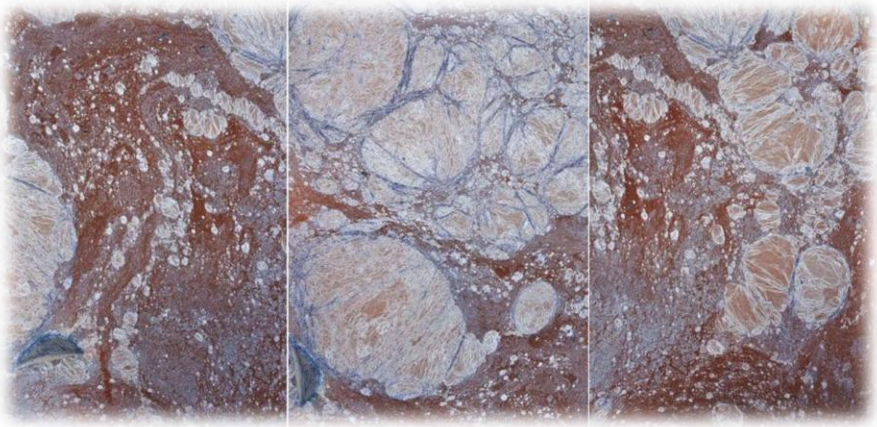
Environment and Social Development Organization-ESDO

PFAS: Bangladesh Situation Report

2019



PFAS: Bangladesh Situation Report

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Produced as part of ESDO's Research and Documentation Initiatives for public interest and to promote human and environmental health safety

Disclaimer
"This report is prepared based on secondary information, journal review and analyses, vigorous study of existing reports and online findings to ensure environmental protection by creating public awareness. And support and collaborated with IPEN."

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PFAS: Bangladesh Situation Report

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We take this opportunity to thank all those who were instrumental in compiling and shaping this study report.

We deeply acknowledge Dr. Joe Di Gangi for his guidance and support to review of this report. His excellent article on the “Dangerous aspects of PFAS and PFAS containing products” helps to formulate the report. Special thanks go to IPEN and Toxics Link for their valuable information regarding PFAS and associated health issue.

We express our sincere gratitude to Dr. Abu Jafar Mahmood, Professor (Retired), University of Dhaka for his counsel and guidance for this work.

This report was produced under ESDO's Research and Documentation Initiatives. The overall objective was to raise awareness about PFAS and PFAS containing products use and their health hazards.

Finally, this study would not have been possible without continuous effort of ESDO team and support from IPEN.

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Executive Summary

Per- and polyfluoroalkyl substances (PFAS) are a group of man-made fluorinated organic compounds that are highly stable and persistent in the environment. These compounds have been used in industrial applications and consumer products since the 1950s, and many different PFAS have been detected in environmental media, food, biota and human serum. However, the presence of PFAS within environmental samples was not widely reported until the late 1990s and early 2000s.The most commonly studied PFAS are perfluorooctanoic acid (**PFOA)** and perfluorooctane sulfonic acid (**PFOS).** The next most commonly studied are perfluorohexane sulfonic acid **(PFHxS)**, and perfluorononanoic acid **(PFNA)**. The chemicals are very persistent in the environment and in the human body – meaning they don't break down and they can accumulate over time.

The report is done by Environment and social Development Organization (ESDO). This report is prepared under the IPEN initiative on country situation on PFOA and based on existing data, journal review and secondary source. ESDO has documented information on the PFAS generating practices and the contaminated sites in the country as the first attempt in this report. The information presented here can be seen as a tip of the iceberg. It is necessary to conduct further investigation on the issue and to come up with a comprehensive documentation of the PFAS situation in Bangladesh. This shall be important in taking remedial measures.

Findings reveal that there is no significant PFAS production in Bangladesh. However, import and use of PFAS and PFAS-containing products are likely to be the main source of PFAS pollutants. These are used mainly in manufacturing industries and are found in different industrial area like Dhaka city and the surrounding areas namely Gazipur, Norshindhi, Narayanganj and Chittagong, Cox's Bazar, Khulna, Sylhet, and Rajshahi

This report reviews the indiscriminate use of the hazardous chemicals and its dangerous effect among general users of PFAS containing products. This report reveals that textiles products those are manufactured in Bangladesh and sold to Argentina contained 29.7µg/ kg ionic PFAS and 6967µg/kg volatile PFAS which exceeds EU PFAS regulatory limits by approximately 30-fold to 7000-fold for ionic and volatile PFAS respectively.

The study also observed that most of the women who used non-stick cookware (which releases severe amount of PFOA and PTFE) were suffered from respiratory, kidney and liver diseases, hormonal problems, etc. Among 450 women, 421 were suffered from kidney problems and asthma. Among 378 women about 25 to 35 women were suffered from pregnancy related problem. Among children, 310 were suffered from kidney problems and asthma. These observations do prove direct links between non-stick cookware use and health impacts.

From the study findings it can be said that people of Bangladesh are not aware about PFAS pollutants. Moreover Bangladesh has no policy to stop such pollution; even there is no specific governmental data on the hazardous chemicals. So, it is unavoidable to formulate a policy to stop PFAS containing products manufacture and reduce PFAS pollution in Bangladesh. Moreover, mass awareness about PFAS containing products and its health and environmental impact is very important task.

Introduction

What are per- and polyfluoroalkyl substances (PFAS)?

PFAS is a [1]large class of more than 4,500 persistent fluorinated chemicals. PFAS are both hydrophobic and lipophobic in nature and extremely persistent due to the strength of the carbon-fluorine bond. They are widely distributed in the global environment due to their high solubility in water, low/moderate sorption to soils and sediments and resistance to biological and chemical degradation. The properties of PFAS have resulted in extensive uses surfactants and surface-active agents in products. Two widely-used members of this class have been perfluorooctanesul fonate (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 and use of PFAS and their use in a multitude of products has caused widespread pollution. PFAS are found in wildlife, accumulating in the blood, liver and kidneys of wildlife such as dolphins, polar bears, seals, birds, fish, and other marine wildlife[2]. PFAS substitutes for PFOS and PFOA have been identified as potential global surface water contaminants and they have been found in more than 80% of 30 surface seawater samples from the North Pacific to Arctic Ocean. 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.

Safer cost competitive non-fluorinated alternatives[3]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. 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.

[1]http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=ENV-JM-MONO(2018)7&doclanguage=en
[2]https://www.ncbi.nlm.nih.gov/pubmed/?term=Fluorinated+Organic+Compounds+in+an+Eastern++Arctic+Marine+Food+Web
[3]https://ipen.org/sites/default/files/documents/IPEN_F3_Position_Paper_POPRC-14_12September2018d.pdf

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 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 cleanup is available in Annex 2. Global regulation of PFAS through the Stockholm Convention and evaluations of its expert committee is discussed in Annex 3.

