-smear agent • Surface treatment agent • Photoresist substance • Photo-acid generator • Surfactant • Anti-reflective coating agent • Solder • Adhesive	200 – 1000	Nil

[1] UNEP-POPS-PUB-factsheet-PFOA-201803.English.pdf

	• Paint		
Aviation hydraulic fluids		500 - 1000	24 – 47
Fire fighting foams		5000 – 15000	5946 – 17,837
Metal plating decorative plating of metal, rubber and plastics		50000 – 500000	Nil
Certain medical devices		150 ng/ CCD filter	Nil
Coating and impregnation of paper and packaging		500 - 5000	Nil
Coating and impregnation of synthetic carpets		500 - 5000	1289 – 12,886
Coating and impregnation of leather and apparel		500 - 5000	43 – 425
Coating and impregnation of textiles and upholstery		500 - 5000	571 – 5711
Coating and coating additives		1000 - 10000	Nil
Toner and printing inks		100	312
Cleaning agents, waxes and polishes		50- 100	117 – 235
Chemicals		100%	99
Total quantity			**8444 – 37,596**

Waste management

The average waste generation per day in Sri Lanka is approximately 7500 tons but only 3500 tons are collected daily.[2] According to the draft "National inventory of Mercury releases in Sri Lanka, 2016", the amount of collected Municipal Solid Waste (MSW) adds up to only 38.4%. Out of this only approximately 10% is recycled and 6% is composted or used for biogas generation. The remaining 23% is disposed in sanitary landfills or open dumping sites. It is highly likely that this portion includes articles that contain or are contaminated with PFOA, PFOS and possibly other PFAS substances. In addition, leachate from these waste dumping/ landfill sites will cause water and soil contamination. Air pollution results from waste incineration or open burning.

[2] https://www.unescap.org/sites/default/files/6_CEA.pdf

Although it is not highlighted, the newly formed National waste management policy in response to a case filed by CEJ (SCFR152/17) includes policies to manage all chemical wastes.[3]

PFAS impacts

Major contamination sites in Sri Lanka include dumpsites, landfills and places where waste incineration or fire extinguishing occurred

PFAS-containing firefighting foam

According to the government inventory[4], the Sri Lankan Fire Brigade has a stockpile of around 50,000 liters of firefighting foams imported in the late 1980s.[4] It is likely that this stockpile consists of PFOS-containing firefighting foams since they were imported before many governments and the public realized the substances were hazardous (however the manufacturers knew the substances were hazardous; please see Annex 1). Generally, before the foam is applied it will be mixed with water in a 1:30 ratio at the site and then pumped as needed at the site of the fire, contaminating the soil and the groundwater. However, it has to be noted that three times more than the required amount of the foam has often been used historically to fight fires.

Apogee Holdings (Pvt) Ltd is one of the major importers of fire-fighting equipment and materials to Sri Lanka. They supply the foam named "AFFF". This comes as two types. Namely, "AFFF-XHP 1%" and "AFFF-XHP 3%". According to MSDS given in the company website. The AFFF-XHP 1% contains; 2-(2-Butoxyethoxy)-Ethanol, 5-Chloro-2-methyl-2,3-dihydroisothiazol-3-one and 2-Methyl-2,3-di hydroisothiazol-3-one (3:1), and Alkyl polyglycoside. According the MSDS, AFFF-XHP 3% contains 2-(2-butoxyethoxy)-ethanol, Alkyl polyglycoside, Reaction mass of: 5-Chloro-2-methyl-2H-isothiazol-3-one and 2-methyl-2H-isothiazolin-3-one (3:1)[5].

However, all AFFF foams contain PFAS fluorosurfactants to enable film formation. Neither "AFFF-XHP 1%" nor "AFFF-XHP 3%" foam is listed in the fluorine free category on the manufacturer's website (see photo below). Instead, both foam products are listed under C8 technology – indicating that they use eight-carbon PFAS substances. These could include PFOA, PFOS, and 8:2 fluorotelomers.

The MSDS sheets for "AFFF-XHP 1%" and "AFFF-XHP 3%" foam products are misleading because they fail to mention the PFAS content of the foam product under "general information." The MSDS also claims that the product does not contain a persistent substance, but PFAS are persistent. These are common problems in MSDS documents for firefighting foam products and should be corrected.

