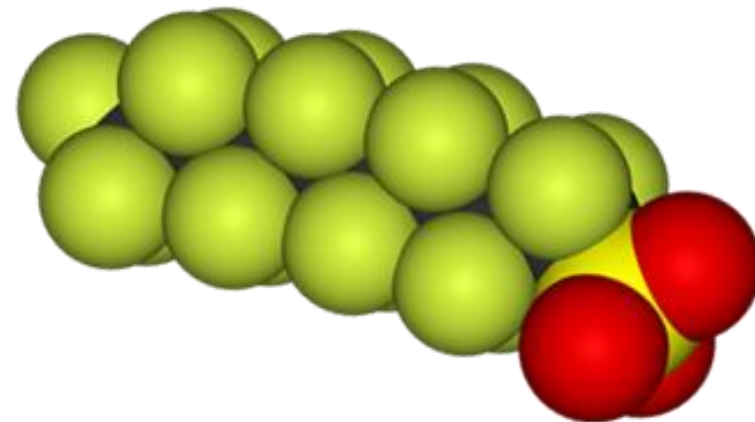


PFAS – per- in polifluoroalkilne snovi, zakaj so „večne“ ?

Agnes Šömen Joksić

Vsebina

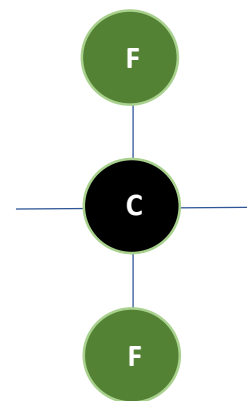
- Predstavitev PFAS
 - Kaj so, o imenu („definicija“) in splošna struktura
 - Zakaj so „večne“ (lastnosti)
 - Družinsko drevo (delno)
- Kratka zgodovina
- Uporaba
- Tveganja (okolje, zdravje)
- Zapuščina PFAS
- Rešitve / ukrepanje / kemijska varnost ?
- Zaključek



Predstavitev

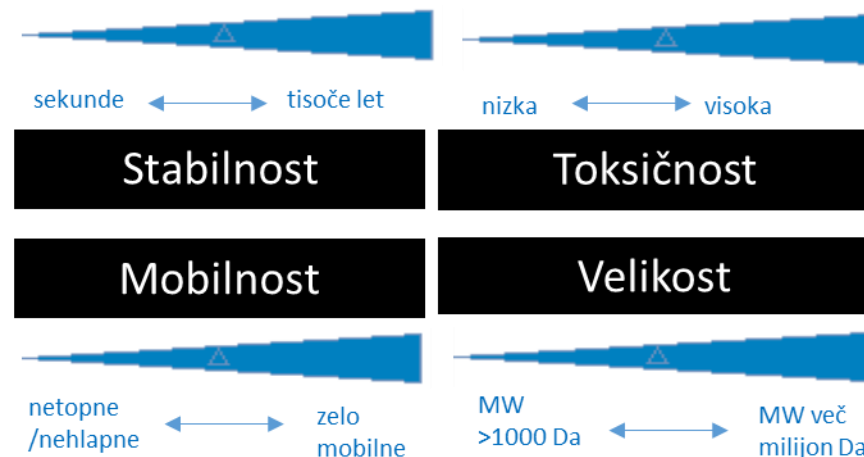
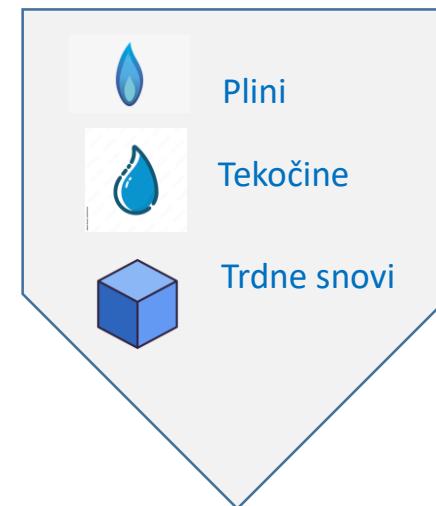
- PFAS je akronim za kompleksno družino (sintetičnih!) fluoriranih organskih spojin (namesto H na C verigo vezanih več atomov F)
 - Perfluoroalkilne: popolnoma fluorirana C veriga
 - Polifluoroalkilne: delno fluorirana C veriga
 - „Kratkoverižne“ (≤ 6 C atomov), „dolgoverižne“ (≥ 8 C) - ??
- Najbolj znani predstavnici: PFOA (perfluorooktanojska kislina) in PFOS (perfluorooktan sulfonska kislina)
- Različni podatki o številu spojin znotraj družine
 - ~15000 (USEPA) <https://comptox.epa.gov/dashboard/chemical-lists/PFASSTRUCT>
 - >4700 s CAS št. OECD, 2021
- Splošna ‚problematika‘
 - Kemična in termična stabilnost → obstojnost v okolju
 - Velika mobilnost → globalna razširjenost, tudi v oddaljenih okoljih (Arktika, Antarktika); prisotnost v vodnih virih, zraku
 - Nagnjenost k bioakumulaciji in biomagnifikaciji → kontaminacija prehranjevalne verige
 - Vse to pri majhnih koncentracijah (ppt)!

Podobnosti



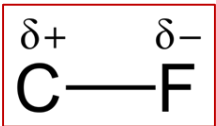
Vsaj en popolnoma fluoriran C atom

Razlike



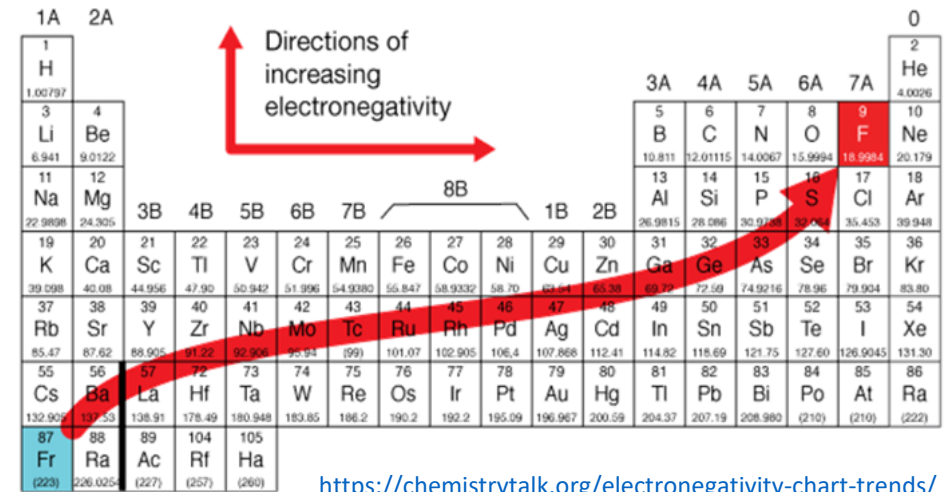
Zakaj so „večne“ ?

Vez



- Ena najmočnejših enojnih vezi v kemiji (B–F, Si–F, H–F)
- Močno polarizirana kovalentna vez
 - Posledica elektronegativnega značaja F
- Dodatna stabilnost zaradi elektrostatične privlačnosti med $\text{C}\delta^+$ in $\text{F}\delta^-$
- Energija vezi se še poveča z večanjem števila F atomov na istem C atomu
 - fluoroalkani, npr. tetrafluorometan (ali ogljikov tetrafluorid), CF_4 spada med najbolj nereaktivne organske spojine

Electronegativity Trend

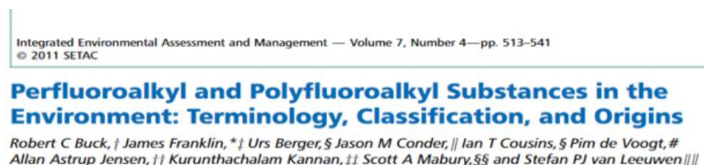


Berzelius I. 1811, nadgradil Pauling I. 1935 z razvojem merljive skale

Elektronegativnost!