Background

No research has been conducted on PFAS situation in Bangladesh yet to address the human health and environmental implications associated with PFAS. Being an environmental organization, Environment and Social Development Organization-ESDO felt a responsibility to take the issue into account and conduct a research on it. ESDO primarily carried out the research using secondary data in order to focus on production, uses and the health and environmental impacts of PFAS and to spread the information to the general public. With a view to working up to policy level about the issue, ESDO planned the study. The study reveals the general scenario of the use of PFAS containing products, health and environmental hazards associated with and the level of public awareness about PFAS.

Objectives

The study was conducted with the following objectives:

I. To identify the major sources of PFAS contamination in Bangladesh.
II. To identify PFAS containing products in Bangladesh
III. To assess PFAS consumption in and release from different sectors
IV. To determine the import, use and management practices of PFAS and PFAS containing products.
V. To know about the rules and regulations regarding PFAS contamination present in Bangladesh.
VI. To evaluate people's perception regarding PFAS contamination.

Justification

No research has been carried out in Bangladesh to obtain sources, hotspots, uses and management of PFAS and PFAS containing products. So, this research is necessary to evaluate PFAS situation in Bangladesh. Environment and Social Development Organization-ESDO conducted a study to determine the sources, contamination sites, imports, uses of PFAS and PFAS containing products and their management practices in Bangladesh. This intervention has been taken by ESDO to encourage and enable civil society to engage in local, national, and international activities aimed at controlling PFAS contamination. The information that originates from the study will be helpful for raising awareness amongst the policy makers, professionals, media and the public as a whole.

Key Findings

Key findings in this report are:

- PFAS are unregulated in Bangladesh, however currently existing laws could be used to regulate them.
- PFAS monitoring, especially near industry locations, would help establish an initial inventory of hotspots.
- The textile industry is potentially an important sector for PFAS use and releases.
- Waterproof coats manufactured in Bangladesh far exceed EU regulatory limits for PFAS.
- PFAS are found in finfish and shellfish at levels similar to those found in China, Spain, Sweden, and USA.
- PFAS are found in coastal surface water and sediment at significant levels.
- Areas of the country near Cox's Bazar and Chittagong showed higher levels of PFAS in seafood and water.
- Paper and pulp industries, textile, and plastic industries situated on the bank of Karnafuli river and the coastal areas are the possible sources of PFAS releases in Chittagong and Cox's Bazar

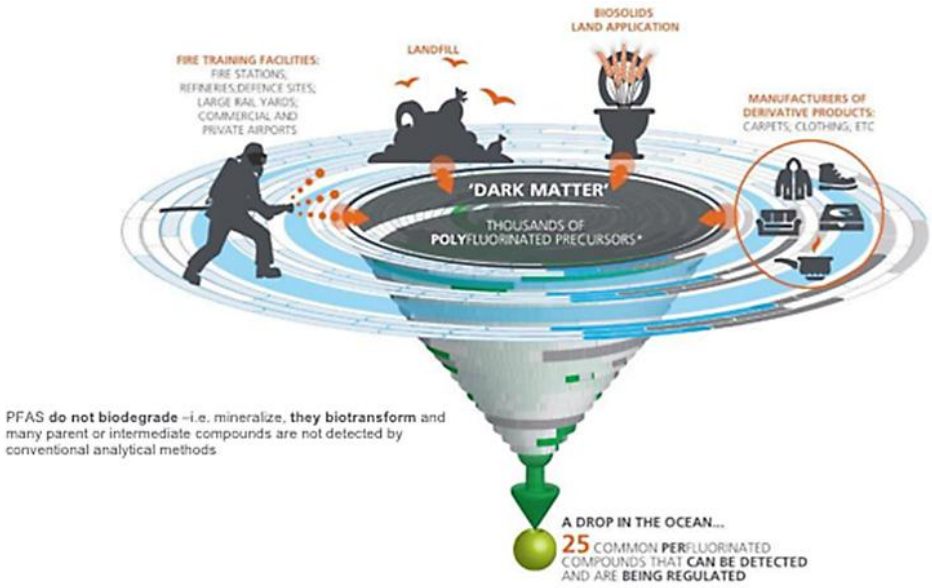

Figure1: PFAS accumulation

Results and Discussion

PFAS production, use, and waste management

Production

In Bangladesh, there are very few studies available which are able to represent the actual status of PFAS clearly. However, through some secondary data and information and review of journal there is no information prevail that about the production of PFAS in Bangladesh. But the import and use of PFAS and PFAS-containing products are likely to be a source of PFAS pollutants. These include mainly textiles products and firefighting foams and paper & pulp production.

Waste management

In general, waste management is not well organized in Bangladesh and there is no specific chemical waste management system. Although there are some processes and rules for solid waste management and hazardous waste management, these are not sufficient and also not implemented properly.

Textile industry use of PFAS

Textile is [4]a major manufacturing sector in Bangladesh, contributing 16% of GDP in 2013 – 2014. Bangladesh manufactures brand-name clothing for both the domestic and international markets including for H&M, Walmart, C7A, Zara, GAP, Target, TESCO, Carrefour, Levi's, and JC Penney. Apparel items include shirts, trousers, jackets, t-shirts, and sweaters. Concerns over PFAS use in the textile industry come from studies that find PFAS in clothing and footwear.

An investigation[5] carried out by Greenpeace International found a broad range of hazardous chemicals in children's clothing and footwear across a number of major clothing brands, including fast fashion, sportswear and luxury brands. The study follows on from several previous investigations published by Greenpeace as part of its Detox campaign, which identified that hazardous chemicals are present in textile and leather products as a result of their use during manufacture. It confirms that the use of hazardous chemicals is still widespread – even during the manufacture of clothes for children and infants.

Eighty-two children's textile products were purchased in May and June 2013 in 25 countries/regions worldwide from flagship stores, or from other authorized retailers. They were manufactured in at least twelve different countries/regions. The products were sent to the Greenpeace Research Laboratories at the University of Exeter in the UK, from where they were dispatched to independent accredited laboratories. All products were investigated for the presence of nonylphenolethoxylates (NPEs); certain products were also analyzed for phthalates, organotins, per/poly-fluorinated chemicals (PFAS), or antimony, where the analysis was relevant for the type of product. In that investigation, PFOA and PFOS were included.

Bangladesh was presented as 6th country where the textile products were manufactured. The study revealed that waterproof coats (body 100% polyester; lining 65% polyester, 35% cotton) manufactured in Bangladesh and sold to Argentina contained 29.7µg/ kg ionic PFAS and

[4] http://www.bkmea.com/History-of-Development-of-Knitwear-of-Bangladesh.html
[5] http://www.greenpeace.org/eastasia/publications/reports/toxics/2014/little-story-monsters-closet/

6967µg/kg volatile PFAS. Note that the marketing and use of PFOS within the EU has been prohibited for certain uses since 2008, with a maximum limit of 1 µg/m² set for PFOS in textiles. This indicates that PFAS-containing clothing manufactured in Bangladesh and measured in this study exceeds EU PFAS regulatory limits by approximately 30-fold to 7000-fold for ionic and volatile PFAS respectively.