[3] http://mmde.gov.lk/web/images/pdf/2018/nationalwastemanagementpolicy-english.pdf
[4] Ministry of Mahaweli development and Environment, Preliminary Inventory of Perfluorooctane Sulfonate (PFOS) and its salts in Sri Lanka- 2015.
[5] http://angusfire.co.uk/products/foam-concentrates/guidance-documents/material-safety-data-sheets/

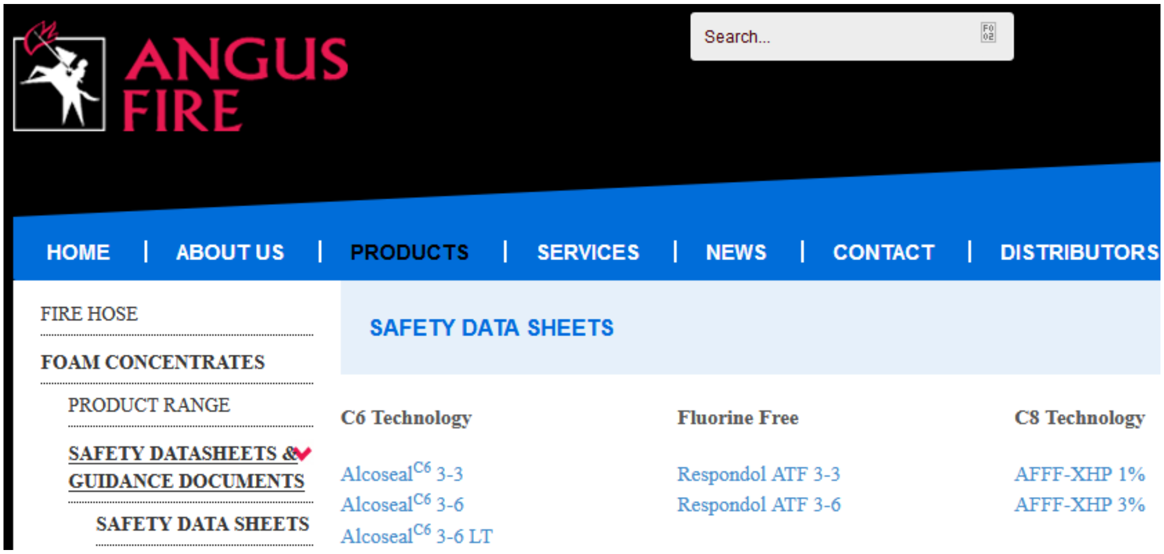

Figure 1: Screen shot of Angus Fire website showing MSDS sheets for firefighting foams, indicating that AFFF-XHP 1% and 3% are not fluorine free and instead use C8 technology.

According to the company, during last 30 years they imported firefighting foams only from Europe (UL-certified foams). Usually, they do not maintain any stock and deliver directly from the manufacturer to the site of the customer. According to them, all foams supplied by the company are UL-registered and non-PFOS containing eco - friendly brands. However, these foams likely contain C6 PFAS substances. The main buyers are Airport & Aviation Services (Sri Lanka) Ltd, Ceylon Petroleum Corporation, Sri Lanka Air Force, Sri Lanka Port Authority, Sri Lanka Navy and Customs Fire brigade and Colombo Municipal Council (for fire brigade). These stations maintain their own stock of fire -fighting foam.

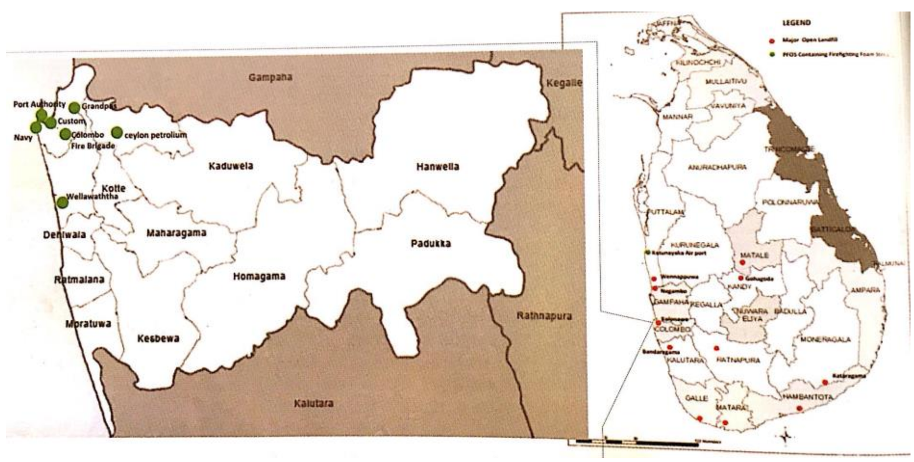

Figure 2: Suspected PFOS-contaminated sites in Sri Lanka. Source: Preliminary Inventory of Perfluorooctane Sulfonate (PFOS) and its salts in Sri Lanka- 2015.

