Úvod do problému chemického znečištění

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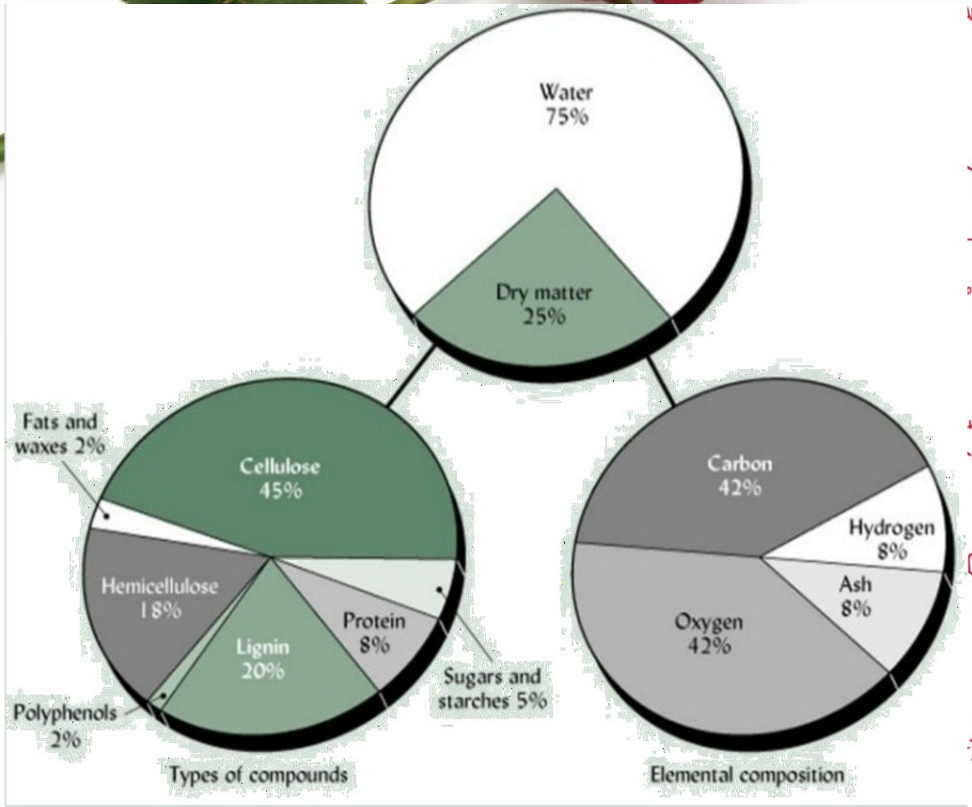
Seminář
4.10.2021

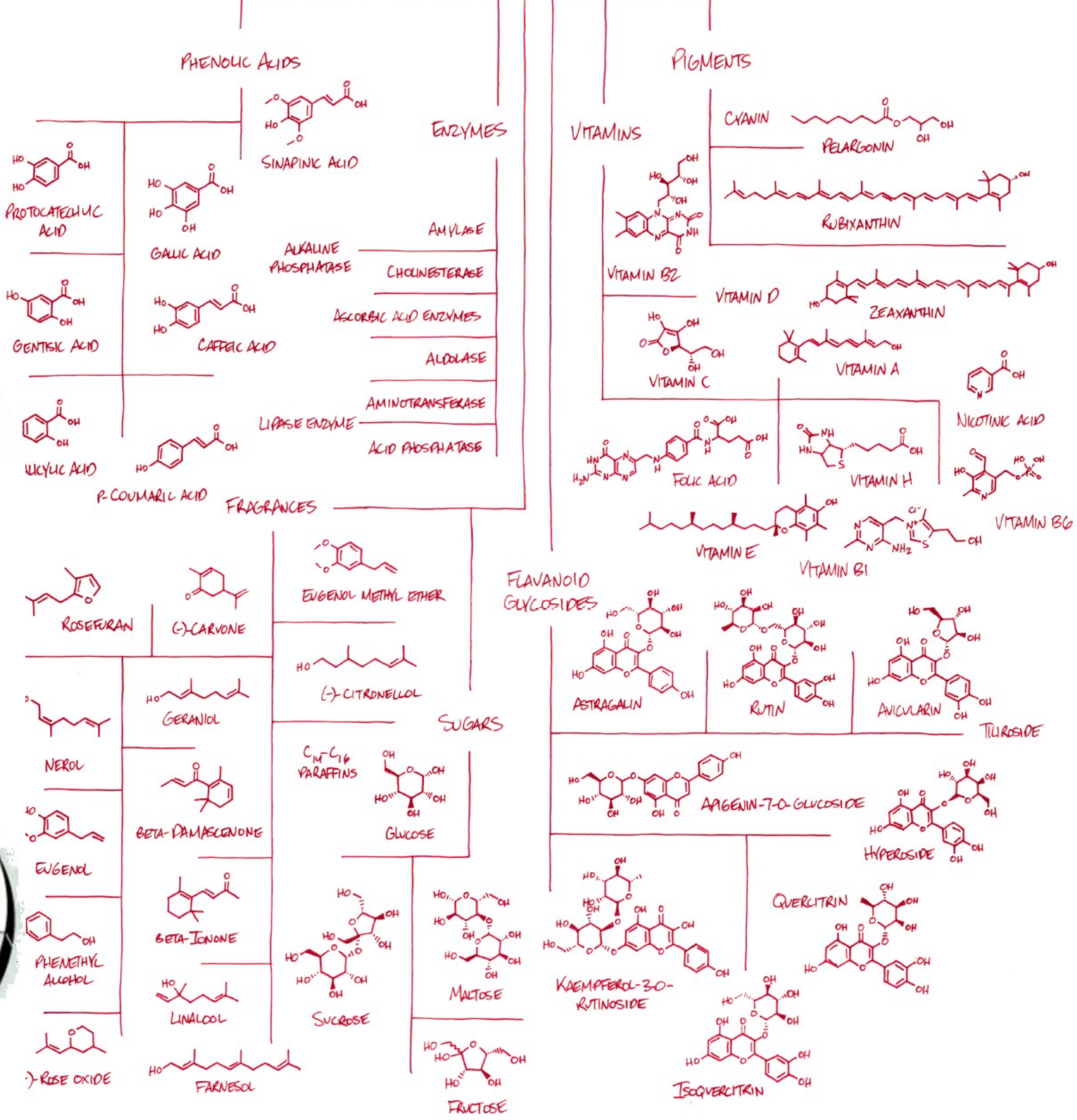
www.PollEv.com/lindan443

Je všechno kolem nás JEN chemie ?

Všechno kolem nás je chemie ... (?)

https://www.whatsinsidescjohnson.com/us/en/everything-is-chemistry-posters





Chemické látky

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Kolik (řádově) chemických látek zná lidstvo?

- deset tisíc
- sto tisíc
- milion
- deset milionů
- sto milionů
- ani jedna odpověď není správně

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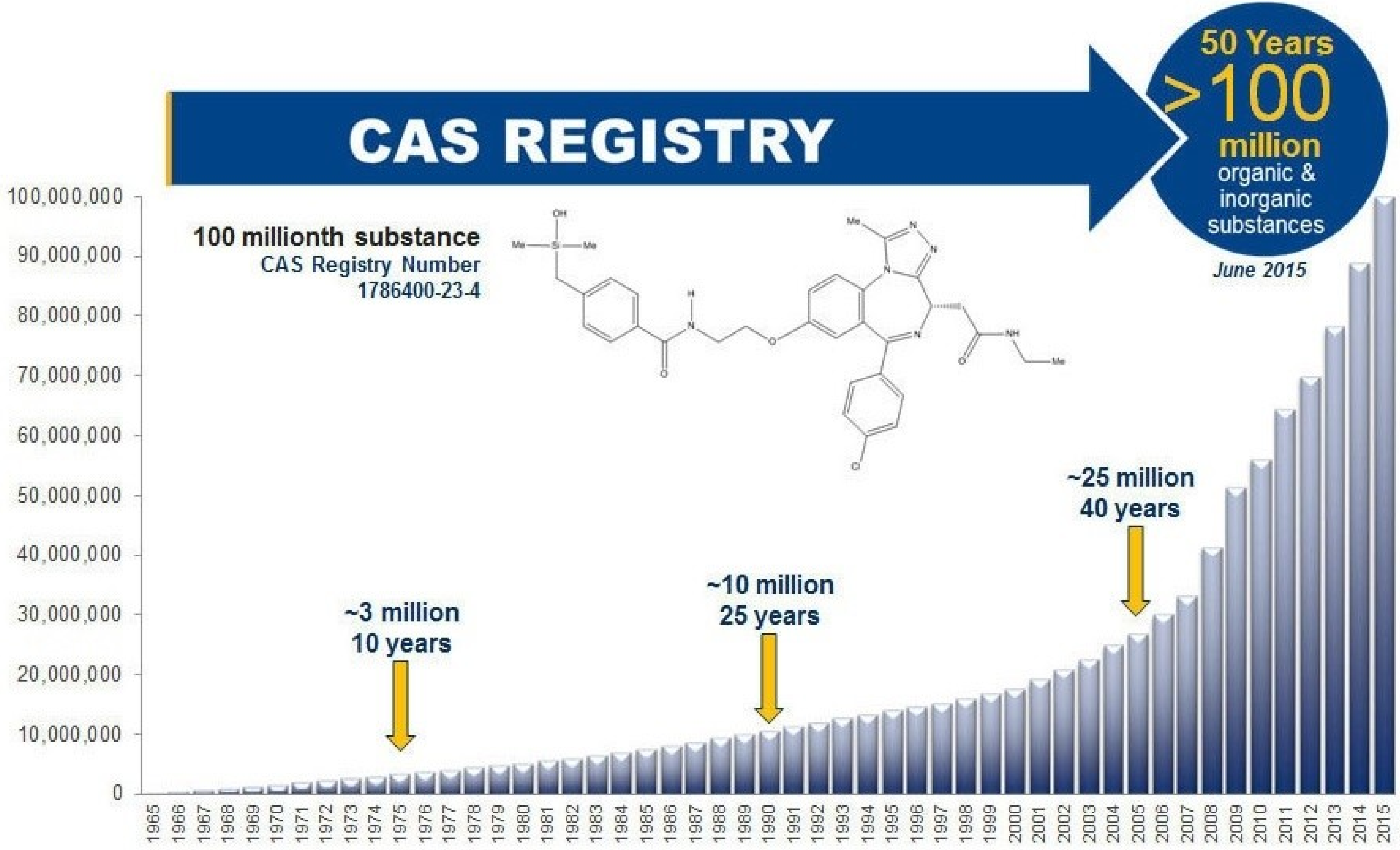
Chemické látky

- **svět kolem nás = chemie** (známe > 100 mil. chemických látek)



Chemické látky

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Kolik chemických látek (řádově) vyrábíme a používáme?