Terminologija („definicija“)

- Buck *et al.*, 2011: Fluorirane spojine, ki »vsebujejo 1 ali več atomov C, na katerih so vsi atomi H (prisotni v nefluoriranih analogih, iz katerih navidezno izhajajo), nadomeščeni z atomi F, na tak način, da vsebujejo perfluoroalkilni del „-C_nF_{2n+1}-“ ; <https://doi.org/10.1002/ieam.258>



- ITRC, 2021: „Atomi C povezani med seboj in z atomi F, vezanimi na večini ali vseh razpoložljivih C veznih mestih“ ; <https://pfas-1.itrcweb.org/>



- US EPA OPPT (Office of Pollution Prevention and Toxics): „PFAS imajo vsaj dva sosednja atoma C, pri čemer je en C v celoti, drugi pa vsaj delno fluoriran“ (ne vključuje ~40% spojin po OECD, tudi ne večino hladilnih in PFAS plinov!) – opuščena „definicija“ zaradi kritik (maj, 2023); <https://r744.com/atmo-america-u-s-epa-drops-narrow-working-definition-of-pfas-that-excluded-f-gases>



- OECD, 2018 in 2021: „PFAS so katera koli kemikalija z vsaj eno perfluorirano metilno skupino -CF₃ ali perfluorirano metilensko skupino -CF₂- (brez atomov H/Cl/Br/I) ; [Reconciling Terminology of the Universe of Per- and Polyfluoroalkyl Substances: Recommendations and Practical Guidance](https://one.oecd.org/document/ENV/CBC/MONO(2021)25/En/pdf) ([https://one.oecd.org/document/ENV/CBC/MONO\(2021\)25/En/pdf](https://one.oecd.org/document/ENV/CBC/MONO(2021)25/En/pdf))

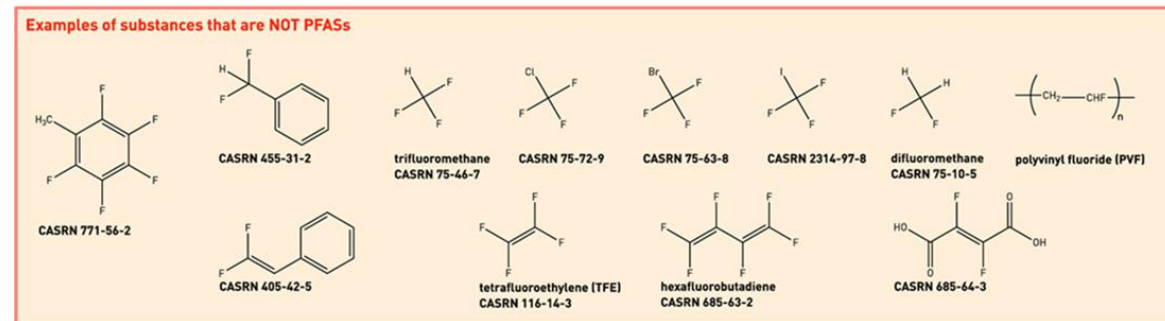
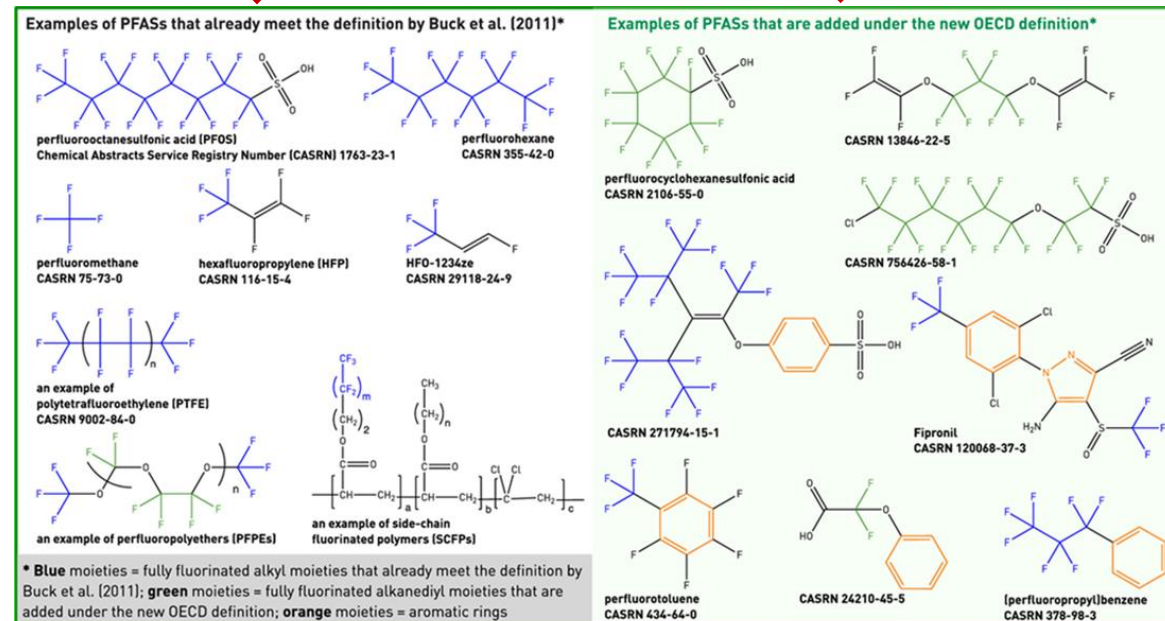
- Širše sprejeta definicija, ki vključuje tudi F-pline in trifluoroocetno kislino, TFA



Portal on Per and Poly Fluorinated Chemicals

Buck *et al.*, 2011

OECD, 2018, 2021



Environ. Sci. Technol. 2021, doi.org/10.1021/acs.est.1c06896

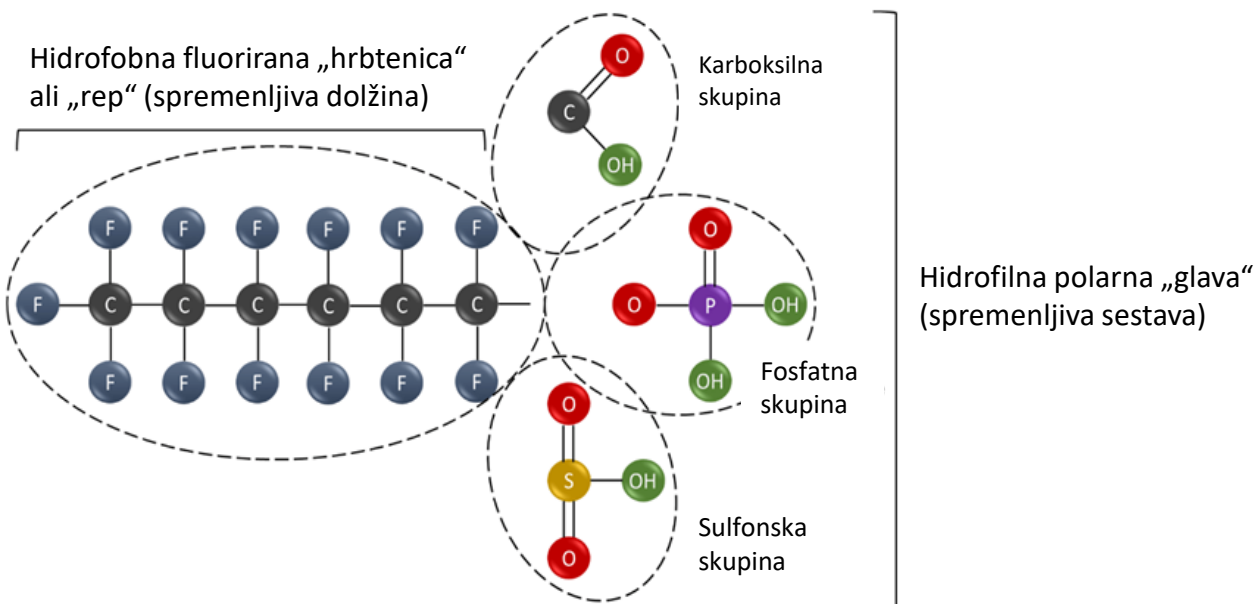
- Potreba po znanstveno osnovani enotni definiciji! (OECD dobra osnova)

Splošna struktura (klasifikacija)

Ne-polimerne PFAS:

- hidrofobna „hrbtenica“ oz. „rep“ („back-bone“ / „tail“)
 - različna dolžina
 - različna stopnja fluoriranja (per-, poli-)
- hidrofilna funkcionalna skupina - polarna „glava“

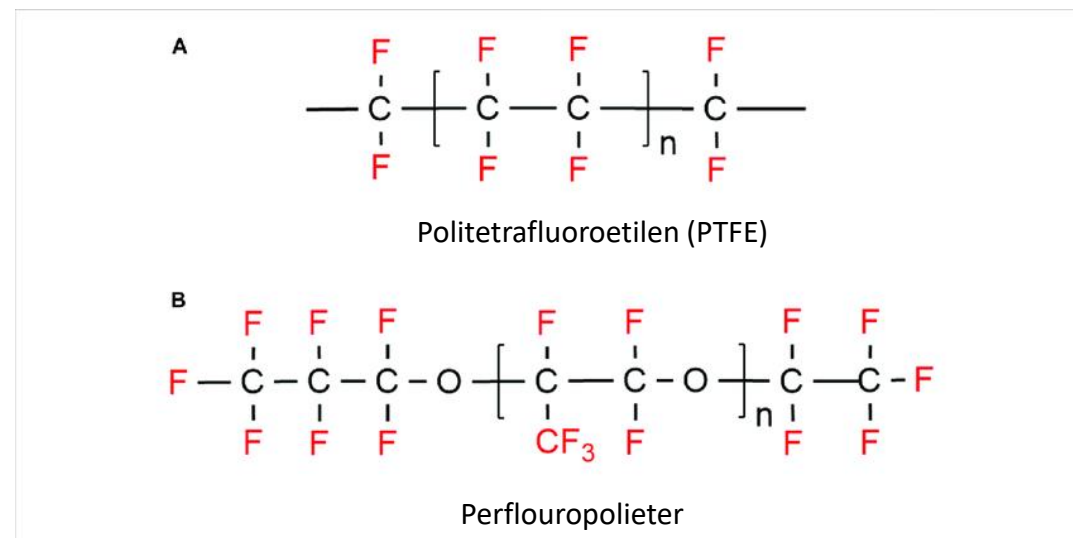
Splošna struktura ne-polimernih (perfluoriranih) PFAS