Scientific studies on PFAS in Sri Lanka

Guruge KS, Taniyasu S, Yamashita N, Wijeratna S. Mohotti KM, Seneviratne HR, Kannan K, Yamanaka N, Miyazaki S (2005) **Perfluorinated organic compounds in human blood serum and seminal plasma: a study of urban and rural tea worker populations in Sri Lanka**, J Environ Monit 7:371-377

The study by *Guruge et al.* reveals contamination levels of 13 fluorinated organic compounds in human sera and seminal plasma of tea workers in Colombo, Talawakele and Haldummulla. Thirty workers were sampled and PFBS, PFOSA, and PFPeA were below the detection limit. However, PFOS (perfluorooctanesulfonate), PFHxS (perfluorohexanesulfonate), PFUnA (perfluoroundecanoic acid), PFDA (perfluorodecanoic acid), PFNA (perfluorononanoic acid) and PFOA (perfluorooctanoic acid), were detected in all sera samples. Relatively high levels were found and mean levels of PFOS and PFOA in conventional tea workers in the rural area (PFOS mean: 6.3 ng/mL; range: 1.8-17.5 ng/mL and PFOA mean: 9.06 ng/mL; range: 1.9-23.5 ng/mL) were similar to those in people living in the capital, Colombo ((PFOS mean: 7.8 ng/mL; range: 1.5-18.2 ng/mL and PFOA mean: 9.54 ng/mL; range: 0.6-22.8 ng/mL). In addition, PFOS and PFHS, were found in all seminal plasma samples (Table 2). It also reveals that the detection frequency for PFOA was >70% in seminal plasma. The researchers state that organic tea workers had comparatively lower levels of accumulation than conventional tea workers.[1] For example, PFOS levels in organic tea workers were 0.96 mg/ml compared to 6.3 ng/mL in conventional tea workers. Overall the PFAS with the highest concentration in sera was PFOA.

Guruge K, Taniyasu S, Yamashita N, Manage P (2008). **Fluoroalkyl surfactants in fish and water from Sri Lanka: an estimation of PFOS and PFOA intake via fish**, Research in Asia 1:167-172

Another study by *Guruge et al.* reveals the presence of PFOS and PFOA in Fish, shellfish and water samples (Table 2). According to their analysis, the estimated amounts for dietary intake of PFOS via fish is 7.5 ng/kg body weight/day and that of PFOA is 1.8 ng/kg body weight/day.

Table 2: Detection of fluorinated organic compounds (FOCs) in different samples collected in Sri Lanka

	Human sera	Seminal plasma	Fish	Shellfish	Water
PFOS (perfluorooctanesulfonate): $F(CF_2)_8SO_3^-$	✓	✓	0.021 to 12.4 ng/g wet weight	ND	0.66-47 ng/L
PFHS (perfluorohexanesulfonate),	✓	✓			
PFUnA (perfluoroundecanoic acid),	✓				
PFDA (perfluorodecanoic acid),	✓				
PFNA (perfluorononanoic acid)	✓				

PFOA (perfluorooctanoic acid), $F(CF_2)_3COO^-$,	✓	✓		0.67 – 0.74 ng/g wet weight	0.83-12.4 ng/L
N-EtFOSAA: $(F(CF2)_8SO_2N(C_2H_5)(CH_2COO)^-$,					0.034-4.1 ng/L
PFOSA: $F(CF_2)_8SO_2NH^-$,					<0.016-7.5 ng/L
THPFOS: $F(CF_2)_6(CH_2)_2SO_3^-$					0.64 ng/L (Mean value)
Reference	Guruge *et al.*, 2005[6]	Guruge *et al.*, 2005[5]	Guruge *et al.*, 2008[7]	Guruge *et al.*, 2008[6]	Guruge *et al.*, 2008[6]

The inventory also reveals another study by Seneviratne, *et al*. in 2009 on pipe borne water and river water contamination from PFAS. According to the information given, the water samples collected from different locations in the Mahaweli River contained 1.5 ng/L of PFOA on average.[4]

Press reports on PFAS

No press reports on PFAS in Sri Lanka were identified.

PFAS regulations

The Ministry of Mahaweli development and Environment has published two documents on PFOS (PFOA is not included for it has not been confirmed under the list). One is the "Revised National Implementation Plan under the Stockholm Convention on POPs for Sri Lanka, 2015" and the other is the "Preliminary Inventory of Perfluorooctane Sulfonate (PFOS) and its salts in Sri Lanka- 2015". This document has identified several goals to control PFOS in the future. Those include: undertaking law and policy assessment related to management of PFOS; amending existing laws

[6] Guruge et al. *Perfluorinated organic compounds in human blood serum and seminal plasma: a study of urban and rural tea worker populations in Sri Lanka.* Journal of environmental monitoring (4) 2005. https://pubs.rsc.org/en/Content/ArticleLanding/2005/EM/b412532k#!divAbstract

[7] Guruge K, Taniyasu S, Yamashita N, Manage P (2008). *Fluoroalkyl surfactants in fish and water from Sri Lanka: an estimation of PFOS and PFOA intake via fish.* https://www.researchgate.net/publication/283892588_FLUOROALKYL_SURFACTANTS_IN_FISH_AND_WATER_FROM_SRI_LANKA_AN_ESTIMATION_OF_PFOS_AND_PFOA_INTAKE_VIA_FISH

or developing new laws where necessary to manage PFOS; establishing a database on PFOS and related substances including integrated management and waste disposal mechanisms; and to control chemicals and chemical products at customs level.