- sto
- tisíc
- deset tisíc
- sto tisíc
- milion
- ani jedna odpověď není správně

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Chemické látky

- lidstvo v rámci svých aktivit vyrábí a používá > 100 000 látek

ECHA > Information on Chemicals > EC Inventory

ECHA
EUROPEAN CHEMICALS AGENCY

EC Inventory

The EC inventory published below is a copy as received from the JRC in 2008 on the founding of ECHA. It is comprised of the following lists:

- **EINECS** (European INventory of Existing Commercial chemical Substances) as published in O.J. C 146A, 15.6.1990. EINECS is an inventory of substances that were deemed to be on the European Community market between 1 January 1971 and 18 September 1981. EINECS was drawn up by the European Commission in the application of Article 13 of Directive 67/548/EEC, as amended by Directive 79/831/EEC, and in accordance with the detailed provisions of Commission Decision 81/437/EEC. Substances listed in EINECS are considered phase-in substances under the REACH Regulation.
- **ELINCS** (European LIst of Notified Chemical Substances) in support of Directive 92/32/EEC, the 7th amendment to Directive 67/548/EEC. ELINCS lists those substances which were notified under Directive 67/548/EEC, the Dangerous Substances Directive Notification of New Substances (NONS) that became commercially available after 18 September 1981.
- **NLP** (No-Longer Polymers). The definition of polymers was changed in April 1992 by Council Directive 92/32/EEC amending Directive 67/548/EEC, with the result that substances previously considered to be polymers were no longer excluded from regulation. Thus the No-longer Polymers (NLP) list was drawn up, consisting of such substances that were commercially available between 18 September 1981 and 31 October 1993.

Last updated 11 August 2017. Database contains 106211 unique substances/entries.

› Filter the list

Page 1 of 2,125 | 50 Items per Page | Showing 1 - 50 of 106,211 results. | ← First | Previous | Next | Last →

Name	EC no.	CAS no.	Molecular Formula	Description
"mercurous oxide"	239-934-0	15829-53-5	Hg2O	
((2-ethyl-1-oxohexyl)oxy)-(1-phenyl-1,3-decanedionyl)dioctyl stannane RHODORSIL ACCELERATEUR 2025	422-920-5	-		RHODORSIL ACCELERATEUR 2025
((4-phenylbutyl)hydroxyphosphoryl)acetic acid	412-170-7	-		SQ 26999

https://echa.europa.eu/cs/information-on-chemicals/ec-inventory

M U N I

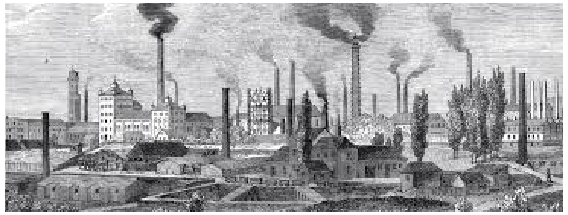
Člověk vždy používal ChL, produkoval odpad a čelil následkům

- skládky odpadů známé již ze starověku
- olověná potrubí v římském impériu
- **průmyslová revoluce** - drastický nárůst produkce ChL a produkce odpadu
- polovina 18. století – znečištění ovzduší, londýnský smog, nemoci
- začátek 19. století – zpracování nafty, produkce organických chemikálií, umělá hnojiva, olovo do benzínu
- polovina 19. století – boom pesticidů - **green revolution**, využívání HMs
- od 60. let – zlepšení nakládání s odpady, legislativa
- od 70. a 80. let environmentální legislativa, regulace ChL
- produkce ChL a odpadu stále roste s růstem populace a GDP

ECHA EUROPEAN CHEMICALS AGENCY

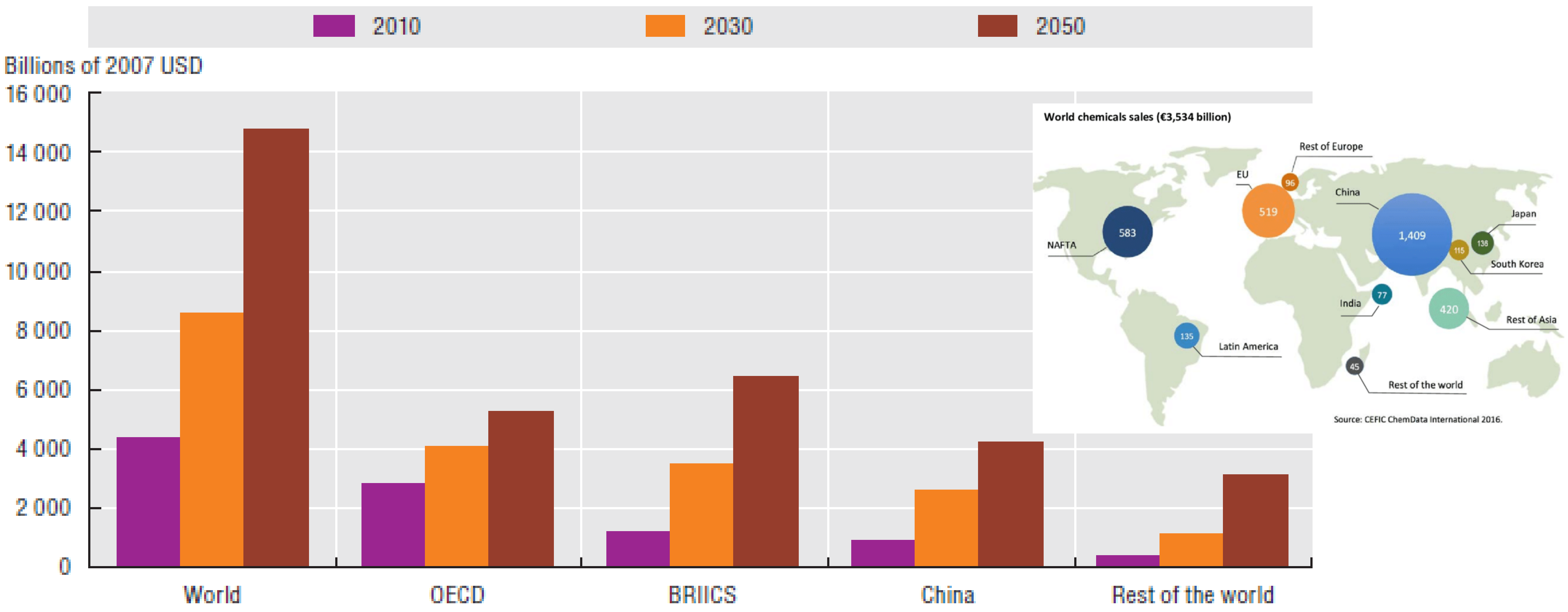
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

efsa European Food Safety Authority



Produkce chemických látek roste

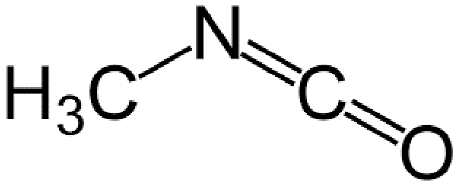
Figure 6.13. **Projected chemicals production by region (in sales): *Baseline*, 2010-2050**

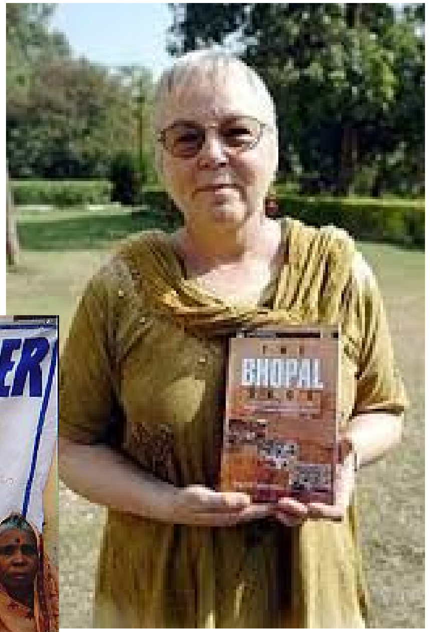


OECD (2012)

Bhopal

- továrna společnosti Union Carbide, výroba pesticidů pro Indii
- 2-3.12.1984 havárie zásobníku methylisokyanátu
- mrak vysoce toxického plynu těžšího než vzduch – MIC, CO, NOx, HCN, MMA, CO_2, $COCl_2$ ...
- > 8000 úmrtí během týdne
- 100-200 tisíc osob s trvalými zdravotními následky

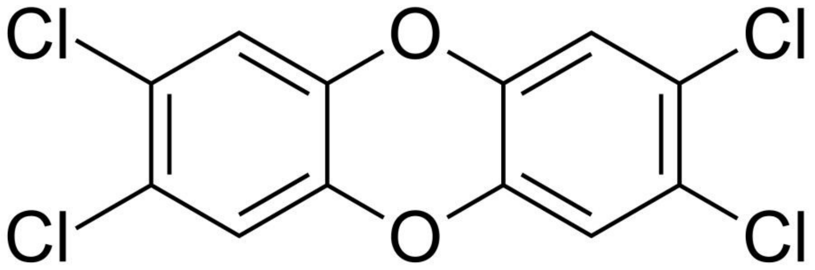




Eckerman (2005)