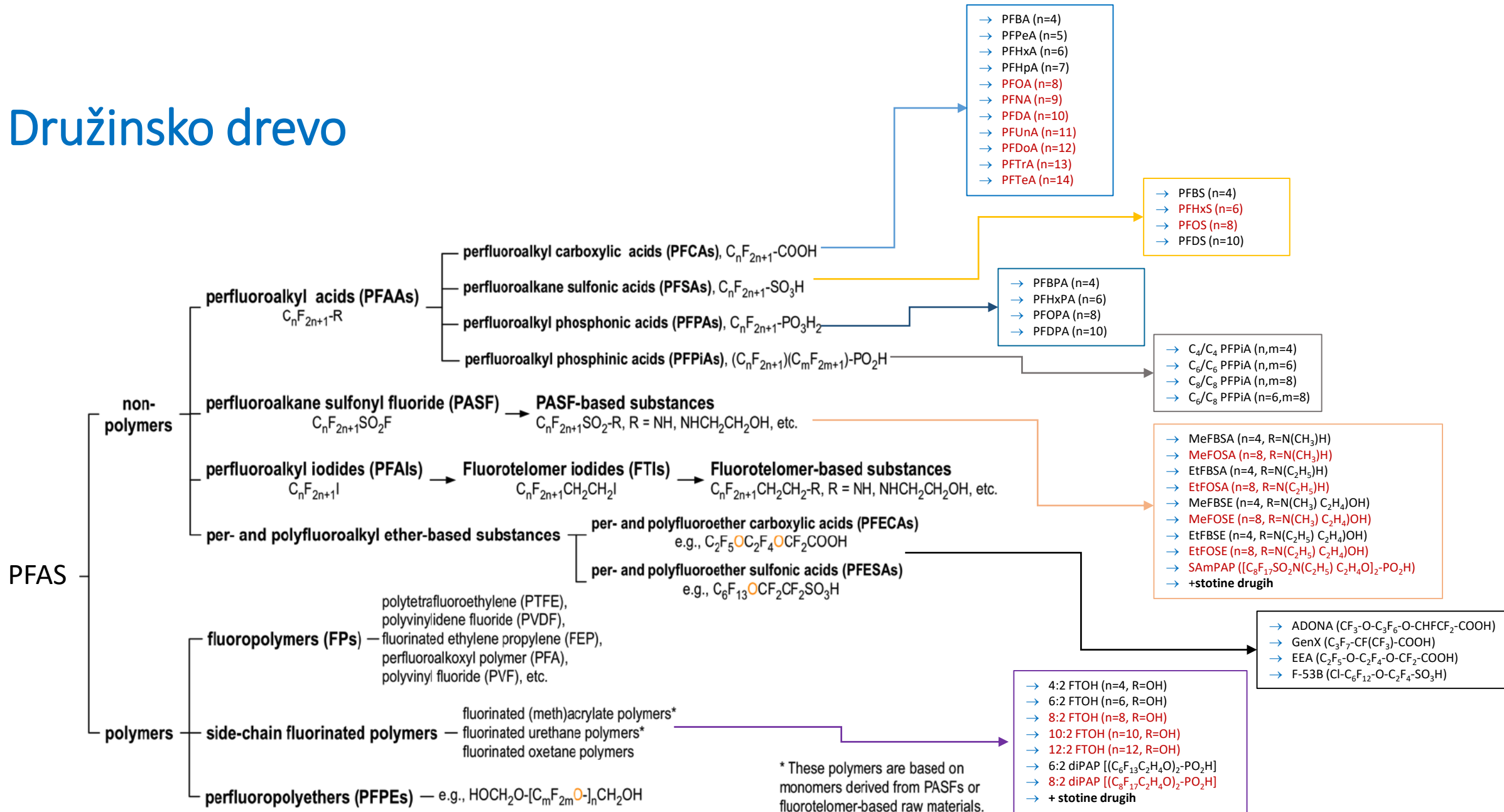
Polimerne PFAS:

- več enot s krajšo verigo → fluoropolimeri
 - A. $(CF_2-CF_2)_n$ ($n \sim 1000$)
 - B. $(CF[CF_3]-CF_2-O)_n$ ($n = 10-60$)

Struktura polimernih (perfluoriranih) PFAS



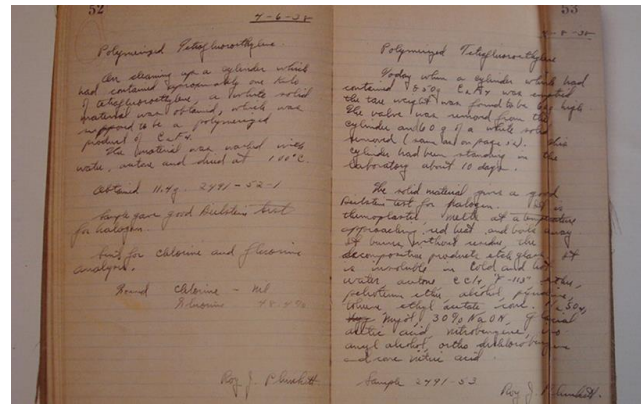
Družinsko drevo



Zelo strnjena zgodovina



Roy J. Plunkett (1910 – 1994)
 Plastics Hall of Fame, 1973
<https://plasticshof.org/members/roy-j-plunkett/>

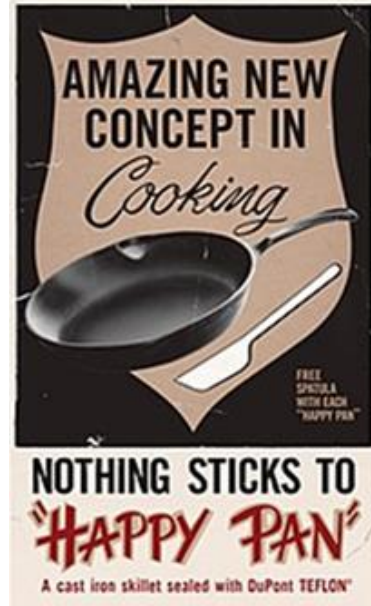


Dve strani iz lab. dnevnika (1938), ki sta spremenili svet – odkritje Teflona® <https://sciencehistory.org/>

Odkritje Teflona® naključen dogodek – ponesrečen eksperiment v laboratoriju DuPont v 30-tih letih prejšnjega stoletja

Časovnica pomembnih dogodkov v zgodovini PFAS

	1930s	1940s	1950s	1960s	1970s	1980s	1990s	2000s	2010s	2020s
Proizvodnja	Sinteza / razvoj		Izdelava in komercialna proizvodnja							
								Opuščanje, zmanjšanje, alternative		
Okolje in zdravje						Skrb za zdravje				
								Odkrivanje v okolju, izboljšave analitskih metod		