However, the last updated list of Special Import License Regulations (Gazette Extraordinary 2044/40, November 2017) that include banned items, does not highlight PFOA or items containing such. In fact, the pure form of chemical is listed under the HS code 2904.31-36 (Perfluorooctane sulfonic acid, its salts and perfluorooctane sulfonyl fluoride) and HS code 2922.16 Diethanolammonium perfluorooctane sulfonate are all listed in the Schedule I that can be imported under a license. Those that are containing or contaminated with PFOS and PFOA are difficult to trace.

Recommendations

Recommendations for Stockholm Convention COP9

1. PFOA should be listed in Annex A with no specific exemptions. If exemptions are granted, they should be for specific products and the listing should require labeling new products that contain PFOA so that Parties can fulfill requirements under Article 6 as done previously for HBCD (SC-6/13).

2. Due to the costly, highly polluting nature of firefighting foams, and the availability of cost-effective, technically feasible non-fluorinated alternatives, no specific exemptions should be adopted either for PFOS or PFOA production and/or use in firefighting foams.

3. Specific exemptions or acceptable purposes for the following 11 uses of PFOS should be ended: photo-imaging, photo-resist and anti-reflective coatings for semiconductors; etching agent for compound semiconductors and ceramic filters; aviation hydraulic fluid; certain medical devices; photo masks in semiconductor and LCD industries; hard metal plating; decorative metal plating; electric and electronic parts for some color printers and color copy machines; insecticides for control of red imported fire ants and termites; and chemically-driven oil production.

4. The following 3 acceptable purposes should be converted into specific exemptions: metal plating (hard metal plating only in closed loop systems); firefighting foams; insect bait for control of leaf-cutting ants from *Atta* spp. and *Acromyrmex*spp. Sulfluramid should be named in the PFOS listing and its use sharply limited to cultivation of specific crops.

National recommendations

Sri Lanka has identified several obstacles in managing PFOS and related substances and thereby has identified several gap areas to improve. Such include;

1. Specific regulations are needed to prohibit PFAS production, use, import, and export. To avoid costly mistakes, PFAS should be banned as a class.

2. Conduct assessments on alternatives to PFOS and PFOA used in different applications and approving the most sustainable alternative/s within the process of sustainable consumption and production.

3. To prevent PFAS pollution and subsequent costly remediation, Sri Lanka should promptly inventory firefighting foam stocks and replace PFAS-containing foams with fluorine-free foams

4. Identify methods to assess and manage existing stockpiles of contaminated items and contaminated sites.

5. Identify methods to minimize PFOS, PFOA discharges into inland waters, oceans, air and soil.

6. Conduct awareness raising for both officials and general public.

Annex 1. PFAS toxicity

The Stockholm Convention expert committee (please see Annex 3) evaluated the toxicity characteristics of PFOS in 2007 and PFOA in 2017. Since then, more scientific information has emerged for both these substances along with some of the shorter-chain PFAS aggressively promoted by the industry as substitutes.

Recent research shows the harmful impacts of PFAS

Recent studies have linked PFAS substances to a variety of human health effects: cardiovascular disease, markers of asthma, damage to semen quality, ovarian insufficiency, altered glucose metabolism, lower testosterone levels in male adolescents, association with shorter birth length in girls, elevated blood pressure, abnormal menstruation, lower birth weight in infants, possible increased risk of female infertility due to endometriosis, and decreased lung function in children with asthma.

The chemical industry promoted perfluorohexane sulfonate (PFHxS) as a substitute for PFOS. In 2018, the Stockholm Convention expert committee concluded that it "warrants global action." PFHXS is found in 2 – 4 month-old infants and associated with damage to semen quality. The Stockholm Convention expert committee found that PFHxS has been detected in human blood and breast milk in many regions, and is together with perfluorooctane sulfonic acid (PFOS), perfluorooctanoic acid (PFOA) and perfluorononanoic acid (PFNA) one of the most frequently detected and predominant PFASs in human blood. The Committee noted that the fetus is exposed to PFHxS via umbilical cord blood and that animal studies show impacts on reproduction, liver function, thyroid hormone levels, and lipid and lipoprotein metabolism.

Studies showing the toxicity, environmental fate, and occurrence of PFAS in current use include:

Perfluorobutanoic acid (PFBA)

- Effects on thyroid and developmental delays in offspring exposed during pregnancy
- Similar toxicity to liver as PFOA
- Associated with damage to semen quality
- Found in home-produced eggs
- Found in the Arctic
- Efficiently translocated into plants
- Taken up by corn
- Found in fruits and vegetables
- Contaminates fish
- Found in humans in a community with known drinking water contamination
- Found in consumer products

Perfluorobutane sulfonate (PFBS)

- Associated with damage to semen quality
- Disrupts pancreas formation in zebrafish
- Associated with cardiovascular disease in humans
- Associated with markers of asthma in humans