Seveso

- 10.7.1976 únik chemikálií z továrny na výrobu pesticidů
- cca 6 tun chemikálií s cca 1 kg 2,3,7,8-TCDD
- zamoření oblasti cca 18 km^2
- 37.000 lidí s následky otravy



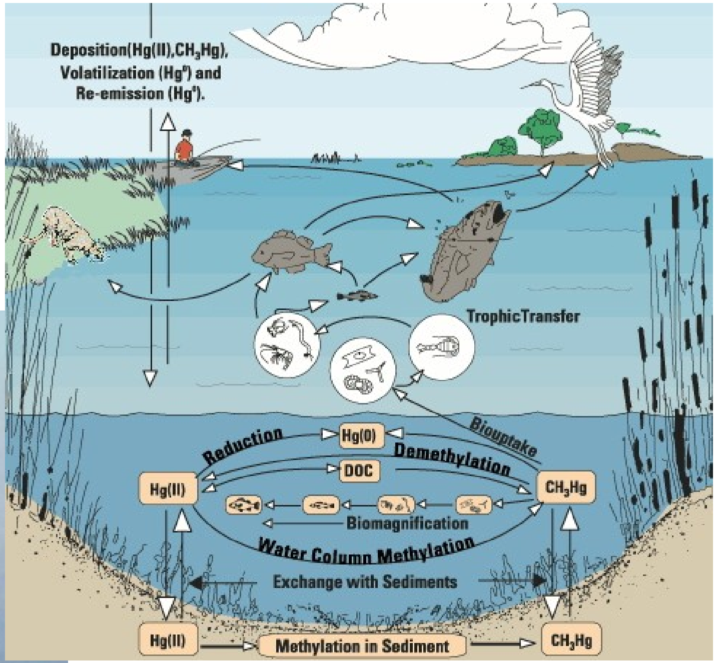
Eskenazi et al. (2018)

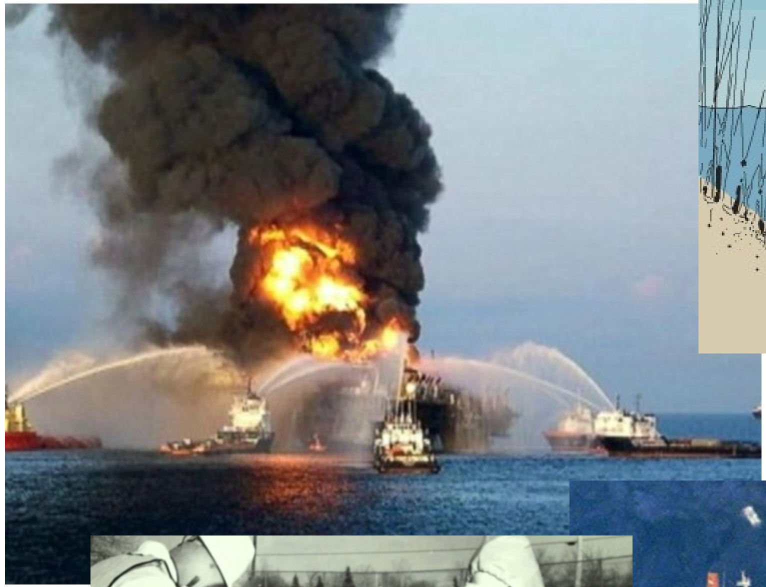
Další chemické katastrofy

- Minamata 1950’s
- Love Canal 1950’s
- Agent Orange 1961-71
- Chernobyl 1986
- Exxon Valdez 1989
- Gulf war 1991
- Deepwater Horizon 2010
- Fukushima 2011

- desítky dalších ...

https://en.wikipedia.org/wiki/List_of_industrial_disasters

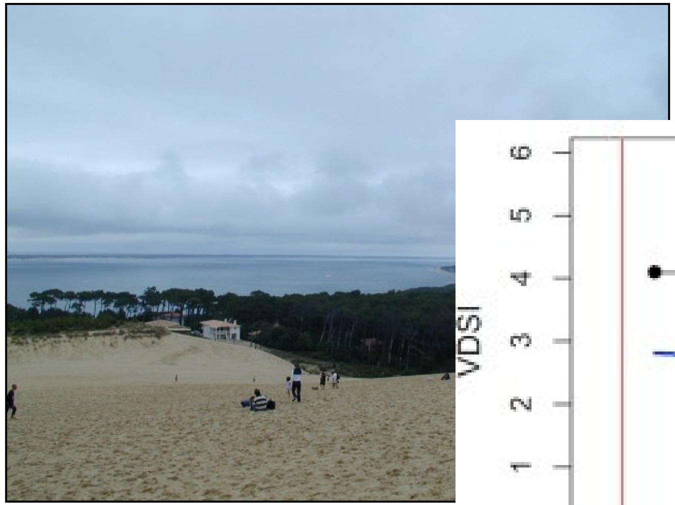


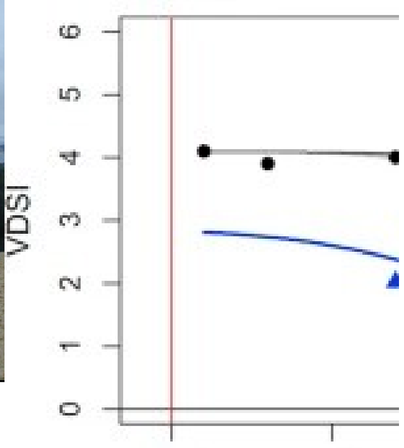


Management při chemických katastrofách

nejen katastrofy ...
Tributylcín

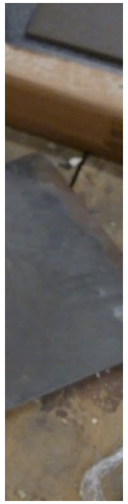
- biocid, široké využití
- uvolnění do mořskýc
- bioakumulace, meta
- vliv na hormonální s

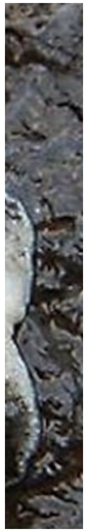




Early 1970s	Rapid increase in the use of TBT antifouling paints on vessels of all sizes and first reports of imposex in marine snails (Blaber, 1970; Smith, 1971)
1976–81	Repeated failure of larval settlement leads to near collapse of oyster fishery, Arcachon Bay, France
1982	France introduces legislation prohibiting the use of TBT paints on small vessels
1985	First controls introduced in United Kingdom limiting concentrations of TBT in paints
1986	Bryan *et al.* (1986) report widespread imposex in dogwhelks on southern coast of United Kingdom, linked to TBT
January 1987	United Kingdom announces further restrictions on TBT content of applied antifouling paint
May 1987	United Kingdom introduces ban on retail sale of TBT paint for use on vessels < 25 m and on fish cages
June 1987	PARCOM Recommendation 87/1 calls for similar ban over entire convention area (Northeast Atlantic)
1988	United States introduces restrictions. Waldock *et al.* (1988) highlight significance of inputs from shipyards
1989	Restrictions introduced in Canada, Australia and New Zealand
1991	Harmonised ban on retail sale of TBT paint introduced at European Union level
1994	Early reports of imposex in whelks from offshore areas of North Sea linked to shipping activity
1995	Ministerial declaration of fourth North Sea conference (Esbjerg) commits to working for global phase-out of TBT paint within IMO
1997	Concept of global phase out of organotin containing paints agreed at MEPC's 40th session
1998	Draft mandatory regulations aimed at such a phase-out adopted. OSPAR (Convention for the Protection of the Marine Environment of the Northeast Atlantic) prioritises organotins for action to cease all releases. Cessation of all releases of organotins to marine environment, under OSPAR's hazardous substances strategy in 2020
November 1999	Deadlines for phase-out adopted under IMO Assembly Resolution A.895(21)
2001	Text of International Convention on the Control of Harmful Anti-fouling Systems to be finalised. In 2003 worldwide prohibition on new application of organotin antifoulants to all vessels and in 2008 the existing organotin antifouling coatings will be replaced on all vessels worldwide

EEA (2001)



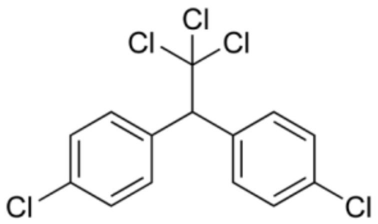


Schøyen et al. (2019)

nejen katastrofy ...