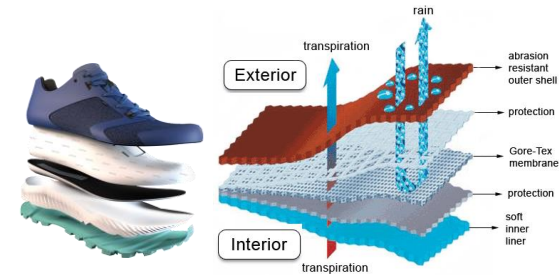


https://en.m.wikipedia.org/wiki/File:Happy_Pan_Poster.jpg

Razširjenost na vseh področjih življenja



Chemosphere,
<https://doi.org/10.1016/j.chemosphere.2020.128078>



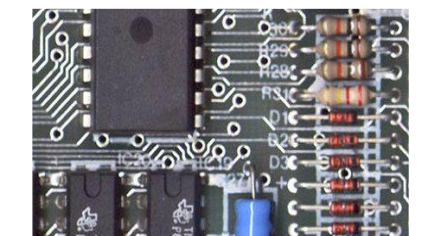
<https://www.gore-tex.com/>



<https://chemsec.org/>



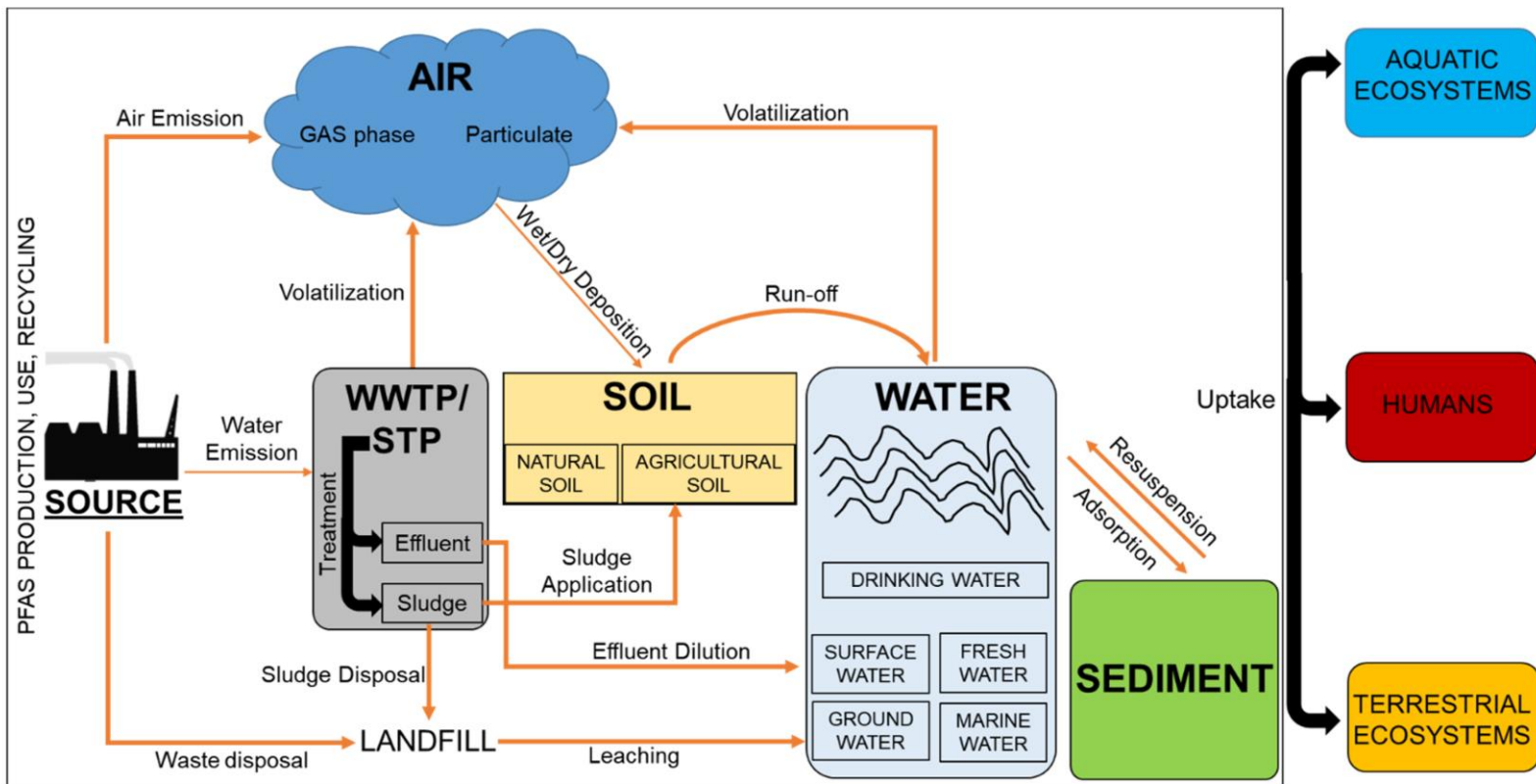
„Unfortunately you can't just consider the finished product – the frying pan in your hand. You have to look beyond this “use phase”, before the PTFE was applied to the product. The thing is that a chemical has two more such phases in its life: the production and the waste phase. When you bring these additional phases, and the available science, into the analysis, well, then PTFE, you're not looking so great there, buddy.“



Področja in primeri uporabe ter učinkovanje

Področje	Primeri uporabe	Primeri spojin	Primeri učinkovanja
Tekstil in usnje	Vrhnja oblačila, dežniki, torbe, šotori, avto-sedeži, čevlji, preproge, tkanine za pohištvo, sredstva za impregnacijo	PTFE, FTOH, FTS, PFOA	Repelenti za vodo, maščobo in umazanijo
Pena za gašenje	Pena razreda B, ki se uporablja za vnetljive tekočine, zlasti pri požarih zaradi goriv	Fluorirane površinsko aktivne spojine, velikokrat vsebujejo prekurzorje 6:2 FTS, PFHxA, PFOA	Sposobnost ustvarjanja tankega filma med peno in gorečo tekočino
Papir in embalaža za živila	Vrečke za pokovko, škatle za pico, kartoni, maskirni papir	PAP/diPAP, 6:2 fluorotelomeri, PFOA	Repelenti za vodo in maščobo
Kozmetika	Ličila, kreme za zaščito pred soncem, vlažilne kreme, podlage	PAP/diPAP, PFCA	Repelenti za olja in vodo, glajenje
Izdelki za gospodinjstvo	Čistila, loščila za tla, izdelki za nego avtomobilov, barve, ponve proti prijemanju, vosek za smuči	FTOH, PTFE (Teflon), PFOA, PFHxA	Gladko prekrivanje, se ne sprijema, zagotavlja drsenje in odbija umazanijo

Poti razširjanja v okolju in izpostavljenost



- PFAS lahko prepotujejo velike razdalje po vsem okolju
- Razširjene povsod v okolju in v telesu skoraj vsakega človeka (organizma)
- Nekateri predstavniki PFAS so v okolju prekurzorji drugih PFAS
- Učinki na strukturo in procese v tleh, ki jih povzročajo mikrobi - oviranje razgradnje organske snovi ter spremembe pH tal
- Vpliv na C in N cikel, privzem v rastline

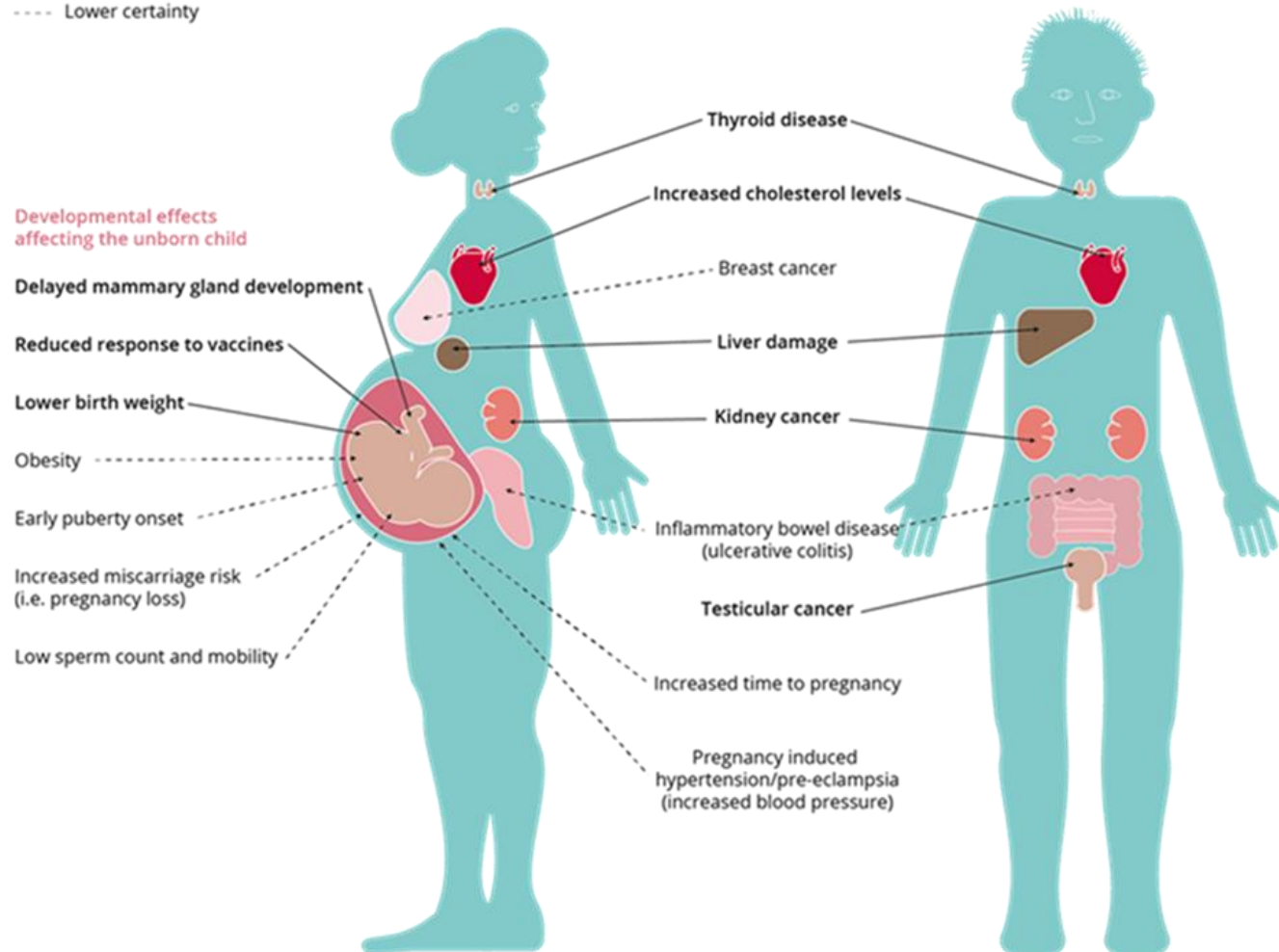
Nastajajoča / zaskrbljujoča kemična tveganja v Evropi