- Increases fatty tissue formation in laboratory studies
- Impairs visual function in fish
- Damages thyroid function in fish in subsequent generations
- Induces reproductive toxicity in animal studies
- Found in 2 – 4 month-old infants
- Found in humans in community with known drinking water contamination
- Found in children
- Found in the Arctic
- Found in consumer products

Perfluorohexanoic acid (PFHxA)

- Similar toxicity to liver as PFOA
- Associated with damage to semen quality
- Negatively associated with testosterone levels in adolescent humans
- Alters zebrafish behavior
- Modulates immune response in vitro
- Contaminated drinking water linked to human body burden
- Alters amphibian embryogenesis
- Exposes the human fetus vis presence in amniotic fluid
- Found in human milk
- Found in house dust
- Found in US wildlife preserves
- Found in the Arctic
- Contaminates fish
- Found in Indo-Pacific humpback dolphins and finless porpoises
- Efficiently translocated into plants
- Resistant to sewage treatment
- Found in US wastewater treatment plants

Perfluoroheptanoic acid (PFHpA)

- Alters amphibian embryogenesis
- Exposes the human fetus via presence in amniotic fluid
- Found in human milk
- Manufacturing sites, military fire training, and wastewater treatment plants are predictors of pollution
- Use in airport firefighting foams pollutes groundwater, lakes, soils, and fish
- Found in remote mountain snow
- Bioaccumulates in plankton
- Contaminates fish
- Efficiently translocated into plants

PFAS in people

Numerous studies show PFAS contamination in people. For example, in one study of 299 infants, PFOS was found in the blood of 297 of them and PFOA was found in all of them.

The Stockholm Convention conducts global monitoring of substances listed in the treaty as part of its effectiveness evaluation. The most recent data is from a series of regional monitoring reports published in 2015.

In Africa, the treaty monitoring study noted that PFOS was detected in mothers' milk from all 11 countries that submitted samples with levels varying from 1 – 34 ppt. The report notes that, *"Assuming that there is no industrial production of PFOS in the region, exposure of humans to PFOS and related chemicals might probably come from different kinds of waste, releases from industrial applications in firefighting and the various consumer products."*

The monitoring report for the Asia-Pacific region notes that only a few countries reported data. The report shows PFOS in air in Fiji, Hong Kong, Japan and in blood including maternal plasma in Japan. PFOS was also measured in marine areas in China, Hong Kong, Japan, Macao and rivers and lakes in Philippines, South Korea, and Thailand.

In Central and Eastern Europe, the Stockholm Convention monitoring report notes that data on water monitoring are scarce and data for the presence of PFOS in human tissues is even more limited.

Stockholm Convention monitoring in Latin America and the Caribbean showed that only Uruguay reported data on PFOS in air and the report notes that at this time (2015) there was no formal monitoring program in the region for determination of PFOS.

In Western Europe and Other States, monitoring data also includes the Arctic where PFOS and PFOA in air were measured. The report notes that phaseouts of PFOS and PFOA are reflected in declining concentrations but that fluorinated substitutes show increasing levels in Arctic air. The study also reveals that of all the measured POPs, PFOS was the predominant substance in human plasma, with the highest level of 470 ppt reported in an Inuit resident of the Arctic.

Recent scientific studies show the widespread presence PFAS in humans. Data include the following:

- Perfluorohexane sulfonate (PFHxS), perfluorononanoate (PFNA), perfluorodecanoate (PFDA), perfluoroundecanoate (PFUnDA), and perfluorotridecanoate (PFTrDA) in human milk in Sweden
- PFOS, PFOA, PFNA, PFDA, PFUnA and PFHxS in maternal sera, placentas, and fetuses.
- PFOS, PFOA, PFHxS, and PFNA in New Zealand adults
- PFOS, PFDoDA, PFUnDA and PFTrDA in pregnant Japanese women
- PFOS, PFOA, PFHxS in >94% of community residents with drinking water contaminated by a former US Air Force base.
- 10 long-chain PFAS in California women.

- PFOS< PFOA< PFHxS, PFNA, PFUnDA, PFHpS found in maternal plasma in Norway.
- PFAS in amniotic fluid in Denmark.
- Prenatal exposure to PFOS, PFHxS, PFHpS, PFNA, and PDFA in Denmark.
- Prenatal exposure to PFBS, PFHxS, PFUA in China.
- Six PFAS in middle-aged US women.
- PFNA, PFDA, PFUnDA, PFHxS, PFOA, and PFOS in more than 99% of sampled pregnant Swedish women.
- PFAS in maternal and cord blood in mothers exposed to the US World Trade Center disaster during pregnancy.
- PFOA, PFOS, PFNA, PFHxS in cord blood of Slovak infants.
- PFOS, PFOS and 6:2 CL-PFESA in cerebrospinal fluid in China indicating ability to cross the blood-CSF barrier.
- PFOS, PFOA, PFNA, and PFHxS in children.
- PFOA, PFOS< PFNA, and PFHxS in pregnant US women.
- PFOS< PFOA< PFHxS and PFNA in maternal serum in the UK.
- PFOA, PFOS, and PFHxS in Chinese women.
- PFOA and PFNA in US children.
- PFAS in Alaska Natives.
- PFHxS, PFOA< PFOA, PFNA, PFDA, PFUdA, PFDoA, and PFTrDA in >85% of sampled pregnant women in China.
- PFAS in pregnant Chinese women.