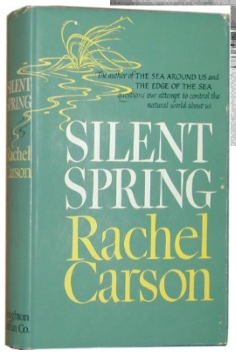
DDT

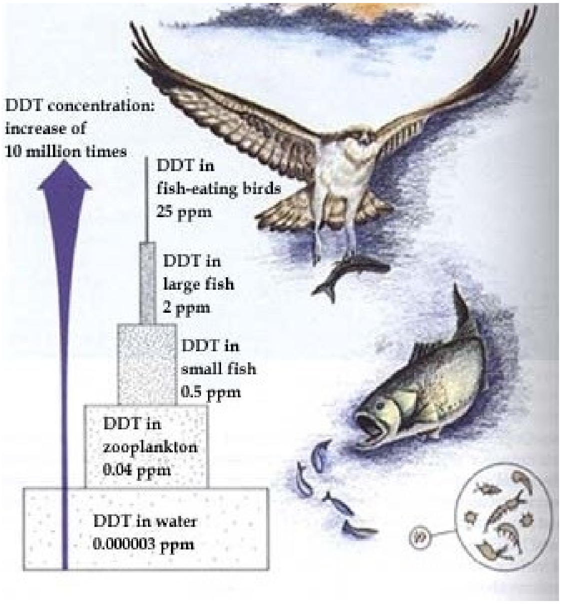
1874



1939

1962

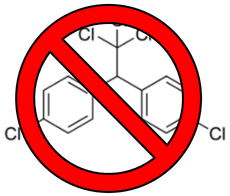


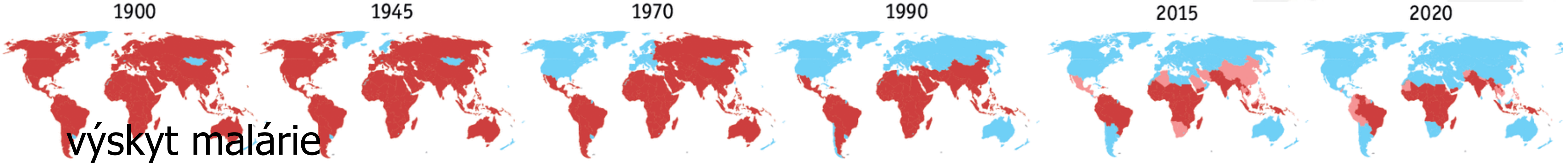


1970

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

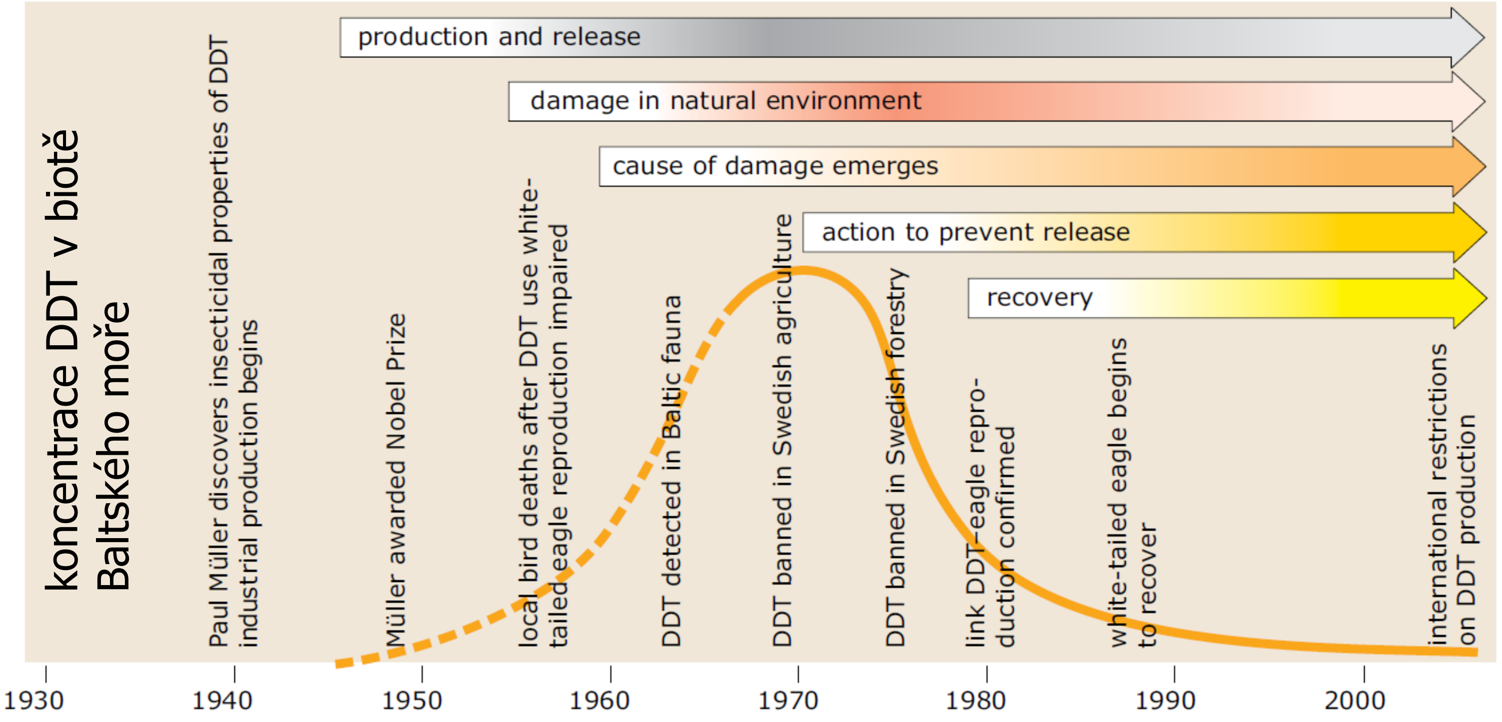
1972



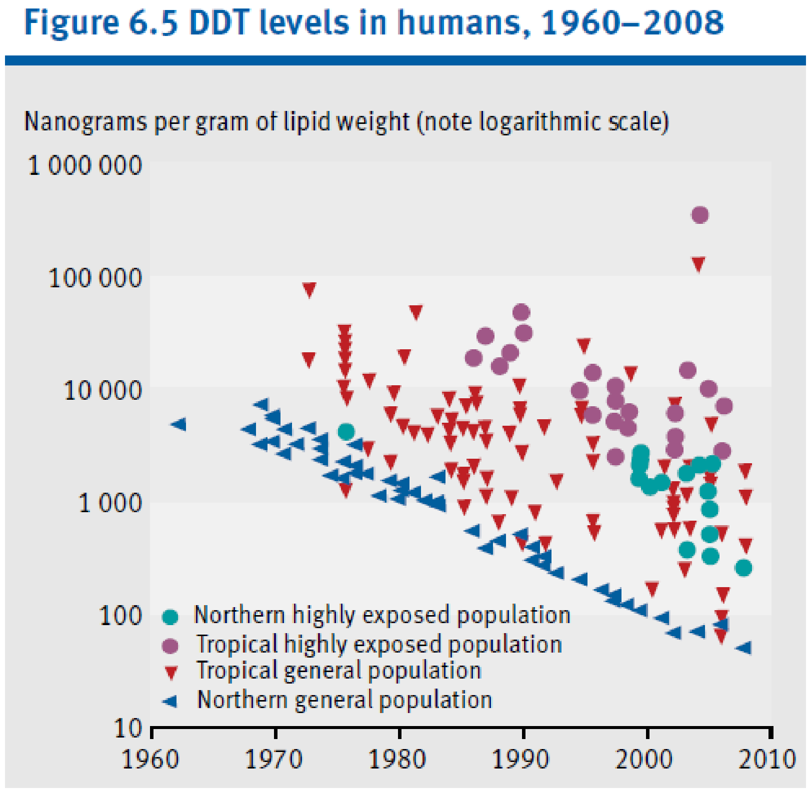


výskyt malárie

Ne všechny příběhy končí špatně ...

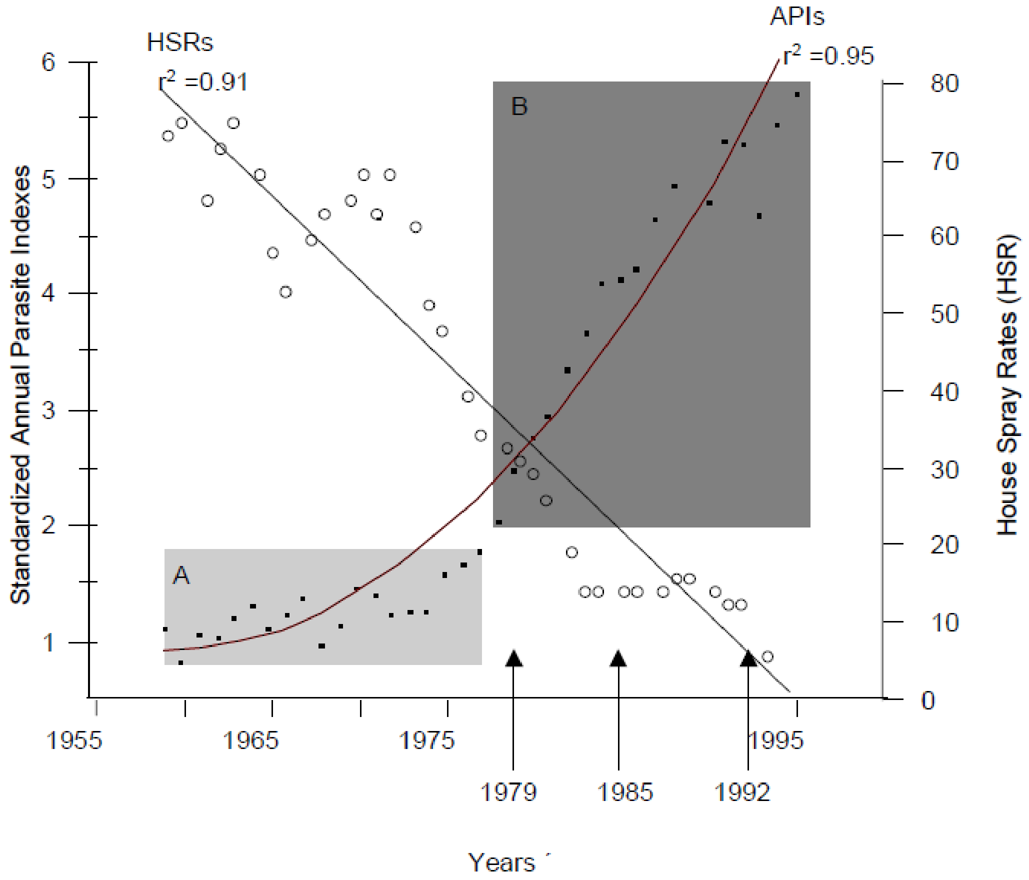


EEA (2013)