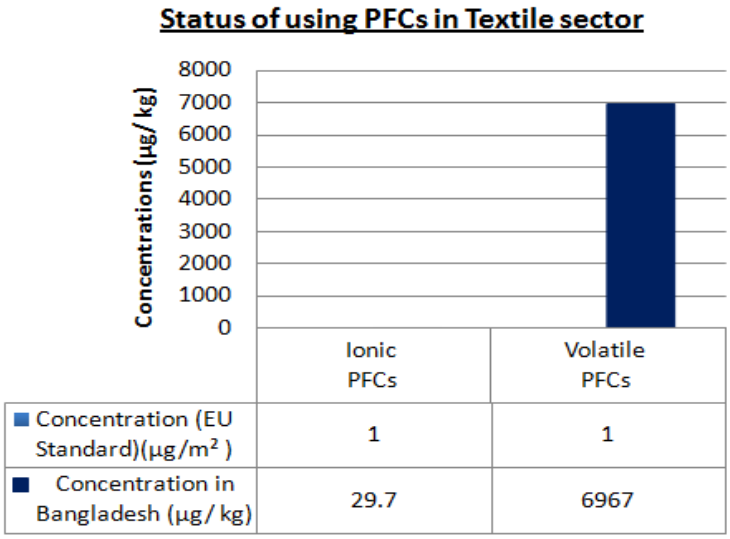

Figure2: Waterproof textiles made in Bangladesh exceed EU PFAS limits

Other possible uses of PFAS in Bangladesh

PFAS are also found in a wide range of consumer products that people use in daily life that can also involve releases during manufacture, use, and when products become wastes. In addition, PFAS exposure can occur through a variety of other pathways. These include:

- Firefighting foams - a known major source of groundwater contamination at airports and military bases where firefighting training occurs).
- Commercial household products, including stain- and water-repellent fabrics, nonstick products (e.g., Teflon), polishes, waxes, paints and cleaning products.
- Drinking water typically localized and associated with a specific facility (e.g., manufacturer, landfill, wastewater treatment plant, firefighter training facility).
- Living organisms, including fish, animals and humans, where PFAS have the ability to build up and persist over time.
- Food packaged in PFAS-containing materials, processed with equipment that used PFAS, or grown in PFAS-contaminated soil or water.
- Workplace, including production facilities or industries (e.g., chrome plating, electronics manufacturing or oil recovery) that use PFAS
- Water-repellent clothing.
- Stain resistant fabrics and carpets.
- Personal care products (shampoo, dental floss) and cosmetics (nail polish, eye makeup)
- Cleaning products
- Products that resist grease, water, and oil.

Most products in Bangladesh are imported from a variety of places including China, various European countries, India, Japan, Singapore, South Korea, Thailand, Taiwan, and USA. Many of manufacturing factories use the chemicals in producing their products and supplier companies are

also involved in trading those toxic chemicals. The factories are mostly located in the large industrialized metro areas of Dhaka, Chittagong, Khulna, Rajshahi, Barisal and Sylhet. The industrial expansion in Bangladesh since 1994 has been very significant.

PFAS exposure pathways

There are a variety of ways that people can be exposed to PFAS:

- Through the diet such as eating fish containing PFAS; contamination that occurs during processing; growing food in contaminated soil and/or water; and food packaging.
- Release from consumer products during normal use, biodegradation or disposal.
- Use of commercially-treated products to make them stain- and water-repellent or nonstick. These goods include carpets, leather and apparel, textiles, paper and packaging materials, and non-stick cookware.
- Occupational exposure at production facilities, or facilities that manufacture goods made with PFAS.
- Drinking water can be a source of exposure in communities where these chemicals have contaminated water supplies. Such contamination is typically localized and associated with a specific facility, for example industrial facilities, airports, and military bases among others.

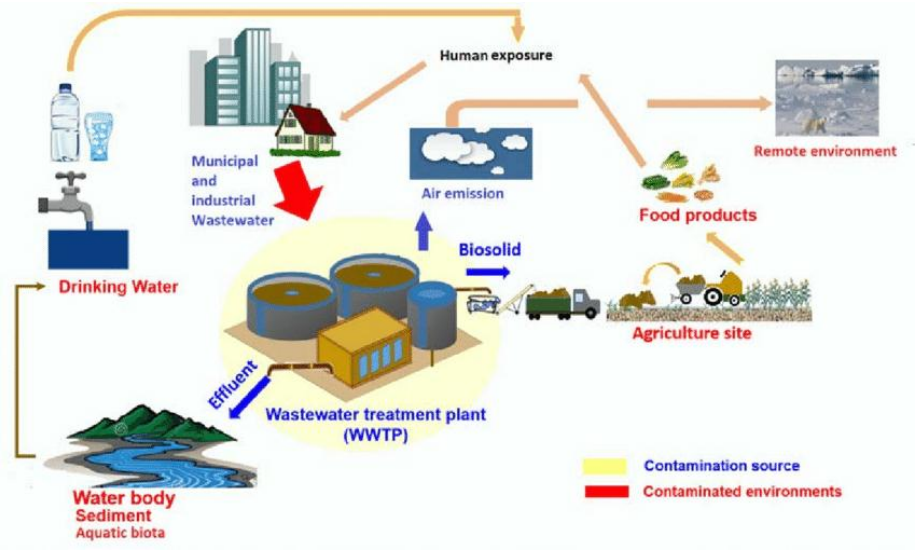

Figure 3: Environmental Pathways of PFAS from wastewater

During handling and use of products containing PFAS, PFAS can migrate into the soil, water, and air. Most PFAS (including PFOA and PFOS) do not breakdown, so they remain in the environment. Because of their widespread use and their persistence in the environment, PFAS are found in the blood of people and animals all over the world and are present at low levels in a variety of food products and in the environment. Some PFAS can build up in people and animals with repeated exposure over time.

Possible sources of PFAS releases and exposures

The Environment and Social Development Organization (ESDO) identified relevant possible sources of PFAS releases in Bangladesh. These include:

- manufacturing industries,
- drinking water
- airfields, military bases and firefighting sites

- oil refineries
- power generating sites
- ship breaking sites
- cosmetic industries
- timber, dyeing and PVC/plastic industries,
- cleaning agents, waxes and floor polishes
- water bodies

The major concentration of these hotspots in Bangladesh is in industrial areas such as Dhaka city and the surrounding areas, Gazipur, Norshindhi, Narayanganj, , Chittagong, Khulna, Sylhet, and Cox's Bazar. Contaminated sites containing PFAS have not been searched for or identified. It is necessary to conduct further investigation on the issue and to come up with a comprehensive documentation of the PFAS status in Bangladesh.

