India PFAS Situation Report-2019

A Study
By

Toxics Link
for a toxics-free world

IPEN
a toxics-free future

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Summary

This report is a survey of information available about per- and polyfluoroalkyl substances (PFAS) in India. These substances have raised increasing concerns due to their wide use in processes and products and toxic properties that lead to wide dispersion and water pollution. Scientific studies of PFAS and examination of regulatory policy in India raise concerns about these substances and reinforces the need for regulatory action.

The principal findings of this report are:

PFAS are unregulated in India

No PFAS substances are regulated in the country. India became a Party to the Stockholm Convention in 2006 and the treaty added PFOS to its global restriction list in 2009. However, India has not accepted the amendment listing this substance and it is unregulated, along with other PFAS.

Breast milk is contaminated with PFAS substances

A 2008 study found significant PFAS levels for PFOS, PFOA, PFHxS, and PFBS in women from Chidambaram, Kolkata, and Chennai. Overall, average PFOS levels in Indian breast milk averaged 46 ppt – more than 2 times higher than the drinking water health advisory limit of 20 ppt for PFOA, PFOS, PFHxS, PFHpA and PFNA combined in the US State of Vermont. The highest level of PFOA exposure in Indian breast milk was more than 16 times higher than this drinking water limit.

PFAS pollutes river, groundwater, and drinking water

A 2016 study found 15 PFAS in one or more locations in Ganges River surface water with levels ranging from 1.3 – 15.9 ppt. Short-chain PFAS (C_5 – C_8) were found more frequently and the authors indicate that this is likely due to ongoing substitution by industry. The study calculated the mean cumulative PFOS and PFOA discharges to the whole Ganges catchment area to be 240 g/day for PFOS and 210 g/day for PFOA. This area covers a population of approximately 400 million people. PFOS could not be detected at the River's origin in Rishikesh, but levels gradually increased downstream and elevated at the confluence with the Yamuna River in Allahabad. The study also found PFAS in groundwater – which is used for drinking water as well as irrigation purposes in most of the Ganges basin. Fourteen PFAS were frequently detected and PFHxA and PFHpA were detected in all samples. The highest intakes per kg body weight were observed for children. Another study found that the Noyyal River contains significant levels of PFOA at 93 ppt and PFOS at 29 ppt. The authors note that this could be due to extensive industrial activity in this area including textile factories that dump directly into the river. PFOS has been found in the Cooum River (3.91 ppt) and in untreated sewage (12 ppt). Tap water samples from Goa, Coimbatore, and Chennai did not contain PFOS or PFOA – but shorter chain PFAS such as PFHxS (81 ppt) instead. Note that this is four time higher than the health advisory limit in US State of Vermont which sets a drinking water health advisory limit of 20 ppt for PFOA, PFOS, PFHxS, PFHpA and PFNA combined.

PFAS contaminates fish

A 2009 study found PFOS in almost all of the fish samples from the Ganges River along with PFUnDA, PFDA, PFNA, and PFOA. Ganges River dolphins contained PFUnDA, PFDA, and PFNA in 80%, 87% and 53% of the samples. The study found that PFAS concentrations increased from the lower trophic level (shrimp) to higher tropic level organisms (fish, dolphins).

Pigs living on an open waste dump become contaminated with PFAS

A 2010 study measured PFAS in the livers of pigs living on a large-scale municipal waste dump site in Perungudi near Chennai. Female pigs contained substantially higher levels of PFOS (71 ng/g wet weight) than male pigs (9 ng/g wet weight). Piglets contained higher levels of PFOS than adult females (13 ng/g wet weight). Other substances found in female pigs included PFHxS, PFDS, PFOSA, PFHpA, PFOA, PFNA, PFDA, PFUnDA, and PFDoDA. PFAS levels in female pigs from the dump site (71 ng/g wet weight) were significantly higher than PFAS levels in female pigs from the reference site (19 ng/g wet weight).

PFAS in India travels outside the border

A 2019 study found that the contribution of the Indian Monsoon to PFAS in snow in western China was approximately 70%. India is also the likely source of PFOA measured on Mt. Zuoqiupu in Tibet and the source of PFBA which dominated the snow pack of Lake Namco.