Manufacturers knew PFAS were harmful

Recently obtained documents indicate that the original manufacturers of PFOS and PFOA knew about the harmful characteristics of both substances decades ago.

A lawsuit filed by the US State of Minnesota against 3M produced internal company documents that demonstrated that the company knew PFOS and PFOA were accumulating in people for more than 40 years. 3M had previously withheld required documents from US regulators which resulted in a USD$1.5 million fine in 2006. In 1975, university researchers found a fluorinated substance in human blood and 3M confirmed that it was PFOS. Subsequent company testing found PFOS levels in 3M personnel at levels 50 – 1000 times higher than normal levels. In 1978, tests on monkeys feed PFOS resulted in all the animals dying and those given PFOA developed lesions on their spleen, lymph nodes, and bone marrow, all relevant to a functioning immune system. By 1989, the company knew that PFOS suppressed the immune system, caused tumors in animals, and that rates of cancers of the digestive organs and prostate were elevated in its own workers. The company proceeded to produce the substance anyway.

Internal company documents reveal that DuPont knew decades ago that PFOA affected the livers of dogs and humans, encouraged the growth of testicular tumors in rats, and appeared to result in endocrine disorders and kidney cancer in workers. In 1978, the company documented immunotoxicity and other adverse effects in tests on monkeys exposed to PFOA and PFOS. By 1984, DuPont knew that PFOA was toxic, didn't break down, accumulated in blood, transferred from mothers to the fetus, and polluted drinking water supplies. DuPont decided to keep producing it anyway as it became incorporated into a multitude of products and processes. The company's real attitude about the consequences of PFOA production is revealed in its internal documents as "the material 3M sells us that we poop to the river and into drinking water."

DuPont was fully aware of PFOA's hazards, but a study of the company's decision-making processes noted that DuPont made a calculated, rational decision to pollute anyway. The authors estimate that for DuPont, "it was value-maximizing to pollute if the probability of getting caught was less than 19%." In reality the probability was much less than that and now communities and governments bear the burden of that private sector decision.

Annex 2. The high cost of PFAS cleanup

PFAS manufacturing and use in a multitude of products such as firefighting foams has resulted in widespread pollution – especially in water due to the solubility of PFAS substances. PFAS-contaminated sites have been identified in Australia, Canada, China, Germany, Italy, Japan, Netherlands, New Zealand, South Korea, Sweden, and the US, including a large number of military bases that contribute to 172 PFAS contamination sites in 40 states.In 2018, the US State of Minnesota entered into an agreement with 3M for the company to pay the state USD$850 million for costs associated with cleanup of PFAS including PFHxS due to manufacturing and releases by the company.

Clean up of PFAS pollution is difficult and costly. According to the Polluter Pays Principle, and sound economic policy, these types of external costs should not be borne by taxpayers, the state or national treasury, or by any other third party. Rather, these costs should be internalized within producer industries to avoid market distortion. As noted by UN Environment in 2012, "The vast majority of human health costs linked to chemicals production, consumption and disposal are not borne by chemicals producers, or shared down the value-chain. Uncompensated harms to human health and the environment are market failures that need correction."

Examples of estimated and actual cleanup costs for PFAS pollution include:

- Recent US government agency estimates for the cost PFAS clean-ups and associated monitoring due to use of firefighting foams at US military bases are more than USD$2 billion. There are also expensive clean up costs and estimates in a variety of US states including Alaska, New Jersey, New York (see also here and here), Vermont, Virginia, and Washington.
- The World Bank estimates that if just 20% of fluorinated firefighting foam in China is used for training or fire extinguishing, remediation costs would exceed USD$800 million.
- Remediation of PFAS-containing firefighting foam at the Düsseldorf Airport in Germany will take years or even decades. Cleanup costs cited by the European Chemicals Agency exceed €100 million. There are additional documented remediation costs due to PFAS pollution in Germany – see here, here, and here.
- Clean up due to use of 3M's "Light Water" firefighting foam containing PFOS and PFHxS at 18 military bases in Australia is estimated to cost hundreds of millions of dollars. The cleanup of just a single firefighting training college in Australia is estimated to cost AUS$80 million.
- To clean up groundwater polluted by PFAS around firefighting areas in Norway costs €3.5-5.5 million per training site.
- Firefighting training sites are the main sources of PFAS pollution in Sweden leading to €1 million in annual costs for charcoal filtering of water in Uppsala and a new water supply in Ronne costing €3 million. Extrapolated estimates for advanced cleaning of all waste water treatment plants in Sweden would only moderately remove fluorinated compounds but still cost USD$230 million per year.
- New Zealand has budgeted NZE$1 million to investigate cleanup of PFAS associated with firefighting foam use by military bases.