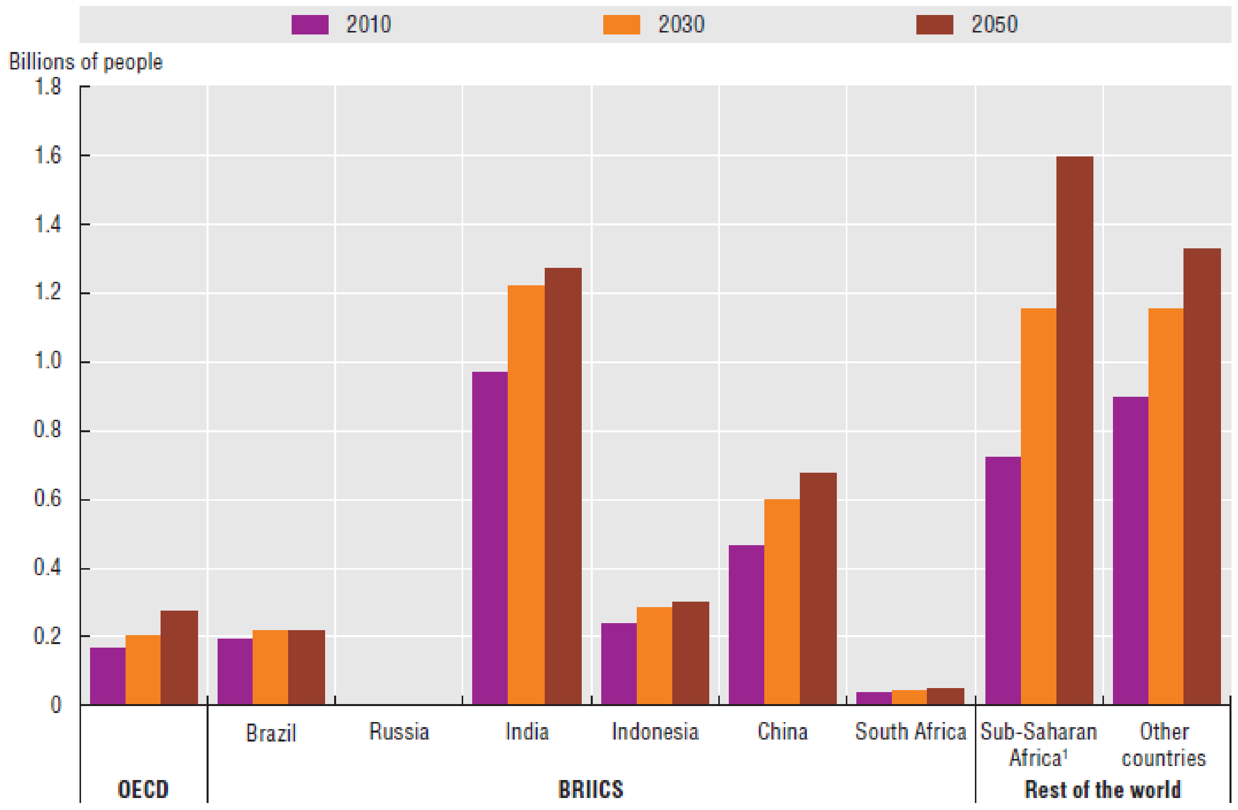
UNEP (2012)

i když ...

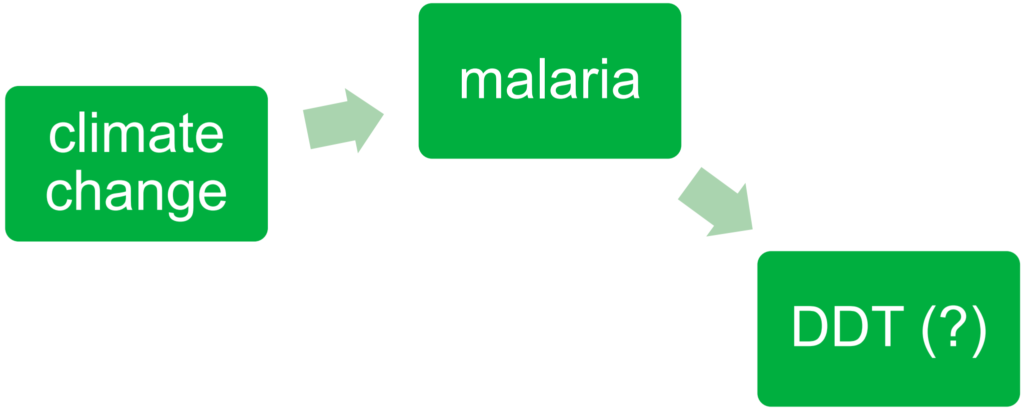


Roberts (1997)

Figure 6.14. **Potential population at risk from malaria: *Baseline*, 2010-2050**

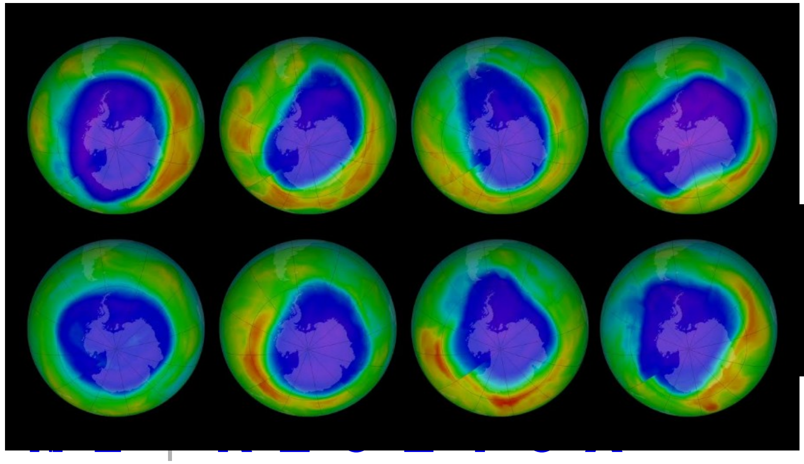


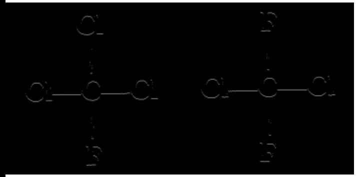
OECD (2012)



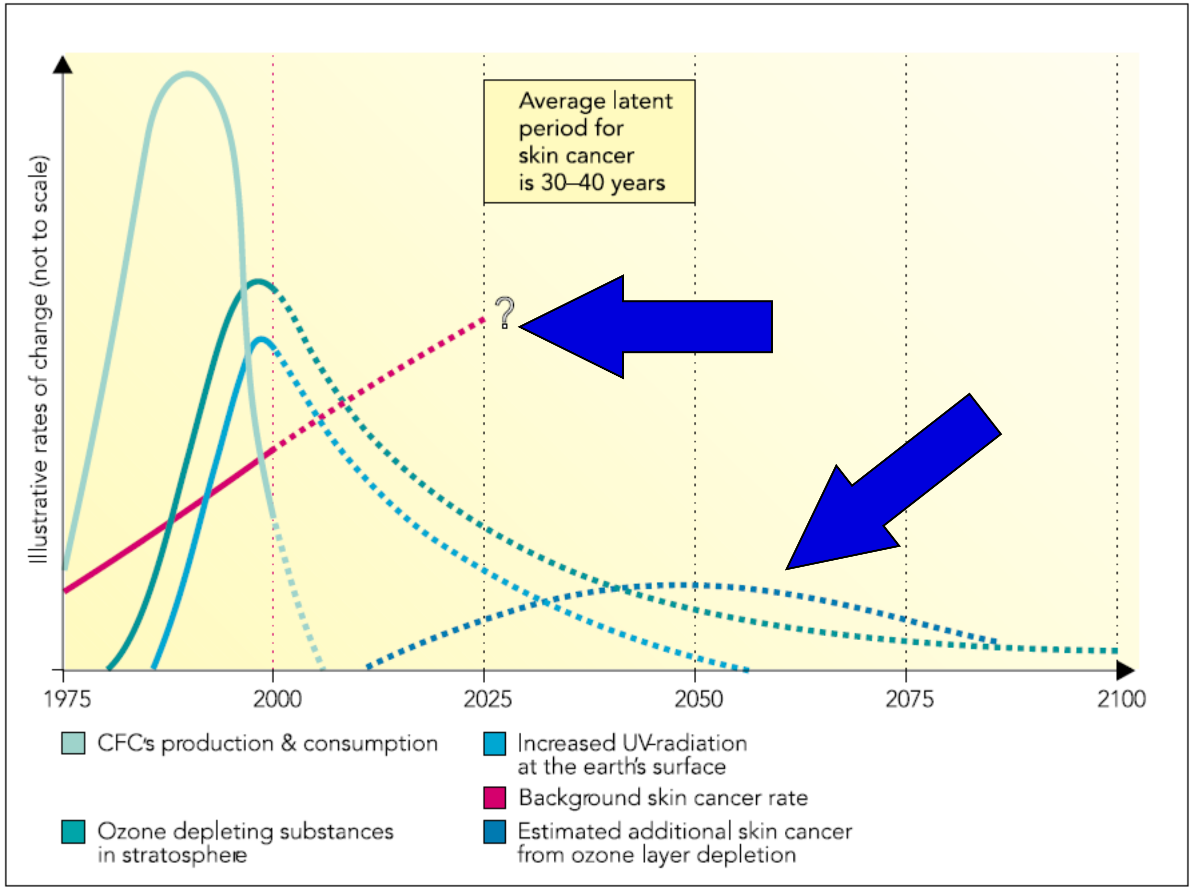
Ne všechny příběhy končí špatně, i když ...