PFAS pollution occurs in deep groundwater

A 2018 study showed water aquifers greater than 100 meters deep were polluted with PFAS, pharmaceuticals and pesticides. PFOS levels ranged from <0.1 – 33 ppt, far higher than the drinking water health advisory limit of 20 ppt for PFOA, PFOS, PFHxS, PFHpA and PFNA combined in the US State of Vermont.

Particulate air pollution in India contains PFAS

PFAS in particulate air pollution in Chennai was in the 2.5 – 10 um range with a $PM_{2.5}$ / PM_{10} ratio of 0.38. PFOA was the dominant component in samples. Ultrafine particles ($PM_{0.1}$) had the largest PFAS mass fraction. The largest PFAS concentration was found in Hong Kong followed by Chennai and the two locations in Japan.

PFOA is found in the Sundarbans mangrove wetland

In the Sundarban mangrove area, PFOA was found in all five sampled sites at an average level of 11.61 ppb dry weight. The Sundarbans contains four protected areas that are listed as UNESCO World Heritage Sites.

PFAS elimination contributes to achievement of the Sustainable Development Goals (SDGs)

Actions to control and phase-out PFAS as a class contribute to achievement of several key Sustainable Development Goals (SDGs) due to the impacts of the substances on health and ecosystems including water pollution. These include SDGs 3, 6, 9, 12, 14, 15, and 16.

What are per- and polyfluoroalkyl substances (PFAS)?

PFAS is a large class of more than 4,500 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 use as surfactants and surface-active agents in products. 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.

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 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.

Actions on PFAS and the Sustainable Development Goals

Actions to control and phase-out PFAS as a class contribute to achievement of several key Sustainable Development Goals (SDGs) due to the impacts of the substances on health and ecosystems including water pollution. These include

Sustainable Development Goal 3: Ensure healthy lives and promote well-being for all at all ages. Targets under SDG3 include:
3.4: *"reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being"*
3.9: *"substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination."*

Sustainable Development Goal 6: Ensure availability and sustainable management of water and sanitation for all. Targets under SDG6 include:
6.3: *"improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally."*

Sustainable Development Goal 9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation. Targets under SDG9 include:
9.4: *"greater adoption of clean and environmentally sound technologies and industrial processes."*

Sustainable Development Goal 12: Ensure sustainable consumption and production patterns. Targets under SDG12 include:
12.4: *"By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frame works, and*

significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment."
12.5: *"substantially reduce waste generation through prevention, reduction, recycling and reuse."*
12.6: *"Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle."*
12.7: *"Promote public procurement practices that are sustainable, in accordance with national policies and priorities."*

Sustainable Development Goal 14: Conserve and sustainably use the oceans, seas and marine resources for sustainable development. Targets under SDG14 include:
14.1: *"By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution."*

Sustainable Development Goal 15: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss. Targets under SDG15 include:
15.1: *"By 2020, ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands, in line with obligations under international agreements."*
15.5: *"Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and, by 2020, protect and prevent the extinction of threatened species."*
15.9: *"By 2020, integrate ecosystem and biodiversity values into national and local planning, development processes, poverty reduction strategies and accounts."*

Sustainable Development Goal 16: Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels. Targets under SDG16 include:
16.7: *"Ensure responsive, inclusive, participatory and representative decision-making at all levels."*
16.10: *"Ensure public access to information…"*

PFAS production, use, and waste management

There is no comprehensive information available on production, use and waste management for PFAS in India.

Toxics Link has undertaken a preliminary survey of PFOA use in cookware. A small market survey was conducted in Delhi NCR (Bhogal and Vaishali) to ascertain the presence PFOA-coated and PFOA-free cookware and four retailer shops were randomly selected. The data from the field shows that some of the brands are selling PFOA-free cookware and these products are labeled as PFOA-free as well. However, PFOA-free is not the same as PFAS-free and it is likely that many of these manufacturers are simply using fluoropolymers made without using PFOA. Fluorine-free alternatives include silicone-, ceramic- or enamel-based coatings. More research is required to be done in India to establish the constitution and shifts in the coated cookware market.