Figure 4: Sources of PFAS

Manufacturing industries

There are leading manufacturing sectors textiles (10,983 companies; 26%), manufacture of food products (8,441 companies; 20%), manufacture of clothing and apparel (6, 984 companies; 16%). The total number of manufacturing industries is 42, 792 of which there are 3,639 large industries Bangladesh Bureau of Statistics-2013)[6].

Type of manufacturing industries	Number	Percentages (%)
Manufacture of textiles, clothing and apparel	10983	26
Manufacture of readymade garments (RMG)	6984	16
Manufacture of leather and related products	930	2

[6]http://bbs.portal.gov.bd/sites/default/files/files/bbs.portal.gov.bd/page/303f0460_e79c_40d2_8157_acfcf64845a8/BBS_Publication.pdf

Manufacture of food products and beverages	8441	20
Manufacture of non metallic mineral products	4654	11
Manufacture of furniture	1055	2.5
Manufacture of fabricated metal products	1449	3
Manufacture of printing and recorded media	904	2
Manufacture of rubber and plastic products	1036	2.5
Manufacture of wood and products of wood and cork, except furniture	302	0.7
Manufacture of paper and paper products	902	2
Manufacture of chemicals and chemical products	563	1.5
Manufacture of tobacco products	487	1
Manufacture of basic metal	1205	3
Manufacture of computer, electronic and optical products	149	0.3
Manufacture of electrical equipment	884	2
Manufacture of pharmaceuticals, medicinal chemical and botanical products etc.	494	1
Others	1370	3.5
Total	42792	100

Figure 5: Total Number of Industries

Major industries include-

- Manufacture of textiles, clothing and apparel
- Manufacture of readymade garments (RMG)
- Manufacture of leather and related products
- Manufacture of food products and beverages
- Manufacture of non metallic mineral products
- Manufacture of furniture
- Manufacture of fabricated metal products
- Manufacture of printing and recorded media
- Manufacture of rubber and plastic products
- Manufacture of wood and products of wood and cork, except furniture
- Manufacture of paper and paper products
- Manufacture of chemicals and chemical products
- Manufacture of tobacco products
- Manufacture of basic metal
- Manufacture of computer, electronic and optical products
- Manufacture of electrical equipment
- Manufacture of pharmaceuticals, medicinal chemical and botanical products etc.

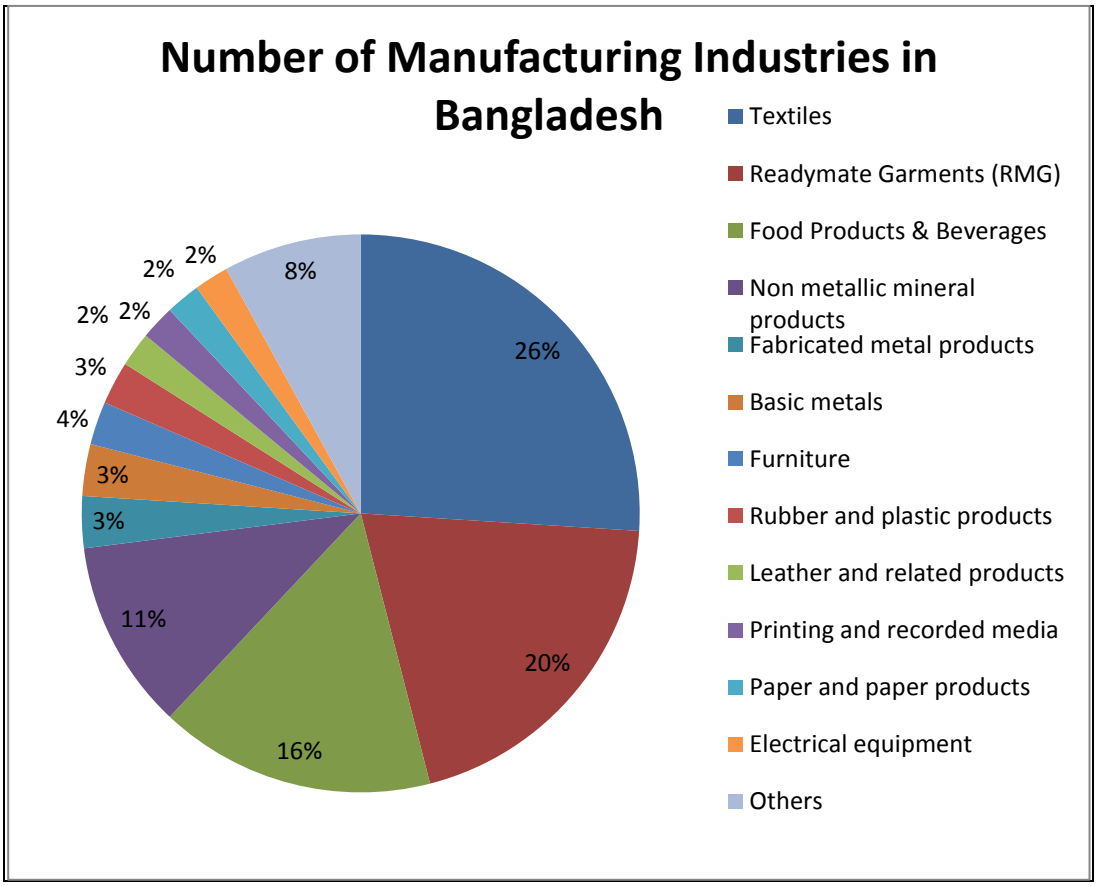

Figure 6: Number of Factories in percentages Bangladesh

These industries use more than 40 different types of chemicals among which PFAS may be used. PFAS are known to be extensively used by the textile industry and by private consumers to form a coating on textiles, leather and carpets, which will repel both water and oil. The products used are polymers based on fluorinated acrylates and methacrylates. Textiles used for e.g. tablecloth, upholstery, rainproof clothing and bed linen are treated with approximately 2-3% PFAS (of the fiber weight) to obtain water repellence.

In textile sector, PFAS substances are also used as wetting agents to e.g. enhance dyeing and as a binder in non-woven fabrics. PFAS substances are also used as e.g. antifoaming agents in textile treatment baths, as emulsifying agents for fiber finishes, and as penetration aids for bleaches. PFAS-related substances have also been used as carpet spot cleaners. An average of 15% fluorinated polymers is used for carpet protection.

The PFAS-related compounds typically used for textile and carpet surface treatment applications are the acrylate, adipate and urethane polymers of *N*-ethyl per-fluorooctanesulfonamidoethanol (FOSE).Polymeric fluorochemicals are used as water repellents for treatment of leather. Water repellent consumer sprays are also available for leather products. Only about 0.025-0.05% perfluorochemicals (of the leather weight) is necessary to obtain water repellence.

