Background Paper

PFAS (Per- and Poly-fluoroalkyl Substances)

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Protecting the Health of Current and Future Generations

PFAS or per- and polyfluoroalkyl substances are a large group of complex synthetic chemicals. They were first produced in the 1940/50s and are estimated to include over 10,000 different substances. Of these, 4,700 PFAS are known in chemical structure, and an estimated 1,400 PFAS are currently in commercial use. PFAS are completely man made and are best known for their water-, oil- and grease-repellence and high thermal stability. These qualities make their industrial and manufacturing applications extensive. PFAS can be found in all types of products like packaging, firefighting foams, clothes, cookware, and protective coatings for fabrics or electronics [1, 1a , 2].

PFAS exhibit high existence and extreme persistence in the environment, humans, and all other life forms and are associated with environmental and health impacts [2, 5, 9].

The main human exposure to PFAS is through food, air (dust) and drinking water. Food (especially fish, eggs and fruits) is the main source of exposure to PFASs for humans [2, 3, 5, 6].

PFAS in the Environment

Environmental contamination with PFAS is ubiquitous, as the substances are produced and emitted in large numbers and enter the environment through various pathways. Due to their chemical stability, there are no natural biological or abiotic degradation mechanisms that can lead to the total mineralization (decomposition to mineral form) of PFAS. This means that PFAS can accumulate in the environment and organisms and exist in the air, water or soil for a long time. Furthermore, they are difficult and costly to treat and remove from the environment once they have entered it [2, 5].

Environmental pollution from PFAS is associated with significant adverse effects on ecosystem functions, plants, animals, microorganisms, and humans, especially in locations where PFAS contamination reaches high levels- so called hotspots [2, 3, 5, 9, 10].

The Forever Pollution Project - a collaboration of journalists and media from across Europe - has identified more than 17,000 locations across Europe with relevant PFAS pollution, including 2,000 hotspots with significant PFAS pollution levels. German journalists in the project, from NDR, WDR and SZ, have found more than 1,500 locations with PFAS pollution, including more than 300 hotspots [8].

PFAS and (drinking) water

PFAS have been detected in various aquatic matrices, including rain, snow, groundwater, tap water, oceans, lakes, and rivers. They enter water bodies through a variety of pathways: via effluents from industrial and municipal wastewater treatment plants, by washing off PFAS-contaminated soil, and via the air. Some PFAS are mobile when dissolved in water and can be transported long distances via groundwater. Groundwater investigations in Germany show high PFAS concentrations at monitoring wells with known PFAS contamination in the catchment area. [2, 3, 5, 6].
Based on the toxicological information available to date on PFAS, and considering the thresholds considered acceptable by the various regulatory agencies, the health risks to normal consumers of municipal/tap water do not appear to be of concern [2, 4, 6].
Drinking water is considered a special or concerning PFAS source if the raw water has been contaminated with PFAS through damaging events. In Germany, only a few such cases are known to date [2, 5].

Wastewater treatment methods available to date, such as activated carbon filters and ion exchange resins, remove PFAS only to a certain extent, are rather suitable for certain types of PFAS, and can be expensive. Other processes are under development but not yet ready for use [2, 5]. As a recent example, researchers at the Fraunhofer Institute for Interfacial Engineering and Biotechnology IGB may have succeeded in developing a process based on the use of plasma that can degrade the molecular chains of PFAS - to the point of complete mineralization of the environmental toxin [7]. PFAS are not isolated to tap water sources, but can be found in bottled water, too. Studies have found that two out of six commercial German brands tested had concentrations of PFAS in the water [6].

PFAS Hotspots in Germany [2]	
Raststatt: Contamination of 700 hectares of arable land and groundwater by spreading PFAS-contaminated paper sludge as fertilizer	https://www.landkreis-rastatt.de/landratsamt/aemteruebersicht/amt-fuer-umwelt-und-gewerbeaufsicht/pfc_pfas
Chemical Park Gendorf: The production of fluoropolymers, PFOA, led to the contamination of soils, groundwater and surface waters.	https://www.lgl.bayern.de/lebensmittel/chemie/kontaminanten/pfas/et_uebersicht_pfoa_aoe.htm
Military Airport Manching: Fire-fighting foams contaminated groundwater and a nearby small stream.	https://www.landkreis-pfaffenhofen.de/umwelt/pfas-belastungen-am-flugplatz-manching/
Hochsauerland: Large-scale contamination caused by the application of a soil additive that illegally contained sewage sludge from the paper industry.	https://www.lanuv.nrw.de/umwelt/gefahrstoffe/pfas/pfas-in-boeden/aufbringungsflaechen
Düsseldorf Airport: Fire-fighting foams contaminated soil and groundwater.	https://www.duesseldorf.de/umweltamt/umwelt-und-verbraucherthemen-von-a-z/altlast/pft-lohausen-kwerth

PFAS and human health

In the human body, PFAS bind to proteins in the blood, liver and kidneys and can cause a wide range of adverse health effects. These include endocrine effects, carcinogenicity, reproductive toxicity, effects on lipid metabolism and the immune system and thus, among others, the formation of vaccine antibodies.

The magnitude of health effects depends on the circumstances of exposure (extent, duration, route of exposure, etc.) and the factors of the exposed individuals (e.g., age, sex, ethnicity, health status, and genetic predisposition).The slow elimination kinetics, which increases the accumulation of the substance in the body, and the fact that some PFASs are transferred from mother to child during pregnancy and lactation are other critical issues regarding PFAS and human health [2, 5, 9, 11].