Non-stick cookware with fluorinated and other coatings on the Delhi NCR market

PFAS impacts

PFAS impacts have not been written about in public press, but a significant amount of peer-reviewed scientific information is available in the next section below.

A study conducted in India by Hairline International Hair Clinic tried to establish a link between Teflon containing PFOA and hair loss. The group measured PFOA in 500 people 18 – 44 years-old who suffered from hair loss and used Teflon cookware and compared their blood levels with 500 people who used earthen, steel, or aluminum cookware. They found that 80% of the people using non-stick cookware were PFOA positive while 3% of the people using earthen, steel, or aluminum cookware were PFOA positive.[1]

Scientific studies on PFAS in India

There are several peer-reviewed studies that show PFAS pollution in India or pollution due to sources in the country.

Wang X, Chen M, Gong P, Wang C (2019) Perfluorinated alkyl substances in snow as an atmospheric tracer for tracking the interactions between westerly winds and the Indian Monsoon over western China, Environ Int 124:294-301

This study examined 16 PFAS substances in snow from western China. PFBA was the most common PFAS but geographical variations were observed. Long-chain PFAS (greater than 10 carbons) were dominant in the north and west of the region and short-chain PFAS (less than 6 carbons) predominated in the south and east. Researchers estimated that the contribution of the Indian Monsoon to PFAS in western China was approximately 70%.

Lapworth DJ, Das P, Shaw A, Mukherjee A, Civil W, Petersen JO, Gooddy DC, Wakefield O, Finlayson A, Krishan G, Sengupta P, MacDonald AM (2018) Deep urban groundwater vulnerability in India revealed through the use of emerging organic contaminants and residence time tracers, Environ Pollut 240:938-949

Researchers examined the vulnerability of deep alluvial aquifers to contaminant migration in Varanasi, India. The results showed that sources less than 100 meters deep and greater than 100 meters were both polluted with a range of substances including pharmaceuticals, PFAS, and pesticides. PFOS levels ranged from <0.1 – 33 ppt.

Ge H, Yamazaki E, Yamashita N, Taniyasu S, Ogata A, Furuuchi M (2017) Particle size specific distribution of perfluoro alkyl substances in atmospheric particulate matter in Asian cities, Environ Sci Process Impacts 19:549-560

This study measured PFAS in atmospheric particulate matter in Japan (Kanazawa and Okinawa), Hong Kong (City University), and India (Chennai). The largest PFAS concentration was found in Hong Kong followed by Chennai and the two locations in Japan. In Chennai, the peak concentration was in the 2.5 – 10 um range with a $PM_{2.5}$ / PM_{10} ratio of 0.38. PFOA was the dominant component in samples. Ultrafine particles ($PM_{0.1}$) had the largest PFAS mass fraction.

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[1] The information is retrieved from http://www.hairline.in/en/images/pdf/PFOA%20%201%20final%2015%20ver.pdf on 19th Feb 2019.

Sharma BM, Bharat GK, Tayal S. Larssen T, Becanova J, Karaskova P, Whitehead PG, Futter MN, Butterfield D, Nizzetto L (2016) Perfluoroalkyl substances (PFAS) in river and ground/drinking water of the Ganges River basin: Emissions and implications for human exposure, Environ Pollut 208:704-713

Fifteen PFAS were found in one or more locations in Ganges River surface water with levels ranging from 1.3 – 15.9 ppt. Short-chain PFAS (C_5 – C_8) were found more frequently and the authors indicate that this is likely due to ongoing substitution by industry. The researchers believe this is first study to show higher levels of shorter chain PFAS than PFOA in an emerging industrial economy.

PFHxA, PFHpA, and PFOA were found in all samples. The highest concentrations were measured for PFHxA (0.4 – 4.7 ppt) and PFBS (<MQL – 10.2 ppt). PFOA levels ranged from 0.1 – 1.2 ppt and PFOS levels varied from <MQL – 1.7 ppt. These levels were lower than rivers in Japan and China but similar those in Brazil, Germany, and Vietnam. Sources of short-chain PFAS include degradation of 6:2 fluorotelomer-based goods (including water/oil repellents and aqueous fire-fighting foams) used as replacements for 8:2 fluorotelomer based products.