Drinking Water and water bodies

Bangladesh is agricultural country that is undergoing rapid industrialization, urbanization and economic development in recent years, particularly in the coastal regions. This has brought increasing amounts of municipal, industrial and agricultural waste into water bodies. The

environmental quality in the estuarine and nearby coastal areas has been adversely affected by intense industrial and urban activities. Potential sources of PFAS in the aqueous environment include direct discharge of industrial or municipal waste water and effluents containing these compounds, runoff from contaminated soil by precipitation, accidental spills or by the release of non-treated or semi-treated discharges, landfills, dumping of municipal garbage. Bangladesh has a highly irregular deltaic marshy coastline of 580 km, fissured by many rivers and streams to the Bay of Bengal. The increase in population and industrial pressure along rivers, and estuarine and coastal areas of Bangladesh poses an important threat to the coastal ecosystems since contaminants accumulate in the coastal or marine food chain. The local population is also exposed via contaminated seafood consumption. About 42 million people (30% of the total population) live in the coastal area of Bangladesh, of which about 5 million are engaged directly in commercial fishing.

PFASs have been detected in surface- and groundwater worldwide. Both are important sources for drinking water production and as a result public concern has arisen over human exposure risks to PFAS. A recent Indian study [7] assesses PFAS concentrations in river and groundwater (used in this region as drinking water) from several locations along the Ganges River and estimates direct emissions, specifically for PFOS and PFOA. Fifteen PFAS were frequently detected in the river with the highest concentrations observed for PFHxA (0.4 e4.7 ng/L) and PFBS (<MQL e 10.2 ng/L) among PFCAs and PFSAs, respectively.

Full-scale drinking water treatment plant occurrence data indicate that PFAS, if present in raw water, are not substantially removed by most drinking water treatment processes including coagulation, flocculation, sedimentation, filtration, biofiltration, oxidation (chlorination, ozonation, AOPs), UV irradiation, and low-pressure membranes. The finding of PFAS in coastal waters (see below under scientific studies) raises concerns over possible contamination of ground water in Bangladesh.

Airfields, military bases and firefighting sites

The major air fields of Bangladesh are situated in the Dhaka, Chattogram and Sylhet regions. PFAS are used in some brands of firefighting foams for controlling fires involving liquid hydrocarbon fuels, such as aviation fuel. These are used spontaneously around the country, especially at airports, bulk fuel terminals and other locations which handle large quantities of liquid hydrocarbon fuels. Hydraulic oils are used in airplanes in many places can also contain PFAS for its surfactant function. A specific compound – the potassium salt of perfluoro ethyl cyclohexylsulfonate (CAS-no. 67584-42-3) is often used in hydraulic oils at concentration of 0.1%.

Oil refineries

PFAS are commonly used in firefighting foams to produce a thin aqueous film which spreads across the surface of the fuel, separating the fuel from oxygen, which suppresses vapor to help extinguish a petroleum fire. It is likely that oil refineries and other oil facilities use these PFAS-containing firefighting foams, making them a likely source of PFAS contamination. Major oil refineries and oil companies in Bangladesh are:

1. Eastern Refinery Ltd
2. Padma Oil Company Ltd
3. Meghna Petroleum Limited
4. Jamuna Oil Company Ltd
5. Eastern Lubricants Blendars Ltd etc

[7] https://www.sciencedirect.com/science/article/pii/S0269749115301500?via%3Dihub

In 2018, about 8,700,000MT oil was used to fulfill demand. Oil refineries and companies are situated in the Dhaka, Khulna and Chittagong regions.

Power generating sites

In Power generation sites, domestic cooking and heating use biomass and fossil fuels. Fossil fuels are the main sources of power generation in Bangladesh. This category includes processes and practices that involve use of electrical cables and coatings, cables, lubricants, engine oils etc. which can be another source of PFAS releases.

Ship breaking sites

Ship breaking sites can potentially release large amount of PFAS into the environment. This is a large and growing industry in Bangladesh. The ship breaking units are located in Dhaka, Chittagong, Narayanganj and Barishal; but the main site is in Bhatari, Chittagong, approximately 8-10 km from Chittagong City. There are around 20-25 ship breaking yards where over 50 old ships are dismantled annually. Old ships can contain PFAS in their electrical systems, paints and coatings, cables, lubricants, engine oils etc. In 1998, about 90% of the world's old ships were disposed in these areas.

Cosmetic industries

According to a recent study of Danish EPA[8][8][9] PFAS can be present as emulsifiers and viscosity contributors in cosmetics such as moisturizing creams, foundations, pencils, powders and shaving foams. In Bangladesh, major industries related with cosmetics are in Dhaka, Gazipur and Narayanganj.

Timber, Dyeing and Painting

In Bangladesh, there are some paint and varnish-producing industries in the Dhaka, Narayanganj, Gazipur, Chittagong and Cox's Bazar areas that may use PFAS and related chemicals as wetting, leveling, and dispersing agents and/or to improve gloss and antistatic properties. PFAS and PFAS containing products are used in the region for producing Burmese shoes which are popular in that region. PFAS can also be used as additives in dyestuff and inks, e.g. as foam generators. Furthermore, they are used as pigment grinding aids or as agents to combat pigment flotation. Fluoro surfactants in coatings applications are mainly used for substrate wetting, leveling and reduction of surface tension (e.g. in spray applications).

Papers and Pulps Production

In Dhaka and Chittagong area, a large number of paper industries are found on the bank of Meghna and Karnafuli rivers. Large amount of PFAS and PFAS products are used there to produce paper.

Cleaning agents, waxes and floor polishes

PFASs are used in a variety of industrial and household cleaning products as surfactants such as cleaning agents, automobile waxes, alkaline cleaners, denture cleaners and shampoos. PFAS substances contribute a wetting function in floor polish and are used in dishwashing liquids and carwashes as a rinse-aid.

PVC/plastic and rubber industries

PFAS can be used in many industrial processes, including the production of PVC and other plastics. There are a number of plastic industries in Cox's Bazar, from where PFAS are released dangerously.

[8]https://nipsect.dk/new-danish-report-on-pfas-in-cosmetics/
[9]https://www2.mst.dk/Udgiv/publications/2018/10/978-87-93710-94-8.pdf

Photographic industry

In the photographic industry, PFAS and PFAS-related compounds are used in the manufacturing process of film, photo paper and plates. These compounds function as dirt rejecters, friction control agents, and to reduce surface tension and static electricity. This use has largely been replaced by digital photography. PFAS may also be used in the fabrication of imaging devices such as digital cameras, cell phones, printers, scanners etc. as well as in photo-acid generators (PAGs), in antireflective coatings (ARC), and as surfactants in developers, mixtures and commercial photo resists. Alternatives exist for these uses.