„Emerging-chemical-risks-in-Europe“

Dejstva:

- Uporabljajo jih v različni industriji
- So prisotne v različnih potrošniških izdelkih
- **Večina ljudi je (bila) izpostavljena PFAS**
 - Izpostavljenost ljudi večja na področjih onesnaženosti pitne vode: raziskave v okolju in HBM
- **Znana ali domnevna strupenost** za okolje (organizme) in ljudi
 - **PBT** (Persistent, Bioaccumulative, Toxic) pri relativno nizki koncentraciji (ppt)
 - **vPvB** (very Persistent, very Bioaccumulative)
 - **PMT** (Persistent, Mobile, Toxic)
 - **vPvM** (very Persistent, very Mobile)
 - **CMR** (Carcinogenic, Mutagenic or toxic to Reproduction)
- „Večne kemikalije – večno onesnaženje“

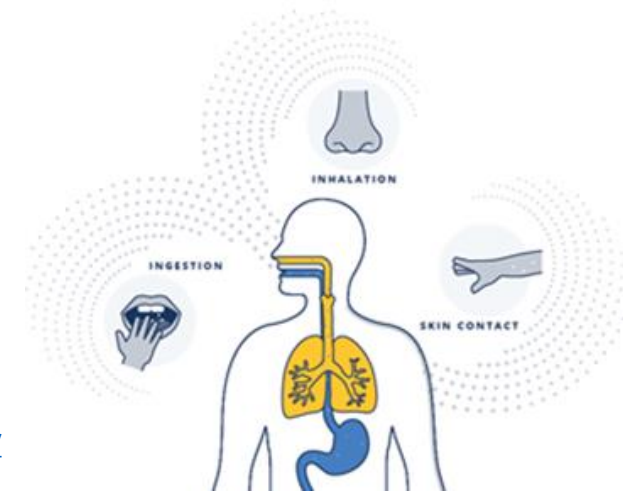
— High certainty
- - - Lower certainty



Strupenost



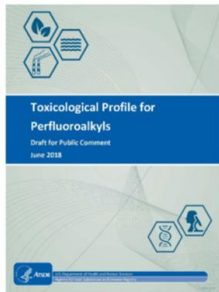
<https://www.chemistryworld.com/>



<https://chemicalinsights.org/pfas/>

Strupenost za živali

- jetra, imunski sistem, razvoj, endokrini sistem, presnova in živčni sistem
- PFOA in PFOS sta povzročala tumorje v kroničnih študijah na podganah
<https://www.atsdr.cdc.gov/toxprofiles/tp200.pdf>



Systematic Evidence Map for Over One Hundred and Fifty Per- and Polyfluoroalkyl Substances (PFAS)

This article accompanies

INVITED PERSPECTIVE: THE PROMISE OF FIT-FOR-PURPOSE SYSTEMATIC EVIDENCE MAPS FOR SUPPORTING REGULATORY HEALTH ASSESSMENT.

Authors: Laura M. Carlson ^{ID}, Michelle Angrish ^{ID}, Avanti V. Shirke ^{ID}, Elizabeth G. Radke, Brittany Schulz, Andrew Kraft, Richard Judson ^{ID}, ... [SHOW ALL ...](#), and Kristina A. Thayer ^{ID} | [AUTHORS INFO & AFFILIATIONS](#)

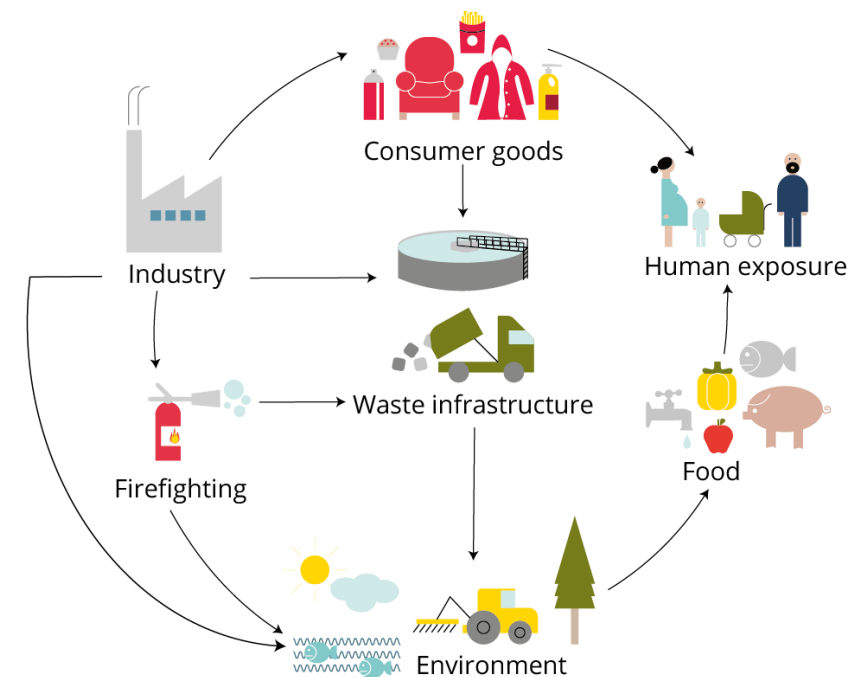
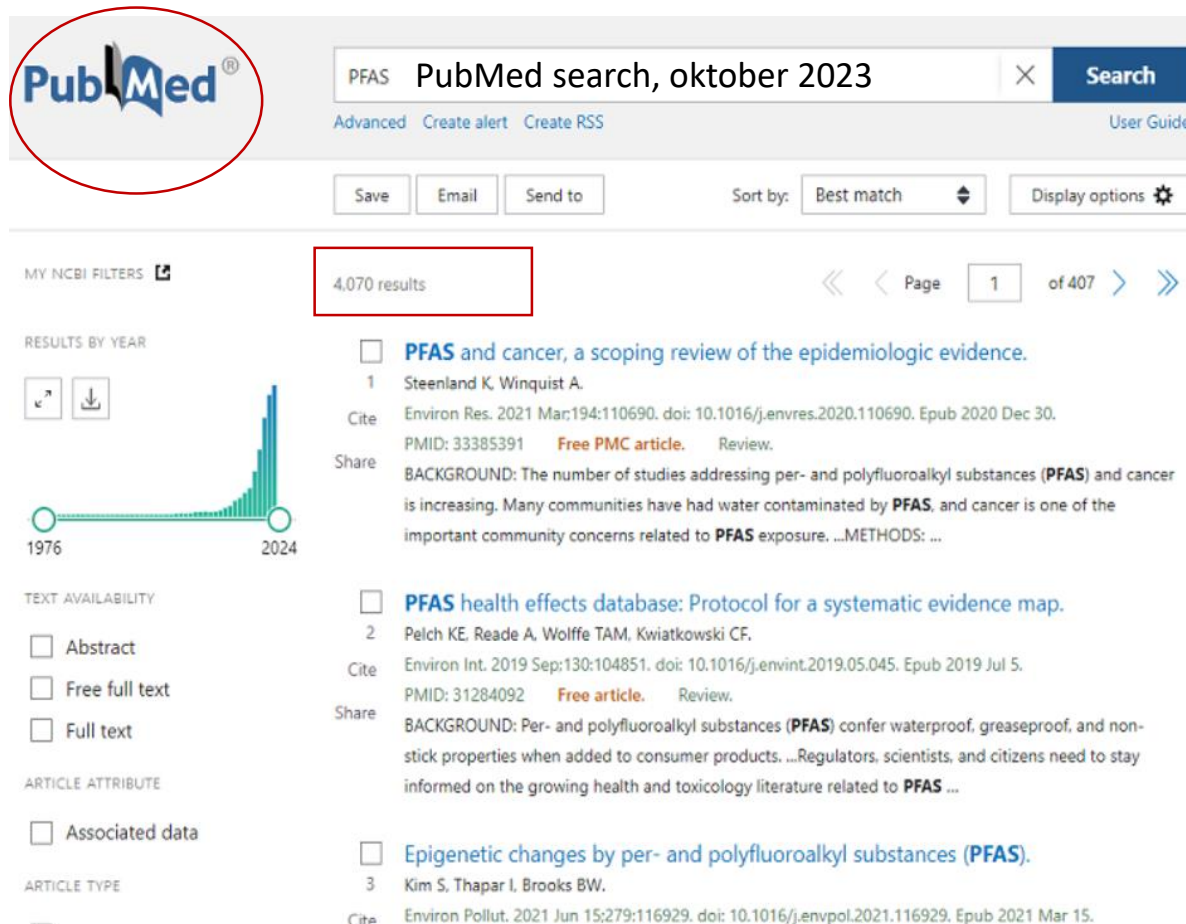
Publication: Environmental Health Perspectives • Volume 130, Issue 5 • CID: 056001 • <https://doi.org/10.1289/EHP10343>