1907	Laboratory experiments by Weigert on the decomposition of ozone photosensitised by chlorine
1934	*Ditto* by Norrish and Neville
1973	Global survey of CFCs by Lovelock *et al.* showing their distribution in the atmosphere worldwide
1974	Molina and Rowland publish their theoretical arguments that CFCs would be destroying the ozone layer
1977	United States bans CFCs in aerosols based on 'reasonable expectation' of damage, followed by Canada, Norway and Sweden.
1977	Research-oriented 'world plan of action on the ozone layer' agreed, overseen by UNEP
1980	European decision restricting use of CFCs in aerosols, but rising use in refrigerators, etc. marginalises this restriction
1985	UNEP Vienna Convention for the protection of the ozone layer agrees research, monitoring, information exchange and restrictions if and when justified
1985	Farman, Gardiner and Shanklin publish results showing hole in ozone layer over Antartica
1987	Montreal Protocol on protection of the ozone layer is signed, with phasing out of ozone depleting substances for both developed and developing countries within different timescales
1990s	Increasing finance to developing countries to help them reduce their dependence on ozone depleting substances
1997	Amendments to the Montreal Protocol in order to restore levels of chlorine by 2050–60
1999	Beijing Declaration calling for efforts to stop illegal trade in ozone depleting substances





EEA (2001)

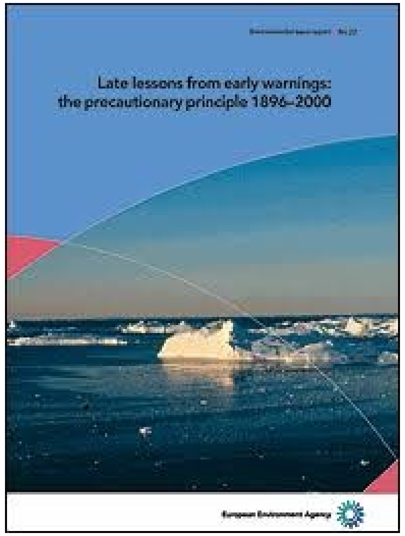


This graph illustrates the approximate time lags between CFC production, the resulting depletion of the stratospheric ozone layer and subsequent extra penetration of UV radiation and the impact this will eventually have on increasing the background rate of skin cancer, given the 30-40 year average latent period for such cancers. Reality is far more complex than this schematic illustration. For example, there are other ozone-depleting chemicals (HCFCs, HFCs and methyl bromide); the ozone hole varies with latitude, time of the year and meteorological conditions; the increased UV radiation varies between different wavelengths and with latitude and cloud cover; and the skin cancer excess comes on top of a rising background rate of skin cancer, with differential effects on the different types of skin cancer, such as malignant melanoma and non-malignant skin cancers. Human behaviour is also a determining effect in skin cancer. Health effects also include cataracts and immune response suppression. However, the figure illustrates the main relationships and time lags between CFC production and skin cancer, and the 'success' in stopping CFC production and averting much more skin cancer from ozone depletion than what is now expected. (Slaper, *et al.*, 1996).

Příběhy - “Late Lessons from Early Warnings”

- olovo v benzínu, MTBE v benzínu
- rtuť a minamata
- azbest ve stavebnictví
- tributylcín
- PCBs v průmyslu
- freony a ozonová vrstva
- antibiotika a mikrobiální resistence
- hormony a „jako“-hormony (BPA)
- kauza dietylstilbestrol
- kouření a rakovina
- pesticidy (DDT, neonikotinoidy,)
- ...

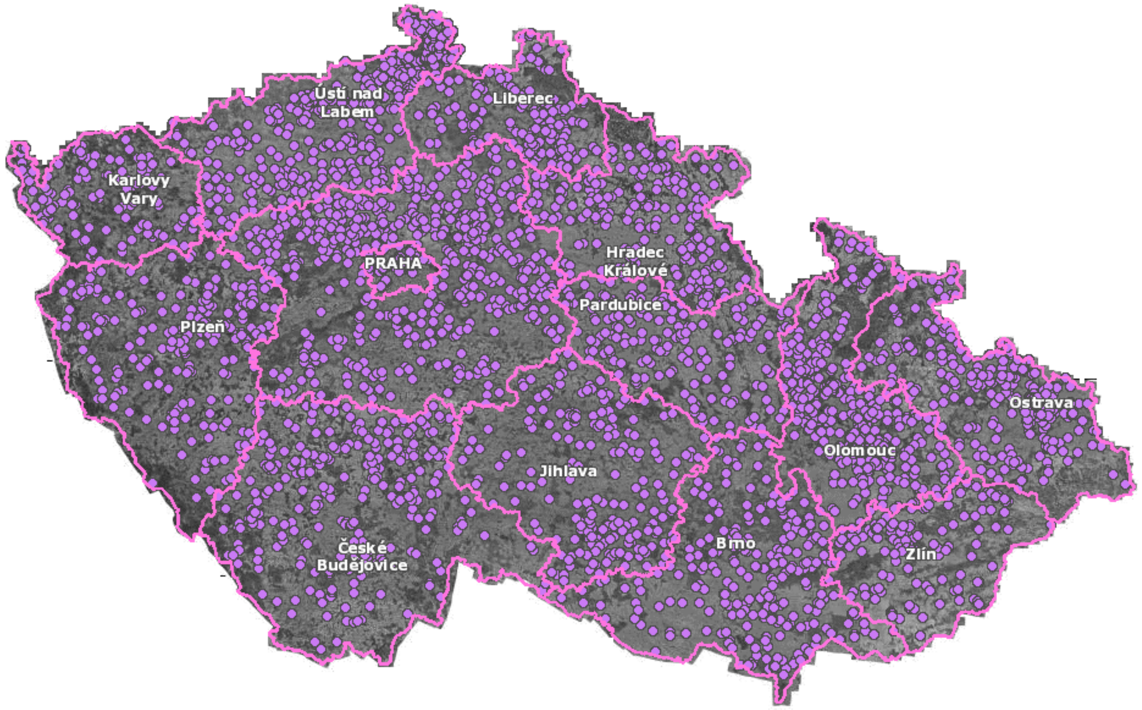
2013

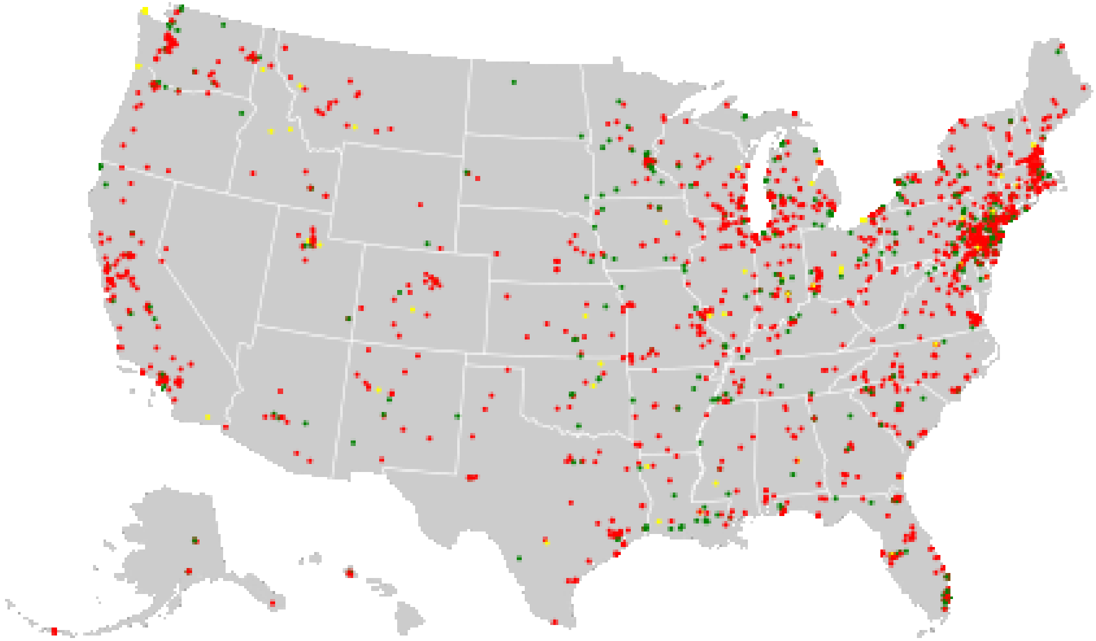


2002

Kontaminovaná místa

- v EU až 3,5 mil kontaminovaných míst, 0,5 mil vážně
- v ČR kolem 10 tisíc kontaminovaných míst http://www.sekm.cz/
- USA – superfund sites
- ...