Scientific studies on PFAS in Bangladesh

Several scientific studies on PFAS in Bangladesh were identified. Further sampling of PFAS in the environment of Bangladesh is critical. Facilities for analysis of PFAS are not currently available in Bangladesh; therefore, it is important that samples are sent abroad to cooperating institutions that can test them. Particularly of interest will be sampling locations downstream of textile producers and other major industries. Samples of firefighting foams would help determine whether these products are important sources of contamination, as they are in many other countries.

Many water supplies in Bangladesh are under scrutiny for the high levels of arsenic found in the nation's groundwater. This fact may provide an opportunity for the additional testing of water supplies for PFAS. Of special interest is the Dhaka water supply, which provides approximately 2.5 billion litres (250 crores litres) per day to the people of that city.

"Occurrence and assessment of perfluoro alkyl acids (PFAAs) in commonly consumed Sea food from the coastal area of Bangladesh" (2017)[10]

This study reported the first findings of PFAS in commonly consumed seafood from the coastal area of Bangladesh. Levels ranged from 0.32 – 14.58 ng/g wet weight in finfish and 1.31 – 8.34 ng/g wet weight in shell fish. The authors noted that these levels were comparable to levels observed in China, Spain, Sweden and USA and that seafood from the southeast part of the country near Cox's Bazar and Chittagong showed higher levels of PFAS.

"Occurrence and distribution of perfluoroalkyl acids (PFAAs) in surface water and sediment of a tropical coastal area (Bay of Bengal coast, Bangladesh)" (2016)[11]

This study reported the first finding of PFAS in surface waters and sediments from the coastal area of Bangladesh. PFAS levels in surface water ranged from 10.6 – 46.8 ng/L (ppt). PFAS levels in sediments ranged from 1.07 – 8.15 ng/g dry weight (ppb). The study noted that PFOA and PFOS were the most abundant PFAS found. The authors noted that the southeastern part of Bangladesh (Cox's Bazar and Chittagong) was more contaminated with PFAS than the southern part (Meghna Estuary) and southwestern parts (Sundarbans).

Hidden Health Hazard in Non-stick Cookware *" (2017)*[12]

ESDO (Environment and Social Development Organization) carried out a study on hazardous chemical use in non-stick Cookware entitled "Uses of Non-stick Utensils and Associated Health and Environmental Impact" in Bangladesh on May in 2017. ESDO disclosed the very clear scenario of the level of use of nonstick cookwares and observed health hazards as the study findings through their study report.

[10] https://www.ncbi.nlm.nih.gov/pubmed/28258724
[11] https://www.ncbi.nlm.nih.gov/pubmed/27450955
[12] http://esdo.org/hidden-health-hazard-in-non-stick-cookware/

The report raised concerns that the non-stick cookware surface coated with polytetrafluoroethylene (PTFE), which is commercially known as Teflon, can release PFOA when the surface is over heated.

The survey was conducted among 1000 families including 800 from cities and 200 from villages. It was observed that the use of non-stick cookware in urban areas was greater than in rural areas. A total of 624 of the 800 urban families (78%) used non-stick cooking pans/pots whereas 74 of the 200 rural families (37%) used non-stick cooking pans/pots.

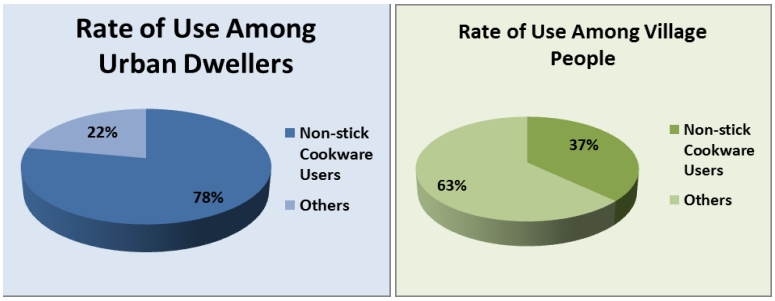

Figure 7: Rate of use of non-stick cookware in Bangladesh

The study also revealed that most of the women who used non-stick cookware were suffered from respiratory, kidney and liver diseases, hormonal problems, etc. These observations appeared to be primarily among cooks, housewives, children present mostly among women. Among 450 women, 421 were suffered from kidney problems and asthma. Among 378 women about 25 to 35 women were suffered from pregnancy related problem. Among children, 310 were suffered from kidney problems and asthma. These observations do prove direct links between non-stick cookware use and health impacts.

Press reports on PFAS

Environment and Social Development Organization (2017), Press Release, 25 May 2018

http://esdo.org/hidden-health-hazard-in-non-stick-cookware/

The release provides news of enhanced monitoring of nonstick cookware including for PFOA and PTFE as described above. The newspaper link is also given below.

THE NewsToday

Hidden health hazard in non-stick cookware

Use of non-stick pots and pans on a daily basis, means exposure to hidden dangers. Non-stick cookware is made using a carcinogenic chemical which starts emitting toxic fumes that one inhale every time while cooking with a non-stick pot. Environment and Social Development Organisation-ESDO disclosed these findings through their study report entitled, "Uses of Non-stick Utensils and Associated Health and Environmental Impacts". Syed MarghubMurshed, former secretary and

chairperson of ESDO, launched the study report at the press briefing Thursday at its head office in Dhaka

http://newstoday.com.bd/index.php?option=details&news_id=2472399&date=2017-05-26

PFAS regulations

PFAS are unregulated, but currently existing laws could be used to regulate them.

Laws and Regulations in Bangladesh

Though the Government of Bangladesh (GoB) has taken some policies and regulations to conserve the environment but these are not sufficient in the present context. There are no specific laws regulating PFAS.

Bangladesh has ratified the Basel and Stockholm Conventions but hazardous waste management remains a relatively unpublicized aspect of industrial development in Bangladesh. Bangladesh joined the Basel convention on 1 April 1993 and it first banned import of all sorts of waste in the Import Policy Order. In 1996, Bangladesh prepared a regulatory framework but there was no significant direct legislative support focused on management of HW or the issues surrounding the GoB obligations under of Basel Convention. However, some established policy and legislation can provide support for hazardous waste management to meet the requirements of the Basel Convention.

Some environmental related policies and regulations that could be relevant to PFAS regulation in Bangladesh are:

National Environmental Policy, 1992 (NEP) (MOEF, 1994): Includes the rules for protection and sustainable management of the environment. The objectives are:

- Maintaining ecological balance and overall development through protection and improvement of the environment;
- Identifying and regulate polluting and environmentally degrading activities;
- Ensuring environmentally sound development;
- Ensuring sustainable and environmentally sound use of all natural resources.

The Ministry of Environment, Forest and Climate Change (MOEF) is responsible to remain actively associated with all international environmental initiatives (e.g. Basel Convention).