Annex 3. PFAS and the Stockholm Convention

The Stockholm Convention objective is to protect human health and the environment from persistent organic pollutants. Persistent organic pollutants (POPs) are a class of highly hazardous chemical pollutants that are recognized as a serious, global threat to human health and to ecosystems. Substances can be added to the Stockholm Convention after evaluation and recommendation by the POPs Review Committee (POPRC). Sri Lanka became a Party to the treaty in 2005.

PFOS

Governments added PFOS to the treaty list at the 4th Conference of the Parties in 2009 and subsequently adopted a series of guidance documents on PFOS alternatives. Sri Lanka has not registered any specific exemptions or acceptable purposes for PFOS production or use.

When PFOS was listed in Annex B of the treaty in 2009, a very large number of loopholes accompanied its listing that permitted continued production and use. At COP9 in April/May 2019, Parties will determine if these loopholes are still needed or if some can be ended. The decision will focus on 6 time-limited ones (specific exemptions) and 8 time-unlimited ones (known as acceptable purposes). The POPRC recommended the following changes to the PFOS listing in the Convention:

End loopholes for 11 PFOS uses: photo-imaging, photo-resist and anti-reflective coatings for semiconductors; etching agent for compound semiconductors and ceramic filters; aviation hydraulic fluid; certain medical devices; photo masks in semiconductor and LCD industries; hard metal plating; decorative metal plating; electric and electronic parts for some color printers and color copy machines; insecticides for control of red imported fire ants and termites; and chemically-driven oil production.

Convert two time-unlimited exemptions to time-limited exemptions: metal plating (hard metal plating only in closed loop systems) and firefighting foams. This gets the clock running on ending these uses in five years. On the firefighting foams, the Committee recommended stopping production and only allowing use for class B fires (ones involving solvents, oil etc.) and only in installed systems. The Committee also noted that, *"a transition to the use of short-chain per- and polyfluoroalkyl substances (PFASs) for dispersive applications such as fire-fighting foams is not a suitable option from an environmental and human health point of view…"* This is extremely important since the fluorinated alternatives are persistent, toxic and readily pollute drinking water.

Continue time-unlimited exemption for one use: insect bait for control of leaf-cutting ants from *Atta* spp. and *Acromyrmex* spp. This vaguely-worded listing actually refers to a pesticide called sulfluramid that degrades to PFOS. The POPRC recommended naming sulfluramid in the treaty under the PFOS listing and narrowing its use to agriculture.

IPEN recommendations for PFOS

Specific exemptions or acceptable purposes for the following 11 uses of PFOS should be ended: photo-imaging, photo-resist and anti-reflective coatings for semiconductors; etching agent for compound semiconductors and ceramic filters; aviation hydraulic fluid; certain medical devices;

photo masks in semiconductor and LCD industries; hard metal plating; decorative metal plating; electric and electronic parts for some color printers and color copy machines; insecticides for control of red imported fire ants and termites; and chemically-driven oil production.

The following 3 acceptable purposes should be converted into specific exemptions: metal plating (hard metal plating only in closed loop systems); firefighting foams; insect bait for control of leaf-cutting ants from *Atta* spp. and *Acromyrmex* spp. Sulfluramid should be named in the listing and its use limited to cultivation of grains, oilseeds, fruit, sugarcane, the forestry species *Eucalyptus and Pinus,* and grass for livestock.

Due to the costly, highly polluting nature of firefighting foams, and the availability of technically feasible, high-performing non-fluorinated alternatives, no exemption should be granted for this use.

PFOA

PFOA is extremely persistent and does not degrade under relevant environmental conditions. It bioaccumulates in air-breathing land and marine mammals, including humans. PFOA is found in water, snow, air, sediment and biota at remote locations including the Arctic. In 2017, the Stockholm Convention POPs Review Committee noted the link between PFOA and serious illnesses in humans, including diagnosed high cholesterol, ulcerative colitis, thyroid disease, testicular cancer, kidney cancer and pregnancy-induced hypertension. PFOA is transferred to the fetus through the placenta and to infants via breast milk. PFOA-related compounds such as fluorotelomer alcohols, fluoropolymers and fluorotelomer-based polymers must be included in actions designed to eliminate PFOA releases since they can degrade to PFOA.

In 2018, the POPRC recommended that governments list PFOA and related substances in Annex A of the Stockholm Convention for global elimination.

Ten time-limited exemptions accompany the PFOA listing recommendation, however, many of these are not justified.

Proposed PFOA Exemption	**Comment**
5 years 3 exemptions connected to semiconductor manufacturing (equipment or plant infrastructure, legacy equipment, photo-lithography, etch process)	Alternatives without PFOS or PFOA are available for photolithography and etch processes. For example, IBM eliminated both in 2010. The other proposals are not sufficiently defined.
Photographic coatings applied to films	Obsolete use of PFOA replaced by digital imaging, including in developing and transition countries.