The study calculated the mean cumulative PFOS and PFOA discharges to the whole Ganges catchment area to be 240 g/day for PFOS and 210 g/day for PFOA. This area covers a population of approximately 400 million people.

The study also found PFAS in groundwater – which is used for drinking water as well as irrigation purposes in most of the Ganges basin. Fourteen PFAS were frequently detected and PFHxA and PFHpA were detected in all samples. As previously observed in surface water, levels of PFOA in groundwater were lower than for PFPA, PFHxS and PFHpA. One finding with consequences for human exposure from drinking water was that concentrations of PFBA, PFPA, PFHxA, PFHpA, and PFOA were higher in groundwater than in the river.

Researchers also made some estimates of human exposure to PFAS using groundwater contamination data. The substance with the highest exposure was PFHxA and PFHpA and PFPA were higher than intakes of PFOS and PFOA. The highest intakes per kg body weight were observed for children.

Sunatha G, Vasudevan N (2016) Assessment of perfluorooctanoic acid and perfluorooctane sulfonate in surface water - Tamil Nadu, India, Mar Pollut Bull 109:612-618

This study measured PFOA and PFOS in the Cauvery River and lakes near Chennai. Overall, PFOA levels ranged from 4 – 93 ppt and PFOS levels ranged from 3 – 29 ppt. PFOS could not be found in the Cauvery River but PFOA was found in all sites at 5 ppt. The highest levels were found in the Noyyal River with levels of PFOA at 93 ppt and PFOS at 29 ppt. The authors note that this could be due to extensive industrial activity in this area including textile factories that dump directly into the river.

Ganesan S, Vasudevan N (2015) Impacts of Perfluorinated Compounds on Human Health, Bull Environ Pharm Life Sci 4:183-191

This review article examines exposure and human health impacts of PFAS. PFOA and PFOS both cross the placental barrier and "exposure of the developing human fetus to these compounds is inevitable. Exposure to the fetus, infants, and children are of the greatest concern as these are the most sensitive stages of human development." Dominant PFAS in blood are PFOS, PFHxS, PFOA and FOSA. The review notes that the lowest PFOS levels in blood were found in India (<3 ppb). However, India and South Korea were the only countries in which PFOA levels were higher than PFOS levels.

PFAS interfere with thyroid function and are associated with reproductive toxicity, developmental toxicity, arthritis, metabolic dysregulation, immunotoxicity, neurotoxicity, and carcinogenesis. The authors note the strong link between PFAS in the environment and an increase in disorders.

The study also provided information about the presence of PFOS and PFOA in human blood. India showed the lowest levels of PFOS but similar levels of PFOA as observed in Canada, US, Italy, and Spain. Note that the data from India was actually from a 2004 study.

Wang X, Halsall C, Codling G, Xie Z, Xu B, Zhao Z, Xue Y, Ebinghaus R, Jones KC (2014) Accumulation of perfluoroalkyl compounds in Tibetan mountain snow: temporal patterns from 1980 to 2010, Environ Sci Technol 48:173-181
PFAS were analyzed in snow-cores from high mountain glaciers on the Tibetan plateau. The highest concentration was found in an older core from the Mt. Muztagata glacier which contained PFOS (61.4 – 349 pg/L) and PFOS (40.89 – 243 pg/L). In Mt Zuoqiupu PFOS could not be measures and PFOA levels varied from 27.8 – 183 pg/L. Variations in PFAS levels in different locations were hypothesized to result from different upwind sources. India was the likely source of PFOA at Mt Zuoqiupu. In addition, India is likely source of PFBA which dominated the snowpack of Lake Namco.

Corsolini S, Sarkar SK, Guerranti C, Bhattacharya BD, Rakshit D, Jonathan MP, Godhantaraman N (2012) Perfluorinated compounds in surficial sediments of the Ganges River and adjacent Sundarban mangrove wetland, India, Mar Pollut Bull 64:2829-2833
This is the first report of PFOS and PFOA in surface sediment samples from the Ganges River. PFOA levels ranged from <0.5 – 14.09 ppb dry weight but PFOS was below the level of detection. In the Sundarban mangrove area, PFOA was found in all five sampled sites at an average level of 11.61 ppb dry weight. The Sundarbans contains four protected areas that are listed as UNESCO World Heritage Sites.