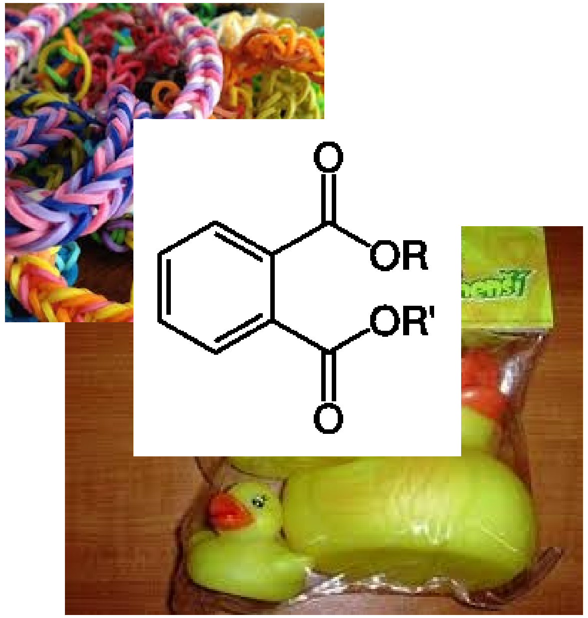


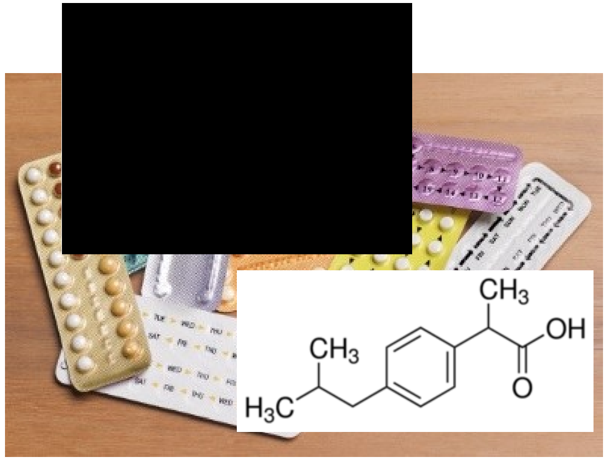
Kontaminovaná místa

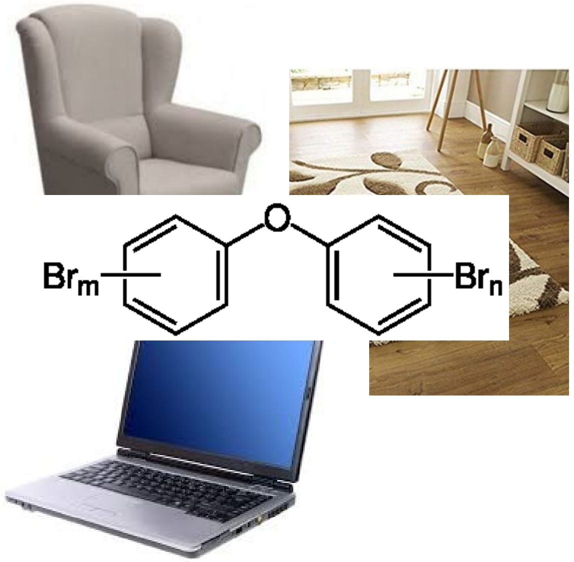
Blacksmith Institute (2006)

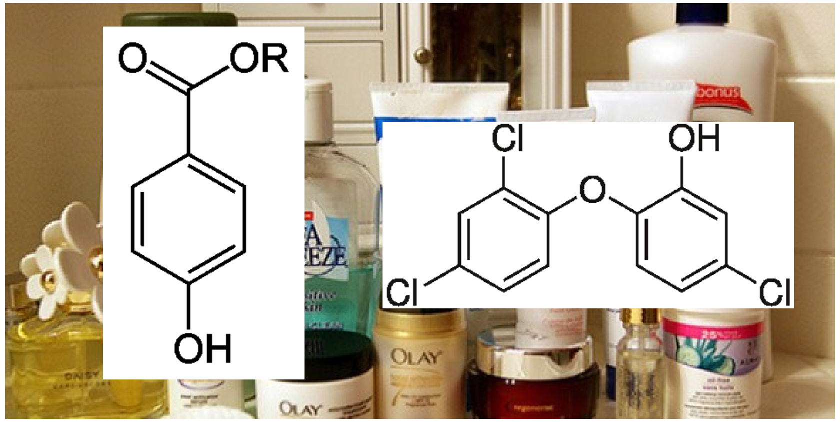
https://www.thoughtco.com/worst-polluted-places-on-earth-1204101
https://www.livescience.com/30353-most-polluted-places-earth.html
https://www.scientificamerican.com/slideshow/10-most-polluted-places-in-the-world/