National Environmental Management Plan, 1995: Includes the framework of programs and interventions to manage resources, reduce environmental degradation, improve the natural and manmade environment, conserving habitats and biodiversity, promote sustainable development and improve quality of human life.

Environment conservation Act (ECA), 1995: Includes important legislative control on industrial water pollution. It is mainly dedicated to the "conservation, improvement of quality standards, and control through mitigation of pollution of the environment".

Environment Conservation Rules (ECR), 1997: The Bangladesh Environment Conservation Act, 1995 originally published in Bengali in the Bangladesh Gazette, in regard to the extra-ordinary issue of 16-2-1995 and amended by Act Nos. 12 of 2000 and 9 of 2002, followed by the Bangladesh Environment Conservation Rules, 1997 was made for the conservation of the environment, improvement of environment standards and control and mitigation of environmental pollution.
Rules under ECA 1995 provide additional guidance for specific components of the Act that is to be enforced by the Department of Environment, which has responsibility for:

1. Coordinating with other authorities or agencies.
2. Adopting safety and abatement measures to prevent environmental degradation.
3. Advising persons on environmentally sound use, storage, transportation, import and export of hazardous material or its components.
4. Conducting research and assisting in conservation and improvement of the environment.
5. Investigating locations, equipment, processes and materials, to ensure improvement of the environment, and control and mitigate pollution.
6. Collect, publish and disseminate environmental information on pollution.
7. Advising Government on processes and materials that cause pollution.
8. Ensuring potable water quality.

Although all the provisions are important in the context of environment conservation, the most relevant part of the Act worth mentioning in regard to PFAS (as an important pollutant) are

-section 2 Definitions of "environment", "environment pollutant", "hazardous substances", "pollution" which are definitely applicable to PFAS because of their nature and characteristics;

-section 6A (6K), under "Restrictions on manufacture, sale etc., if articles injurious to environment" states that… or any other article is injurious to the environment, the Government may, by notification in the official gazette, issue a direction imposing absolute ban on the manufacture, import, marketing, sale, demonstration for sale, stock, distribution, commercial carriage or commercial use, or allow the operation or management of such activities under conditions specified in the notification, and every person shall be bound to comply with such direction, empowers Director General of DOE to take necessary actions for putting ban on such substances or activities related to pollutants or their emissions.

The Environment Court Act, 2000 (Act No. 11 of 2000): The Environment Court Act 2000 (Act No. 11 of 2000) published in the Bangladesh Gazette, in regard to the extra-ordinary issue of 10-4-2000 and amended by Act No. 10 of 2000 is an Act to provide for the establishment of environment courts and matters incidental thereto. Whereas it is expedient and necessary to provide for the establishment of Environment Courts for the trial of offences relating to environmental pollution and matters incidental thereto; enforces that any violation of environmental law, which means as per section 2 of the Environment Court act, 2000 this Act, the Bangladesh Environment Conservation Act, 1995 (Act no. 1 of 1995), any other law specified by the Government in the official Gazette, for the purposes of this Act, and the rules made under these laws. Section 3 of this Act states that "Notwithstanding anything contained to the contrary in any other law for the time being in force, the provisions of this Act shall have effect". Therefore, for prosecuting any legal action against violation of any provisions already existing in the relevant Acts, Rules, Ordinance related to Pollutants like PFAS, the Environment Court Act 2000 might be quite adequate in its content.

Mainly the act supports ECA & ECR by establishment of environmental courts for offences relating to environmental pollution. Protocols for the establishment of court, defines the court's jurisdiction, penalties, powers of search and entry, and procedures for investigation, trial and appeal.

Import Policy Order 2009-2012: In Import Policy Order 2009-2012, the Government of Bangladesh has ordered the authorities of factories and industries to import all types of products in Bangladesh. It includes:

- Regulation of import in Section 3(a)
- Conditions for regulating import 4(e)
- Conditions for importing explosives and radioactive goods (25)

- and a list of controllable import materials in an Annex

National Industrial Policy 2010: In the National Industrial Policy 2010, there are several sections relevant to potential PFAS regulation:
13.2 The government will institute a land-satellite based system to map the land and water terrains in Bangladesh with a view to decide allocation of land and water resources for industrial projects and to monitor land and water use, land water degradation, soil and beach erosions. For that, the Government will track major land, water and related industrial projects and their impact on environment and also create awareness among the public on environment protection, pollution, dumping of hazardous material on land and water.

13.3 The effective implementation of the Environment Protection Act 1995 and other relevant legislation will be actively pursued in consultation with the Ministry of Environment and Forest and major stakeholders and regulatory bodies, with sanctions against the violators. In this respect,

- Government will review industrial pollution classification system of red, yellow and green and ensure that a transparent and effective business support services are available.
- Government will take necessary measures for effective enforcement for proper running of Effluent Treatment Plants (ETP and CETP) in the industries.

13.4The government will undertake a review and coordination of all environment protection and environment related agencies with a view to ensuring that laws, rules and regulations are strictly enforced; that laws, rules and regulations governing environmental protection meet current and future requirements and standards and that adequate mechanism is in place for monitoring, compliance and enforcement of environmental protection laws, rules and regulations. Measures will be taken to revise and update the existing rules and regulations, if necessary.

13.5 The Government will provide positive and proactive incentives by way of tax and duty concessions in order to encourage SMEs and other large scale industries to adopt environmentally sound manufacturing processes and practices, complying with articles of Bangladesh Labour Law 2006 in manufacturing, waste and hazardous material disposal as well as positive efforts toward land and water protection, greening of the environment.

Emphasis will be given on bio/herbal pesticide industry to preserve useful insects, ground microbes, and aquatic life, and avoid the hazardous impacts of environmental pollution.

15.4 (e) Environmental Standards and Audits: Government will institute strict environmental standards and a system of audit and compliance for all industries which will include workplace health and safety, a clean and pollution free workplace environment, waste disposal, treatment of hazardous waste material, air pollution and water pollution prevention.

15.4 (h) Environmental pollution controls: The Environmental Protection Act 1995 and other relevant legislation will be gradually implemented. Those industries that pollute the environment and endanger public health must ensure safety measures in respect of environmental pollution control.

Hazardous waste and ship breaking waste management rules 2011: The government of Bangladesh has ordered the authorities of factories and industries to follow the Basel Convention for the handling, import and export of hazardous waste and chemicals in section (17).

Bangladesh Water Act 2013: Bangladesh Water Act 2013 is an act to make provisions for integrated development, management, abstraction, distribution, use, protection and conservation of water resources in section 1. The water resources include in the section 3(1) surface water, ground

water, sea water, rain water and water in the atmosphere. In section number 28, acts for prevention of any type of water pollution are included and water pollution is explained as any direct or indirect harmful changes of physical, chemical and organic properties of water. As a hazardous pollutant, PFAS are obviously related to this act.