Murakami M, Adachi N, Saha M, Morita C, Takada H (2011) Levels, temporal trends, and tissue distribution of perfluorinated surfactants in freshwater fish from Asian countries, Arch Environ Contam 61:631-641
The PFAS content of freshwater fish was measured in samples of carp, snakehead, and catfish from India, Japan, Vietnam, Malaysia, and Thailand. Samples from India were from Lashmikantapur (snakehead), Diamond Harbor (snakehead), Chingrighata (carp), and Sundarban (catfish). PFAS levels were similar among the different types of fish. PFOS varied from <LOQ

to 0.5 ng/g wet weight and PFUA varied from <LOQ to 1.0 ng/g wet weight. Samples from Vietnam were higher than those from India and Malaysia.

Watanabe MX, Kunisue T, Tao L, Kannan K, Subramanian A, Tanabe S, Iwata H (2010) [Dioxin-like and perfluorinated compounds in pigs in an Indian open waste dumping site: toxicokinetics and effects on hepatic cytochrome P450 and blood plasma hormones], Environ Toxicol Chem 29:1551-1560

This study measured dioxins and PFAS in the livers of pigs living on a large-scale municipal waste dump site in Perungudi near Chennai. PFOS was the predominant PFAS followed by much lower levels of PFHxS. Female pigs contained substantially higher levels of PFOS (71 ng/g wet weight) than male pigs (9 ng/g wet weight). Piglets contained higher levels of PFOS than adult females (13 ng/g wet weight). Other substances found in female pigs included PFHxS, PFDS, PFOSA, PFHpA, PFOA, PFNA, PFDA, PFUnDA, and PFDoDA. The study also compared PFAS levels in pigs living on the dump site with those from a reference site. The results showed that PFAS levels in female pigs from the dump site (71 ng/g wet weight) were significantly higher than PFAS levels in female pigs from the reference site (19 ng/g wet weight). No site-dependent difference was found for male pigs.

Yeung LW, Yamashita N, Taniyasu. S, Lam P, Sinha RK, Borole DV, Kannan K, (2009) [A survey of perfluorinated compounds in surface water and biota including dolphins from the Ganges River and in other waterbodies in India], Chemosphere 76 (2009) 55–62

This study conducted by research scientists from City University of Hong Kong is the first comprehensive study of PFAS pollution in the Ganges River. The study found 12 PFAS substances in water with the highest PFOS levels in the Cooum River (3.91 ppt) and untreated sewage (12 ppt). PFOA was found in 55% of the water samples and PFDA, PFNA, PFPeA and PFHxA were also found. The highest concentration of PFOA (23.1 ppt) was found in untreated sewage samples.

PFOS was found in almost all of the fish samples along with PFUnDA, PFDA, PFNA, and PFOA. Ganges River dolphins contained PFUnDA, PFDA, and PFNA in 80%, 87% and 53% of the samples. The study found that PFAS concentrations increased from the lower trophic level (shrimp) to higher tropic level organisms (fish, dolphins).

The study also found that PFOS could not be detected at the River's origin in Rishikesh, but levels gradually increased downstream and elevated at the confluence with the Yamuna River in Allahabad. Note that the Yamuna River is one of the largest tributaries of the Ganges River and is highly polluted – especially around New Delhi which dumps approximately 57% of its wastes into the river. The study notes that major industries along the Yamuna River include coal-fired power plants and plants manufacturing fertilizer, food processing, textiles, insecticides, and electroplating.

Mak YL, Taniyasu S, Yeung LW, Lu G, Jin L, Yang Y, Lam PK, Kannan K, Yamashita N (2009) Perfluorinated compounds in tap water from China and several other countries, Environ Sci Technol 43:4824-4829

Tap water from Canada, China, India, Japan and US was analyzed for a variety of PFAS. Samples from Shanghai contained the highest average PFAS levels of 130 ppt. Samples from India were collected from Goa, Coimbatore, Chennai, and Patna. Seven PFAS substances were found in Indian tap water: PFOS, PFHxS, PFBS, PFOA, PFHxA, PFPeA, and PBFA. However, samples from Goa, Coimbatore, and Chennai did not contain PFOS or PFOA – but shorter chain PFAS such as PFHxS (81 ppt) instead. Note that the US State of Vermont sets a drinking water limit of 20 ppt for PFOA, PFOS, PFHxS, PFHpA and PFNA combined. The authors suggest movement toward use of short-chain PFAS in India is reflected in this data.