Strupenost za ljudi

- različni učinki na zdravje ljudi, povezani z izpostavljenostjo PFAS v splošni populaciji

- Diabetes
- Rak mod in ledvic
- Povišan tlak v nosečnosti
- Ulcerozni colitis
- Učinki prenatalne izpostavljenosti v mladosti
- Debelost pri mlajših ženskah
- Bolezni ščitnice
- Osteoartritis
- ↓ število semenčic pri mladih moških
- ↑ holesterol
- ↑ sečna kislina
- ↑ jetrni encimi
- ↓ porodna teža
- ↓ odziv na cepiva

Porast zaskrbljujočih izidov raziskav



<https://www.eea.europa.eu/publications/emerging-chemical-risks-in-europe>

Najpogostejša področja raziskav in dokazov:

- Onesnažena pitna voda bližini industrijskih proizvodnih obratov ali odlagališč odpadkov, *Environ. Sci. & Technol.* 2011, (45) 8015 –8021
- Hrana, zlasti ribe iz onesnaženih voda, predmeti, onesnaženi z embalažo in materino mleko, *Inter. J. Hyg. & Envir. Heath* 2009, (212) 239-270, *Environ. Sci. & Technol.* 2015, (49) 10466 -10473
- Hišni prah – zlasti pri otrocih Shoeibet al. 2011, *Environ. Sci. & Technol.* (45) 7999 - 8005
- Izpostavljenost na delovnem mestu: proizvodnja ali izdelava storitev ali neposredna uporaba PFAS, prodaja oblačil, obdelava odpadkov, *Environ. Sci.*, 2013, 15, 814-822
-

Rešitve ?

Regulacija (restrikcija)

What are ECHA and the EU doing?

RESTRICTIONS

The production and use of some PFAS are already restricted as part of the EU's chemicals legislation.

STUDIES

ECHA and the European Commission are carrying out studies related to PFAS used in fire-fighting foams and textiles.

SAFER ALTERNATIVES

Placing them on the REACH Candidate List of substances of very high concern drives their substitution.

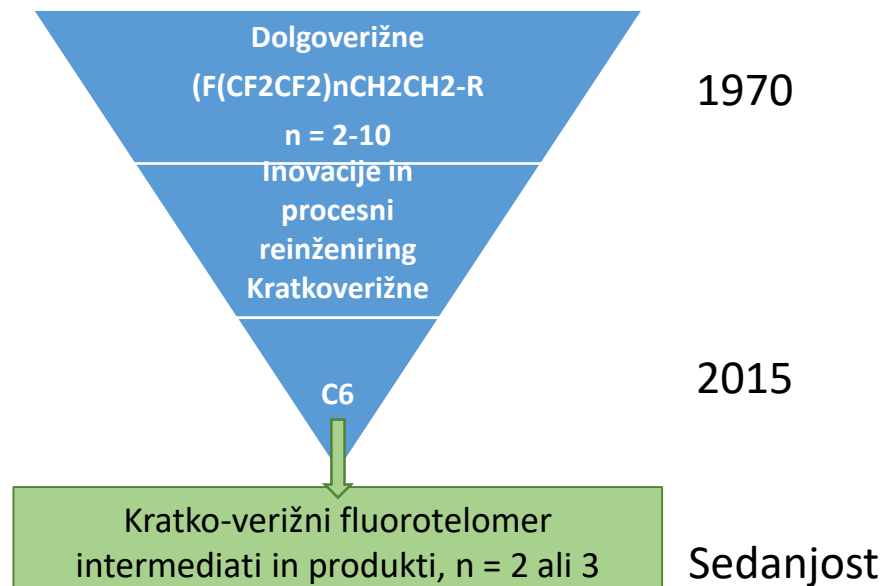
ASSESSMENT

Since 2014, ECHA has assessed PFAS in groups rather than one by one to speed up the process. ECHA's database contains more than 2 000 PFAS.

[Check our database](https://echa.europa.eu/information-on-chemicals/registered-substances)

PFAS Consultation

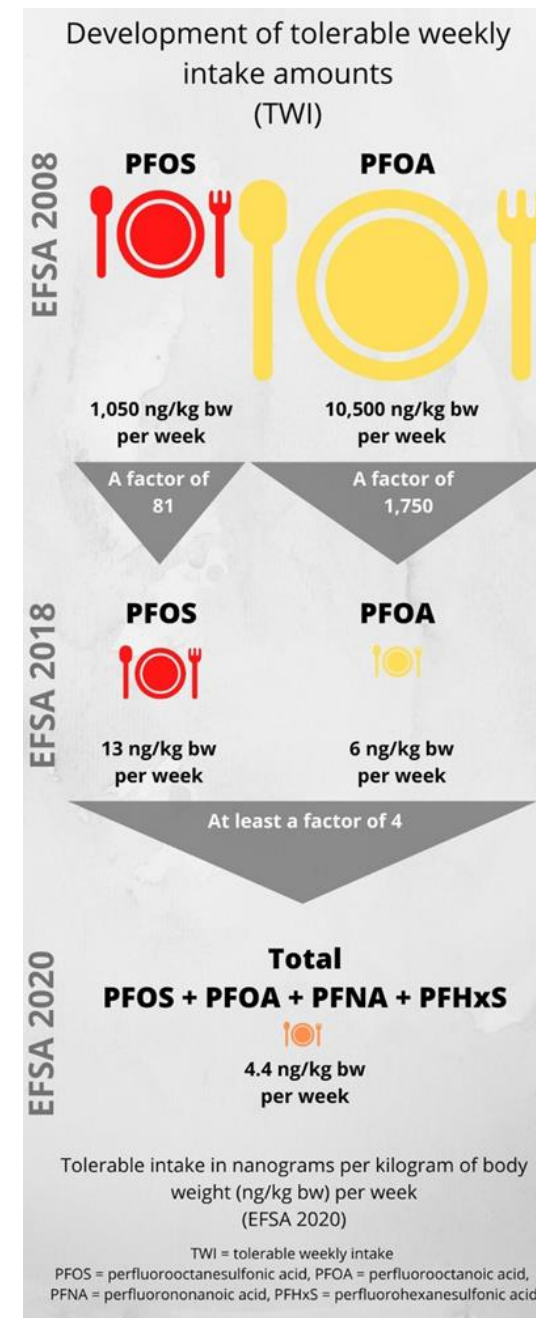
Proposal for a restriction



- Zamenjava posameznih PFAS, ki so prepoznani kot nevarni, z drugimi morda enako nevarnimi PFAS s skoraj neznano kronično toksičnostjo ne more biti rešitev
- Edina možna rešitev je prehod na alternative brez fluora za vse aplikacije, pri katerih PFAS niso nujni
- Problem: proizvodnja PFAS, kjer je regulacija povsem odsotna (Rusija, Kitajska, Indija)



ChemSec (The International Chemical Secretariat)
 „Horizon 2020 research and innovation programme“
https://pfas.chemsec.org/?gclid=CjwKCAjw-eKpBhAbEiwAqFLOmr2DJNUms8zr8gPmwMtZyeNCdbfm9o_hFNtPGgUsS2kTiy_UHg_mA5hoCBkoQAvD_BwE#investigate



Rešitve ?

Informiranje, izobraževanje, ozaveščanje javnosti, proizvajalcev,...

PFAS | KAJ MORATE VEDETI?

1 Možni viri izpostavljenosti

- Hišni prah
- Poklicna izpostavljenost (proizvodnja PFAS, gasilci, voskanje smuči, kromiranje...)
- Izdelki za domačo rabo
- Izdelki za osebno nego
- Materino mleko
- Onesnažena pitna voda
- Onesnažena hrana
- Prehrambeni izdelki

2 Kako lahko PFAS vstopijo v vaše telo?

- Z vdihavanjem
- Z absorpcijo skozi kožo
- Z zaužitjem

3 Kako lahko PFAS vplivajo na vaše zdravje?

4 Kako lahko zmanjšate izpostavljenost PFAS?

- Izogibajte se hitri hrani, ki je zavita v papir, odporen na maščobo
- Izogibajte se hitri hrani, pakirani v karton, kot so npr. nekatere Skatle za pico
- Izogibajte se nenujni uporabi sprejev za zaščito pred vodo na oblačilih in obutvi
- Pri nakupu izdelkov, ki lahko vsebujejo PFAS, zahtevajte izdelke brez PFAS. Prepričajte se, da izdelki ne vsebujejo nobene PFAS (in ne samo PFOS in PFOA)
- V spletnih aplikacijah preverite, ali določen izdelek vsebuje PFAS ali ne
- Namesto za posodo s prevleko proti prijetanju se raje odločite za posodo iz keramike, nerjavečega jekla ali litega železa
- Če živite v ali blizu območju, za katera je znano onesnaženje s PFAS:
 - Izogibajte se ribolovu in uživanju rib iz teh območij
 - Izogibajte se uživanju domačega sadja in zelenjave iz teh območij. Zahtevajte od lokalnih oblasti, da opravijo oceno ravnosti PFAS in se prepričajte, da hrana ne vsebuje PFAS
 - Upoštevajte navzete upravljavcev vodnih virov in vodovoda

Kje jih je mogoče najti?