Textiles for oil and water repellency for workers	Proposal relies on industry claims and does not state what specific products the exemption would cover or how worker protection can be achieved without relying on a toxic chemical-impregnated textile.
Invasive medical devices	Alternative medical devices made without PFOA have passed all regulatory requirements, are available on the market, and in use.
Implantable medical devices	Alternative medical devices made without PFOA have passed all regulatory requirements, are available on the market, and in use.
Firefighting foams	Cost-effective non-fluorinated alternatives are in use at major airports and military installations and perform as well as PFAS-containing foams.
10 years For manufacture of semiconductor or related electronic devices; refurbishment parts containing fluoropolymers and/or fluoroelastomers with PFOA for legacy equipment or legacy refurbishment parts	See above for manufacturing. Legacy equipment proposal is not specific and include thousands of unnamed parts. Retrofitting with parts that do not contain PFOA should be utilized, instead of continuing PFOA production and use.
Until 2036 To use PFOI (a PFOA-related substance) to make PFOB for producing pharmaceutical products *"with a review of continued need for exemptions."*	In 2015, more than 100 governments agreed that environmentally persistent pharmaceutical products are an emerging policy issue of global concern in the SAICM process. A global exemption should not be adopted on behalf of a single company (Daikin) and exemptions for environmentally persistent pharmaceutical products should not be recommended.

IPEN recommendations for PFOA

PFOA should be listed in Annex A with no specific exemptions. If exemptions are granted, they should be for specific products and the listing should require labeling new products that contain PFOA so that Parties can fulfill requirements under Article 6 as done previously for HBCD (SC-

6/13). In addition, due to the costly, highly polluting nature of firefighting foams, and the availability of technically feasible, high-performing non-fluorinated alternatives, no exemption should be granted for this use.

PFHxS

PFHxS and related compounds are persistent in water, soil and sediment and unlikely to undergo degradation in the environment including hydrolysis, aqueous photolysis or under anaerobic conditions. PFHxS biomagnification factors (BMF) greater than 1 have been observed in food chains including Arctic bird/fish, Arctic polar bear/ringed seal, dolphin/fish, and fish/zoo plankton among others, indicating bioaccumulation. PFHxS has the longest half-life in humans determined for any PFAS. PFHxS undergoes long-range transport and is found in Arctic air, sediment, snow, ice, soil, sediment and biota (including humans) and in Antarctic biota and snow. *In vivo* and epidemiological studies show that PFHxS negatively affects liver function, thyroid, and the developing immune system resulting in reduced effects of vaccines and higher incidences of infections and asthma in children. A significant association between PFHxS exposure and breast cancer has been found in Greenlandic Inuit women. PFHxS is widely found in breast milk and is one of the most frequently detected and predominant PFAS in human blood, including maternal and infant cord blood.In September 2018, the POPRC determined that PFHxS "warrants global action" and moved the substance to the third and final evaluation during 2018 – 2019.

PFAS use in firefighting foams

There are many uses of PFAS, but one of the most highly polluting is in firefighting foams. This pollution occurs where the foam is used and quickly contaminates water and moves. Airports and military bases are common sources of PFAS pollution.

PFOS and PFOA were the original components in firefighting foams, but after regulatory pressure in the US, many companies switched to shorter-chain substances such as PFHxS, PFBA, PFBS, PFHxA, and PFHpA. These substances also are persistent and have hazardous properties. Some are found in the Arctic, suggesting ability to undergo long-range transport. Recently, IPEN assembled a group of fire safety experts who produced a detailed report on issues involving firefighting foams and the technical feasibility of fluorine-free firefighting foams. Safer cost competitive non-fluorinated alternatives to PFAS in firefighting foams have been adopted by major airports, including Auckland, Copenhagen, Dubai, Dortmund, Stuttgart, London Heathrow, Manchester, and all 27 major airports in Australia.

In September 2018, the POPRC recommended severe restrictions on the use of PFOS and PFOA in firefighting foams. In addition, the Committee also made an extremely important recommendation **not** to use the fluorinated alternatives to PFOA and PFOS, *"due to their persistency and mobility as well as potential negative environmental, health and socioeconomic impacts."*

The recommended restrictions on firefighting foams containing PFOA, PFOA-related substances, or PFOS include:

- No production.

- Use for 5 years only for liquid fuel vapor suppression and liquid fuel fires (Class B fires) already in installed systems.
- No import or export, except for environmentally-sound disposal.
- No use for training or testing purposes.
- By 2022, restrict use to sites where all releases can be contained.
- Ensure that all firewater, wastewater, run-off, foam and other wastes are managed in accordance with the treaty.

IPEN recommendations on PFAS use firefighting foams

Due to the costly, highly polluting nature of firefighting foams, and the availability of technically feasible, high-performing alternatives, no exemption should be granted for this use. IPEN supports the POPRC recommendation that fluorinated alternatives to PFOA and PFOS should not be used.