Tao L, Ma J, Kunisue T, Libelo EL, Tanabe S, Kannan K (2008) Perfluorinated compounds in human breast milk from several Asian countries, and in infant formula and dairy milk from the United States, Environ Sci Technol 42 :8597-8602

This study examined breast milk for PFAS in samples from Cambodia, India, Indonesia, Japan, Malaysia, Philippines, and Vietnam. In addition, infant formula from five US manufacturers and 11 brands of dairy milk were tested.

PFOS was found in 85% of the samples from India and in 100% of the samples from the other countries. PFHxS was the second most common PFAS substance and found in 50% of the samples.

Breast milk samples from India were from women in Chidambaram, Kolkata, and Chennai. The results showed significant PFAS levels for PFOS, PFOA, PFHxS, and PFBS. Overall, average PFOS levels in Indian breast milk averaged 46 ppt – more than 2 times higher than the drinking water limit of 20 ppt for PFOA, PFOS, PFHxS, PFHpA and PFNA combined in the US State of Vermont. The highest level of PFOA exposure in Indian breast milk was more than 16 times higher than this drinking water limit.

PFAS levels in Indian breast milk from Chidambaram, Kolkata, and Chennai

n = 39 Overall mean PFOS level = 46 ppt

Substance	Range (ppt)	Fraction of samples containing (%)
PFOS	<11.0 – 120	85
PFOA	<42.5 – 335	8
PFHxS	<1.66 – 13.3	36
PFNA	<8.82	0
PFBS	<1.11 – 8.86	5
PFHpA	<4.45	0

The study found that PFAS levels in US infant formula and dairy milk were approximately 10-fold lower than levels in Asian breast milk. This resulted in a daily intake of PFOS by Asian infants that was 7 – 12 times higher than the dietary intakes previously reported for adults in Canada, Germany and Spain.

Press reports on PFAS

There are some reports in the press on the issue of PFAS.

The Indian Express (2017), Dr. Premalatha. V. ***Is your pan Toxic?***
http://www.newindianexpress.com/cities/bengaluru/2017/jan/18/is-your-pan-toxic-1561033.html.
The article gives an overview of a research study conducted on PFOA, its usage and its possible impact on human health. It is from the hair clinic study described above in the section on PFAS impacts.

The Telegraph India (2010) by Saheli Mitra. ***Trouble as you boil and bubble***.
The information is retrieved from https://www.telegraphindia.com/leisure/trouble-as-you-boil-and-bubble/cid/502156.
The article throws lights on the long-term exposure to PFAS due to the use of non-stick cookware. The article quotes a toxicologist who notes that, "“Persistence of PFOAs in the environment and their toxicity can have low-level chronic exposure effects on the liver and thyroid glands. They can also cause modulation of the sex hormone balance, developmental and immune system toxicity, hypolipidemia and reduced body weight.” A consumer activist advocated for a mandatory government advisory that would notify consumers about possible health impacts of PFAS so that customers could make informed choices.

PFAS regulations

Currently India does not regulate PFAS or related compounds.

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 for either 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.

2. A comprehensive inventory of PFAS use should be conducted. In India there is hardly any information available on the use of the chemical in various sectors and this data is needed for control of use and waste management.

3. To prevent PFAS pollution and subsequent costly remediation, India should make an inventory on firefighting foam stocks promptly and replace PFAS-containing foams with fluorine-free foams as early as possible.

4. Export and import data should show sectoral use and help Customs identify trade flows.

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

6. There is need of more scientific study on the presence and health impacts of PFAS in air, food and water.

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 (V), 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:

- 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 cleanup 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). India became a Party to the treaty in year in 2006.

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

India so far has not ratified the amendment listing for PFOS in the treaty.

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 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. 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 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. 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.