PFAS je mogoče najti v potrošniških izdelkih, kot so embalaža za hrano in kuhinjska posoda; izdelki za osebno nego, kot so šamponi, zobne nitke, laki za nohte in ličila za oči; čistilna sredstva, oblačiljeno pohištvo, usnje in preproge ter izdelki za domačo rabo, kot so barve, laki, maziva in tesnila.

Najdemo jih lahko tudi v onesnaženih pitni vodi (v bližini proizvodnih obratov, obratov za obdelavo odpadkov, gasilskih in vojaških vadišč ter letališč) ali hrani (ribe, meso, sadje in sadni izdelki, jajca, zelenjava in rastlinski proizvodi zaradi onesnaženosti zemlje).

science and policy for a healthy future

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 733032

www.hbm4eu.eu

f @ t i n

HBM4EU coordinator:
German Environment Agency hbm4eu@uba.de

Knowledge Hub coordinator:
European Environment Agency hbm4eu@eea.europa.eu

PFAS or Forever Chemicals

Poly- and perfluoroalkyl substances (PFAS) are manufactured chemicals that are widely used throughout society and found in the environment. PFAS resist degradation, persist in the environment and some stay in our bodies. For several of them, there are serious health concerns.

Where can they be found?

Rain clothes, textiles and surface treatments

Non-stick coatings for frying pans and pots, and food packaging

Fire-fighting foams and fire protective clothing

Chrome plating, paints and construction materials

How do some PFAS affect your health?

Studies have shown that PFAS have contaminated rainwater, drinking water and groundwater

Tests indicate some PFAS weaken the immune system

Can also be found in most people's blood and is linked to elevated cholesterol levels

Some PFAS can damage the liver

Studies show that some PFAS contribute to the development of kidney and testicular cancer

PROBLEMI zaradi PFAS kemikalij

KAKO PRIDEJO V NAŠE TELO?

- Kuhanje v posodi s prevleko proti prijemanju
- Izdelki, ki vsebujejo PFAS
- Hrana in voda, onesnažena s PFAS
- PFAS v zraku in prahu

ZDRAVSTVENE TEŽAVE, POVEZANE S PFAS

- Rak ledvic in testisov
- Visok krvni tlak in preeklampsijska
- Povšilen holesterol
- Nišja porodna teža dojenčkov
- Znanjšon odziv na cepiva pri otrocih

PFAS

- Okrajšava za per- in poli-fluoroalkilne spojine, ki se uporabljajo v izdelkih, kot so posoda s prevleko proti prijemanju, določena embalaža za hrano, vodoodporna oblačila in preproge, odporne proti madežem
- Imenujejo se tudi "večne kemikalije", saj njihova razgradnja v okolju traja do 1000 let

KAJ LAHKO STORIMO?

POSAMEZNIKI – izogibajte se izdelkom, ki vsebujejo PFAS in oblikovalce politik prosite za omejitve ali prepoved uporabe PFAS

ZDRAVSTVENI DELAVCI – svetujte pacientom, kako se izognjejo PFAS in podprite omejitve uporabe PFAS

INDUSTRIJA – opustite PFAS in se izogibajte nenujni uporabi

OBLIKOVALCI POLITIK – omejite ali prepovedajte uporabo PFAS

Office of Sustainability
Cornell University

Program on Reproductive Health
and the Environment

HEALTHY ENVIRONMENTAL ACTION

FIGO
International Federation of Gynecology and Obstetrics

Throwaway Packaging, Forever Chemicals

European wide survey of PFAS in disposable food packaging and tableware

Ne pozabimo: Tragična zapuščina PFAS



50 Years of Deception: A Timeline of Companies Hiding Health Risks of PFAS

<https://www.ewg.org/research/decades-polluters-knew-pfas-chemicals-were-dangerous-hid-risks-public>

<p>1956</p> <p>Stanford University study finds that PFAS binds to proteins in human blood.</p>	<p>1965</p> <p>DuPont rat study shows liver damage and increased spleen size.</p>	<p>1978</p> <p>3M concludes that PFOS and PFOA, a PFAS chemical used to make DuPont's Teflon, "should be regarded as toxic."</p>	<p>1989</p> <p>3M study finds elevated cancer rates among PFAS workers.</p>
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Celovečerni film: Temne vode (Dark waters)

MARK RUFFALO ANNE HATHAWAY TIM ROBBINS BILL CAMP VICTOR GARBER BILL PULLMAN

DARK WATERS

RELEASED IN THEATERS 26 FEBRUARY

Dark Waters tells the shocking story of how a heroic attorney fought to uncover a dark secret hidden by one of the world's largest corporations, who poisoned a town for decades with a PFAS chemical. Rob Bilott (played by Mark Ruffalo) risked everything to hold DuPont to account and bring justice to the 70,000 victims of one of the biggest cover-ups in American history.

This briefing highlights how forever chemicals affect Europe and outlines actions that the European Union and National Governments can take in response.

THE PROBLEM OF PFAS IN EUROPE

Per- and Poly-fluoroalkyl Substances, more commonly known as PFAS, are a particularly harmful chemical group. They are virtually impossible to clean up or get rid of. Around 100,000 sites in Europe are potentially emitting PFAS. PFAS accumulate and persist in our environment. It can take up to 1,000 years for PFAS to be broken down by nature.

FOREVER CHEMICALS ARE EVERYWHERE

- CONTAMINATING OUR ENVIRONMENT
- BUILDING UP IN OUR BODIES
- IMPACTING OUR HEALTH, CONTRIBUTING TO ILLNESS AND CANCER

Many PFAS are highly mobile. They are in soil, plants and animals across Europe and have been detected in water, including drinking water, in Austria, Belgium, Denmark, France, Germany, Italy, the Netherlands and Sweden.

This contamination is a potentially serious public health problem. Forever chemicals that didn't exist several decades ago are found today in our blood. Scientists have identified a probable link between PFOA exposure and diagnosed high cholesterol, thyroid disease, testicular and kidney cancer, and pregnancy-induced hypertension.

PFAS CONTAMINATE EVERYDAY ITEMS

- TAKAWAY AND OTHER FOOD PACKAGING
- NON-STICK COATINGS
- STAIN-FREE AND WATERPROOF CLOTHES
- SUN-CREAM AND COSMETICS

Forever chemicals are in all sorts of everyday household products. There are also several hotspots in Europe around industrial sites. The widespread use of PFAS in industrial processes and products and their high contamination levels means that they are in everything and everywhere.

FOREVER CHEMICALS ARE A GENERATIONAL CATASTROPHE

- CONTAMINATING AIR, WATER AND FOOD ALL OVER THE WORLD
- IN ALMOST EVERYONE'S BLOOD
- CHILDREN AND FUTURE GENERATIONS ARE MORE AT RISK

Alarmingly, babies are now born with PFAS already in their bodies. These levels are often higher than their mother's. Children are far more sensitive than adults to toxic chemicals in the environment.

Doku film: Hudič, ki ga poznamo (The devil we know)

FROM THE TEAM THAT BROUGHT YOU FED UP & UNDER THE GUN

THE DEVIL WE KNOW

BUCKEY BAILEY

BUCKEY BAILEY

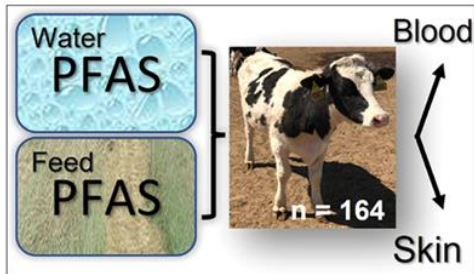
"A must-see" - New York Times
 "A blood-boiling eco-doc..." - Hollywood Reporter
 "One of the most genuinely scary films at Sundance this year..." - Movie City News
 "A riveting tale" - Variety