Legal Regulation of PFAS

Health guidelines concerning PFAS exposure have become increasingly strict over the years. On top of that there are legal regulations and thresholds to further limit the amount of PFAS in the environment and human exposure. PFOS and PFOA, for example, have been heavily regulated under the Stockholm Convention [5, 12, 13].

At EU level, the revised Drinking Water Directive (2020) set a "new group limit value" of 0.5 µg/L for "PFAS Total" (i.e. the totality PFAS) and the limit value of 0.1 µg/L for the "Sum of PFASs considered a concern" a in drinking water. By January 2024, the EU Commission is to define analysis methods including detection limits and frequency of sampling for the parameter "sum of PFAS" [13, 14].
In the German Drinking Water Ordinance, the regulations from the EU Directive were implemented as follows:
For the sum of 20 PFAS (with a chain length of 4 to 13 carbon atoms), an overall limit value of 0.1 µg/L was set. These limits apply from January 12, 2026.
An overall limit of 0.02 µg/L has been set for the sum of 4 PFAS, which account for approximately 50% of PFAS in human dietary intake and approximately 90% of internal body burden (including PFOA and PFOS). The requirements are valid from January 12, 2028 [15].

Experts consider these limits too high to ensure long-term protection (also against cross-contamination) and the implementation period too long. Concerning PFAS exposure (e.g. through Food or water), the European Food Safety Authority (EFSA) has

set a tolerable weekly dose of only 0.0044 µg/kg body weight per week for the sum of four representatives of PFAS (in 2020). According to those limits, the drinking water limit should be set to 0.0022 µg/L [5, 12].
Other countries have set stricter values. Denmark, for example, has set the maximum PFAS content in water at 0.0022 µg/L [5].

The problem with restricting individual substances in the group is that manufacturers continue to release different and new types of PFASs into the environment, the effects of which are not known. This is why Germany, the Netherlands, Denmark, Norway and Sweden are working together to further restrict the entire PFAS substance group. The proposal was published by the European Chemicals Agency ECHA in February 2023 and is now going through the legal process of the ECHA restriction procedure [5, 13, 16]. This approach has met with great resistance from parts of the industry [17].

It is necessary to drastically restrict PFAS in the environment and to exclude the spread of new substances from the PFAS group that could prove harmful in future research. To ensure the future safety and cleanliness of our drinking water and to protect the health of the environment, and all living things.

Further reading:

General understanding of PFAS and their effects:
German Environment Agency 2020 PFAS Report
https://www.umweltbundesamt.de/sites/default/files/medien/2546/publikationen/200922_uba_sp_1-2020_eng-web_0.pdf

Brunn, et al. 2023 - Environmental Sciences Europe.
https://doi.org/10.1186/s12302-023-00721-8

More about the how PFAS effects human health:
Per-and Polyfluoroalkyl Substance Toxicity and Human Health Review: Current State of Knowledge and Strategies for Informing Future Research
https://setac.onlinelibrary.wiley.com/doi/full/10.1002/etc.4890

Status of PFAS legislation around the world:
Global Regulations Around PFAS: The Past, the Present and the Future
https://icrl.lexxion.eu/data/article/18898/pdf/icrl_2023_01-005.pdf

The Forever Pollution Project
a collaboration of journalists and media from across Europe, unveiling the scale and character of the pollution with PFAS
https://foreverpollution.eu/

PFAS-Free Products
Brands, products and retailers that are PFAS proclaimed free - hosted by Fidra
https://www.pfasfree.org.uk/pfas-free-products

Manifesto for an urgent ban of 'forever chemicals' PFAS

Demands of European civil society organisations for EU Member States and the Commission to ban all PFAS in consumer products by 2025 and to have a complete ban by 2030.
https://banpfasmanifesto.org/en/

RIWA-Rijn Annual Report 2022
Annual report of the association of drinking water suppliers using surface water from the Rhine, with special attention to PFASs
https://www.riwa-rijn.org/en/news/riwa-rijn-water-quality-of-the-rhine-falls-short-of-targets/

Innovate beyond PFAS
Editorial summarizing of some key issues related to PFAS
https://www.science.org/doi/10.1126/science.adj7475

Briefing paper: tackling PFAS in drinking water
Culmination of extensive research on PFAS ('forever chemicals') pollution across 20 European countries, and specifically the effects of these substances in drinking water and food.
https://eeb.org/library/briefing-paper-tackling-pfas-in-drinking-water/

PFAS in drinking water: an initial overview of findings and challenges for the water supply
(German) Energie, wasser, Praxis 09/2022
https://energie-wasser-praxis.de//wp-content/uploads/2023/05/ewp_0922_64-71_Borchers.pdf

Exit Plastik
Alliance of civil society actors to solve the plastic crisis. Current information, position and background papers on plastics, chemicals, political processes, etc.
https://exit-plastik.de/

Sources

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https://www.umweltbundesamt.de/sites/default/files/medien/2546/publikationen/200922_uba_sp_1-2020_eng-web_0.pdf

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https://www.igb.fraunhofer.de/de/presse-medien/presseinformationen/2023/pfas-kontaminiertes-wasser

-wird-wieder-sauber-erfolgversprechendes-und-umweltschonendes-verfahren-entwickelt.html (last visited 28.09.2023)

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