Other potentially relevant legislations

- The Explosive Act, 1884
- The Explosive Substance Act, 1908
- Factory Act, 1965
- Pesticide Ordinance, 1983

State of Stockholm Convention Ratification and the National Implementation Plan

The Government of Bangladesh signed the Stockholm Convention on 23 May 2001 and ratified the treaty on 3 December 2007. As a Party, the Government is required to adapt national laws and fulfill obligations to address the substances on the treaty's list, such as PFOS. The government has taken up the initiative to prepare the National Implementation Plan. In preparation, the government has completed the National Inventory on POPs. The Department of Environment (DoE) of the Ministry of Environment and Forest (MoEF) is the concerned authority to prepare and implement the National Implementation Plan. DoE has not taken up any further activities with regard to Pops awareness-raising. Whatever little awareness has been created is due to the effort of civil society organizations. However, the fact that these hazardous chemicals appear to be so widely used in the textile industry and in firefighting foams indicates that existing regulations are failing to protect human health and the environment. An important shortcoming in the current regulatory approach is that PFAS import, export, production and use is not restricted in Bangladesh.

PFAS regulations in other countries

Most PFAS are not regulated, but PFOA and PFOS have come under regulatory scrutiny, particularly in the US where a large number of contaminated drinking water sites have been identified. In 2016, the US established a federal health advisory limit in drinking water of 70ppt[13] (parts per trillion) for PFOA and PFOS combined. This advisory limit is not enforceable but is used as a guideline. A recent US government review by the Agency for Toxic Substances and Disease Registry[14] has proposed tightening exposures which would translate to drinking water limits of 7 ppt for PFOS and 11 ppt for PFOA.

In the absence of federal regulations, individual US states (California Colorado, Minnesota, Michigan, New Jersey, New Mexico, Texas, Vermont, and Washington)have moved forward to regulate PFAS in drinking water, firefighting foam, personal protective equipment and wastes. Another 11 states are considering or have already proposed similar regulatory actions. Information about individual state proposals can be obtained here.[15]

In 2018, state regulators in California set interim notification limits of 13 ppt for PFOS and 14 ppt for PFOA in drinking water. Regulators noted that both substances were listed by the state as developmental toxicants and that the National Toxicology Program concluded that both substances are "presumed to be an immune hazard to humans."Colorado uses a 70 ppt combined limit of PFOS

[13]https://www.epa.gov/ground-water-and-drinking-water/drinking-water-health-advisories-pfoa-and-pfos
[14]https://www.atsdr.cdc.gov/toxprofiles/tp.asp?id=1117&tid=237
[15]http://www.saferstates.com/toxic-chemicals/pfas/

and PFOA as a groundwater quality standard. Colorado also regulates PFOS and PFOA as hazardous waste. Massachusetts sets a 70 ppt limit for PFOA, PFOS, PFHxS[16], PFNA and PFHpA combined. Michigan uses the federal 70 ppt combined PFOS and PFOA standard as a limit for drinking water. The Minnesota Department of health recommends the following guidance values: 2000 ppt for PFBS, 27 ppt for PFHxS, 27 ppt for PFOS, 7000 ppt for PFBA, and 35 ppt for PFOA. New Jersey added PFNA to its hazardous substances list and set a limit for PFNA of 13 ppt in drinking water. New Jersey proposed limits of 14 ppt for PFOA and 13 ppt for PFOS. Vermont sets a drinking water limit of 20 ppt for PFOA, PFOS, PFHxS, PFHpA and PFNA combined. In 2018, Washington banned PFAS in firefighting foams and personal protective equipmentand[17] began a rulemaking process to established drinking water limits. The New York Department of Health has proposed 10 ppt for PFOS and 10 ppt for PFOA. The proposal considered the fact that people already have exposure to these substances from other sources.

Conclusion and Recommendations

Bangladesh is still at the stage of evaluating possible uses of and contamination by PFAS. The assistance of research groups abroad will be important in evaluating the presence of PFAS in Bangladesh. Here are some recommendations which include a mixture of national recommendations and those dealing with the listing of PFOA and consideration of PFOS loopholes at COP9.

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

1. PFAS monitoring should be conducted to identify hotspots near industrial areas.

[16]https://www.mass.gov/service-details/per-and-polyfluoroalkyl-substances-pfas-in-drinking-water
[17]https://www.atsdr.cdc.gov/toxprofiles/tp.asp?id=1117&tid=237

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

3. A no-allowable-residues policy should be established for PFAS in clothing articles, imported or otherwise. In order to offer adequate protection, the limit should cover the entire PFAS class and be set for limits of detection in laboratory testswith the potential for this to be reduced further in the future, as technology improves

4. A comprehensive implementation plan on PFAS should be implemented which contains intermediate short-term targets, a dynamic list of priority hazardous substances requiring immediate action based on the substitution principle, and a publicly available register of data on discharge emissions and losses of hazardous substances, such as a Pollutant Release and Transfer Register (PRTR). Such a plan would prevent ongoing releases into the environment that may require future clean-up and have serious impacts on the environment and on people's health and livelihoods.

   It would set a clear direction for the textiles industry by showing that hazardous chemicals have no place in a sustainable society, which will in turn drive innovation towards safer alternatives. Finally, it would level the playing field and make the actions of leading companies a reality throughout the entire sector and beyond, as many of the hazardous chemicals used in textiles are also in use in other sectors.

5. A political commitment should be made to implement zero discharge of all hazardous chemicals within one generation. Actions should prioritize prevention by avoiding production and use of hazardous chemicals.

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 perfluorohexanesulfonate (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

Perfluorobutanesulfonate (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:

- Perfluorohexanesulfonate (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 immune toxicity 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). Bangladesh became a Party to the treaty in 2001.

PFOS

Bangladesh ratified the Stockholm Convention in 2007. 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

When PFOS was listed in Annex B of the treaty in 2009, a very large number of specific exemptions and acceptable purposes accompanied its listing that permitted continued production and use. Bangladesh did not register for any of these loopholes that result in continued exposure.
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 12 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; firefighting foams, 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. If a specific exemption is allowed for use in firefighting foams, the POPRC recommendations should be adopted.

The following 2 acceptable purposes should be converted into specific exemptions: metal plating (hard metal plating only in closed loop systems); and 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.

PFOA

PFOA is extremely persistent and does not degrade under relevant environmental conditions. Itbioaccumulates 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. None of these can be justified based on the existence of technically feasible, available alternatives. If exemptions are granted, they should not exceed the Convention allowance of five years. In addition, new products containing PFOA should be labeled.

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

Firefighting foams	market, and in use. 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 uses or 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 PFAS-containing firefighting foams and the availability of effective fluorine-free foams, no exemption should be granted. If a specific exemption is allowed for this use, the POPRC recommendations on firefighting foams should be adopted.

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. PFHxSbiomagnification 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 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.