BUCKEY BAILEY



<https://www.ecocenter.org/> ECOLOGYCENTER



J. Agric. Food Chem. 2022, 70, 50, 15945–15954;
<https://doi.org/10.1021/acs.jafc.2c06620>

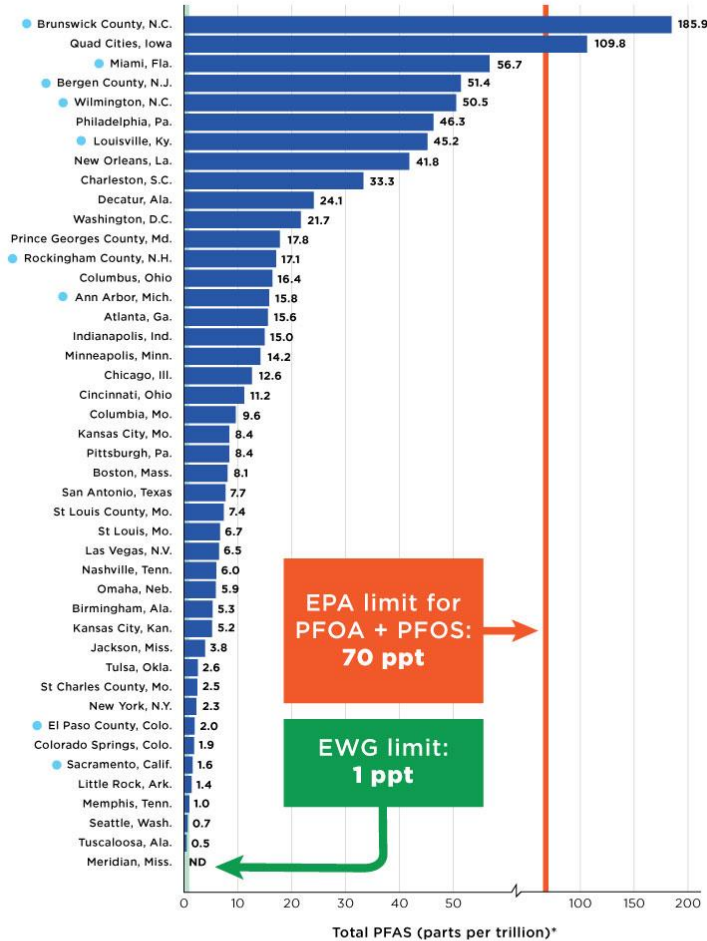
<https://www.youtube.com/watch?v=RvAOuhynhY> (trailer)

<https://www.youtube.com/watch?v=NJFbsWX4MJM> (dostopno)

<https://themeaningofwater.com/2022/06/05/why-dupont-executives-are-heartlessly-killing-people-and-wildlife-and-getting-away-with-it/>

ZDA – dejansko in domnevno onesnaženje

EWG TESTS FOUND TOXIC PFAS CHEMICALS IN TAP WATER IN 31 STATES AND D.C.



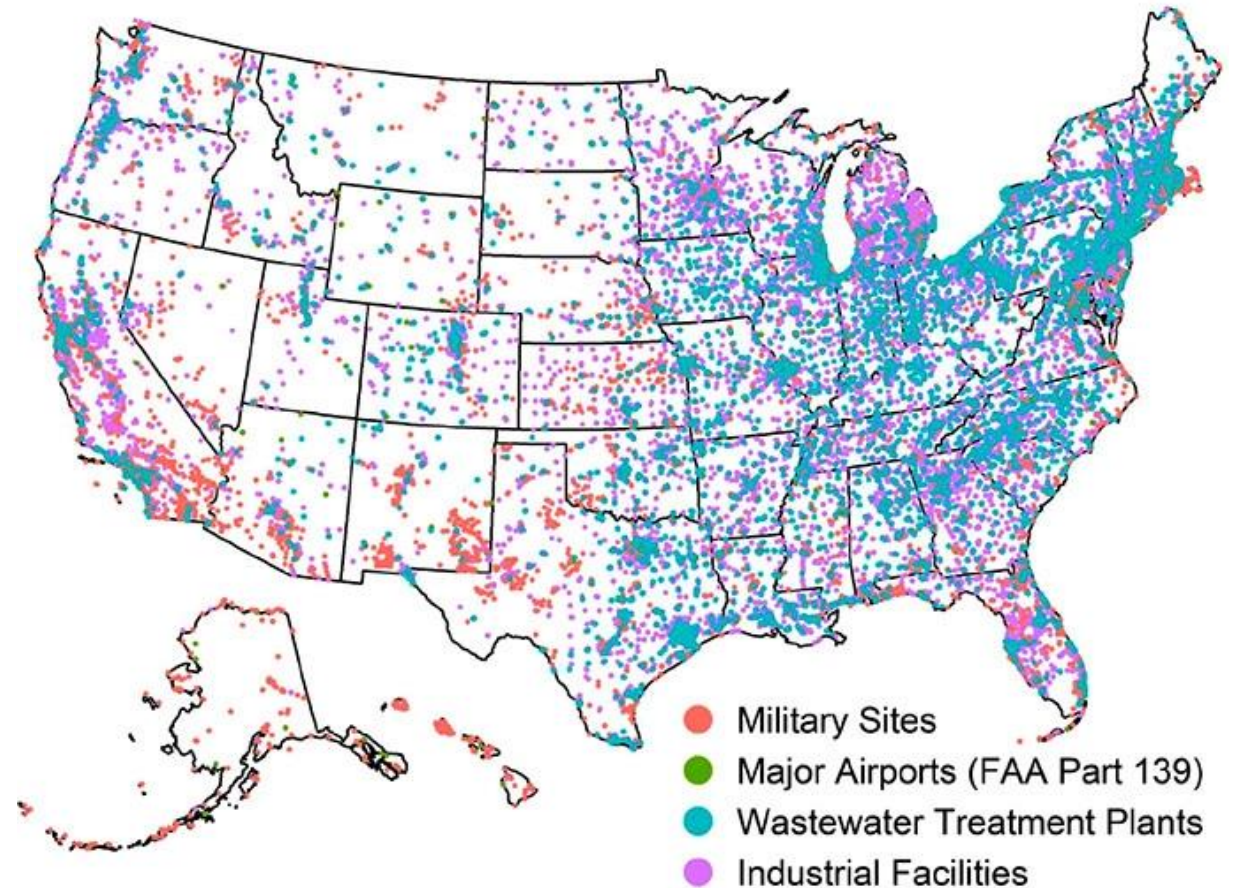
Source: EWG, from samples taken between May and December 2019.

● PFAS previously reported by EPA or State

*Sum of detections of 30 types of PFAS

Samples were taken by either EWG staff or local volunteers and analyzed by an independent accredited laboratory using a modified version of EPA Method 537. Details of all samples taken at each site and the precise sampling dates are in the tables in the Appendix.

Presumptive Contamination Sites (n=57,412)



„Večno onesnaženje“ tudi na stari celini

„Večno onesnaženje:

„Raziščite zemljevid evropskega onesnaženja s PFAS“

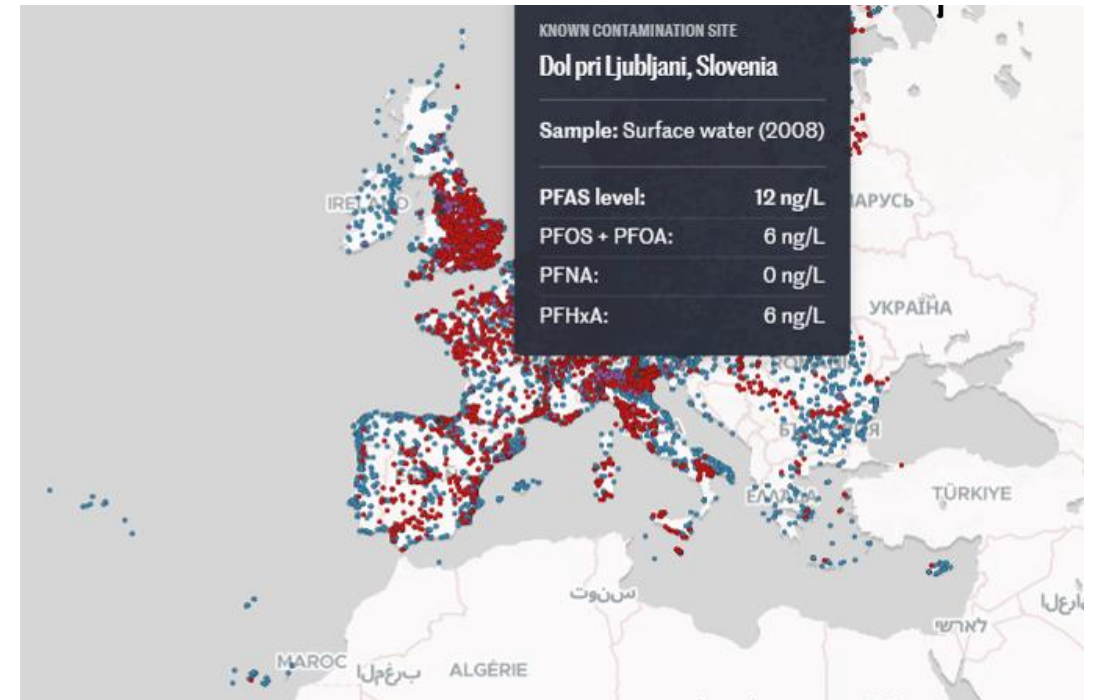
https://www.lemonde.fr/en/les-decodeurs/article/2023/02/23/forever-pollution-explore-the-map-of-europe-s-pfas-contamination_6016905_8.html



Le Monde

Ugotovitve

- 20 proizvajalcev PFAS
- 232 uporabnikov PFAS
- >17000 kontaminiranih lokacij (voda, zemlja, živi organizmi (2002-2023; >10 ng/L)
- >21000 domnevno kontaminiranih lokacij
- >2100 „hot-spot“ lokacij; (>100 ng/L)



● Known contamination ● Known PFAS User ● Presumptive contamination ◆ PFAS manufacturing facility

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