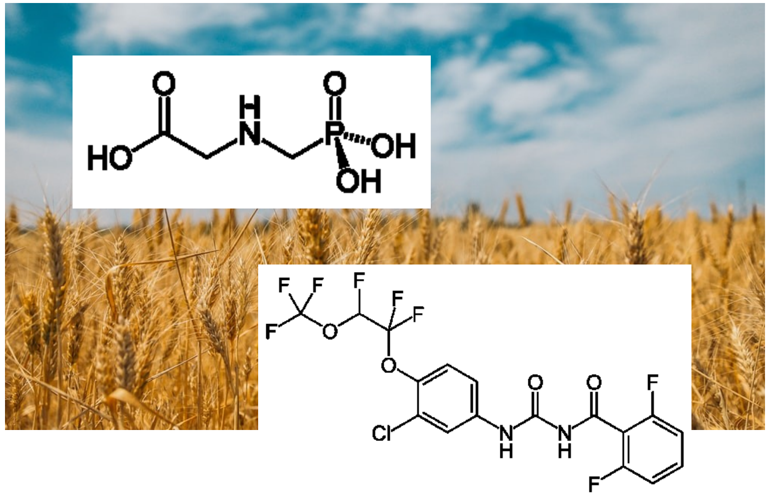
Pomalé uvolňování a působení ChL



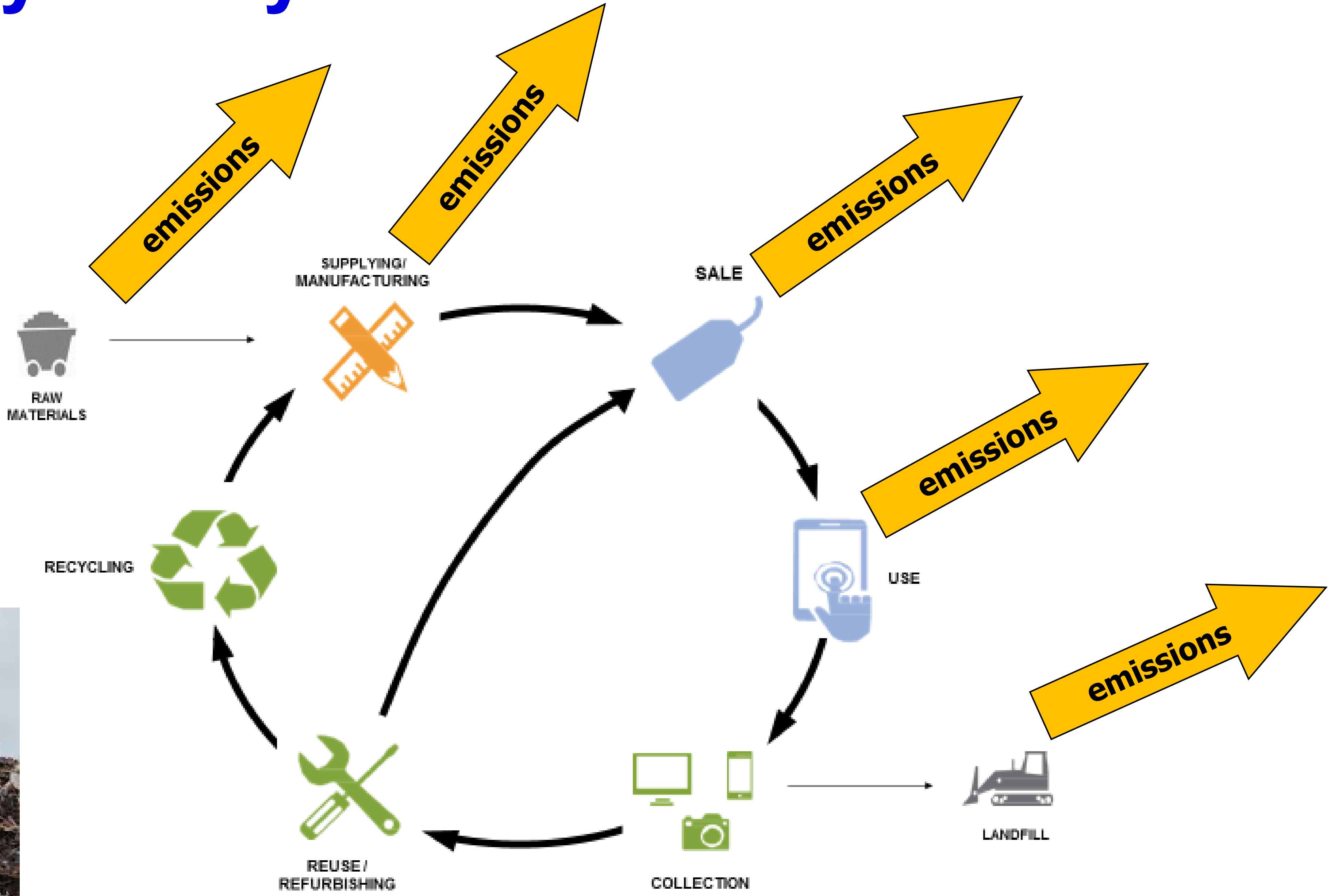








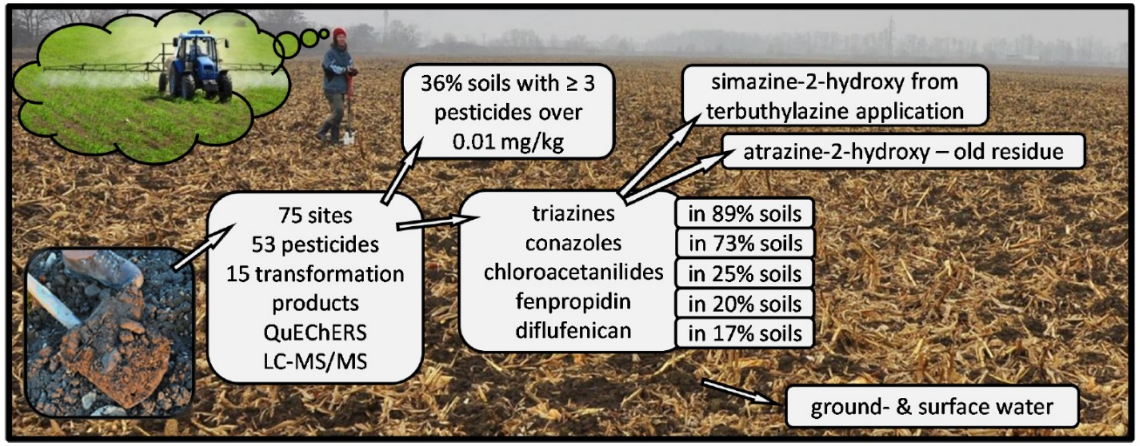
Životní cyklus výrobku

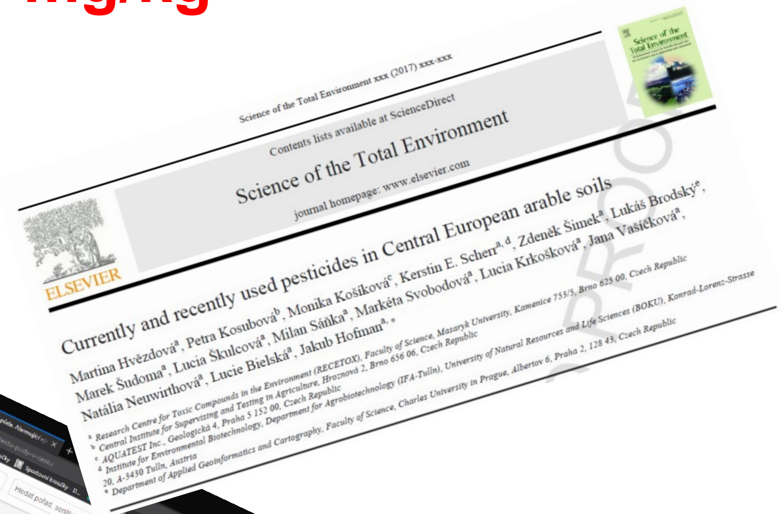


Směsi – koktejly polutantů

Výsledky průzkumu půd 2015

- **81% půd s alespoň jedním pesticidem nad 0.01 mg/kg**
- **36% půd s ≥ 3 pesticidy nad 0.01 mg/kg**





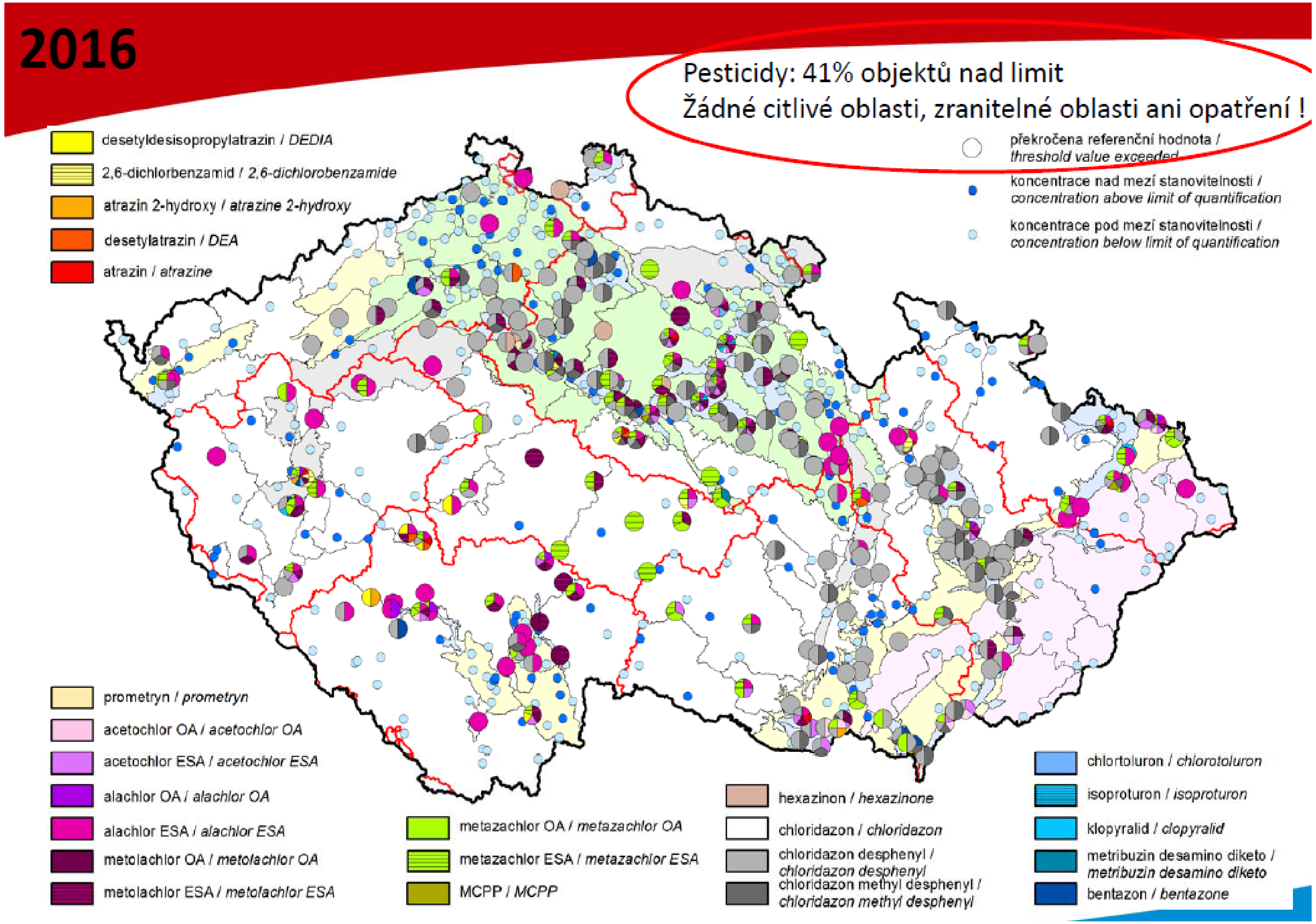
https://www.stream.cz/adost/10028599-zamorena-puda-alarmujici-vysledky-testu-pudy-v-cesku

Směsi – koktejly polutantů

Výsledky monitoringu vod ČR 2014-2016

- 43% objektů
  nad limit 0.1 µg/L
  pro jednotlivý pesticid

- 31% objektů
  nad limit
  pro sumu pesticidů



Proč asi uhynula tato ryba?

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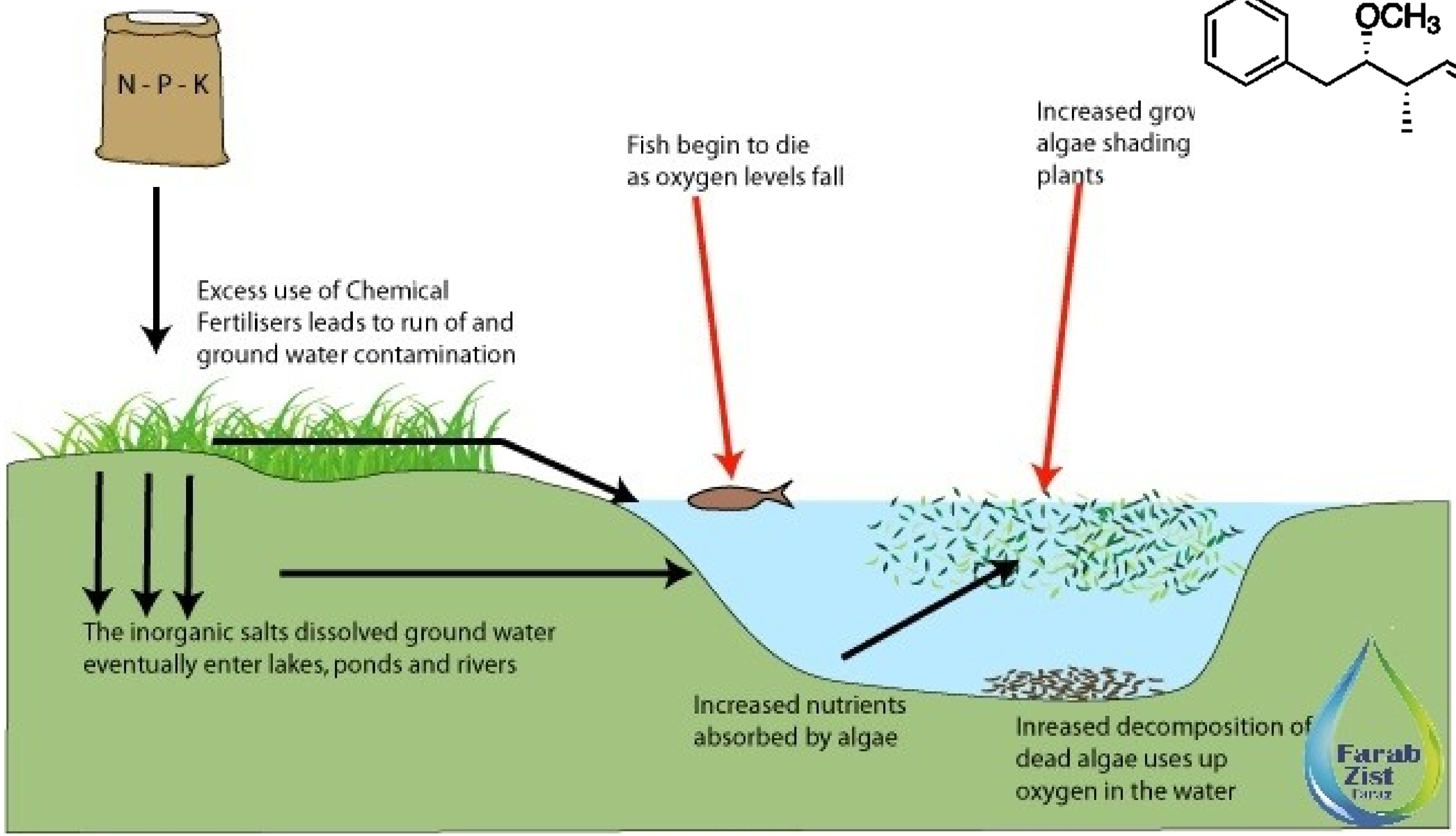
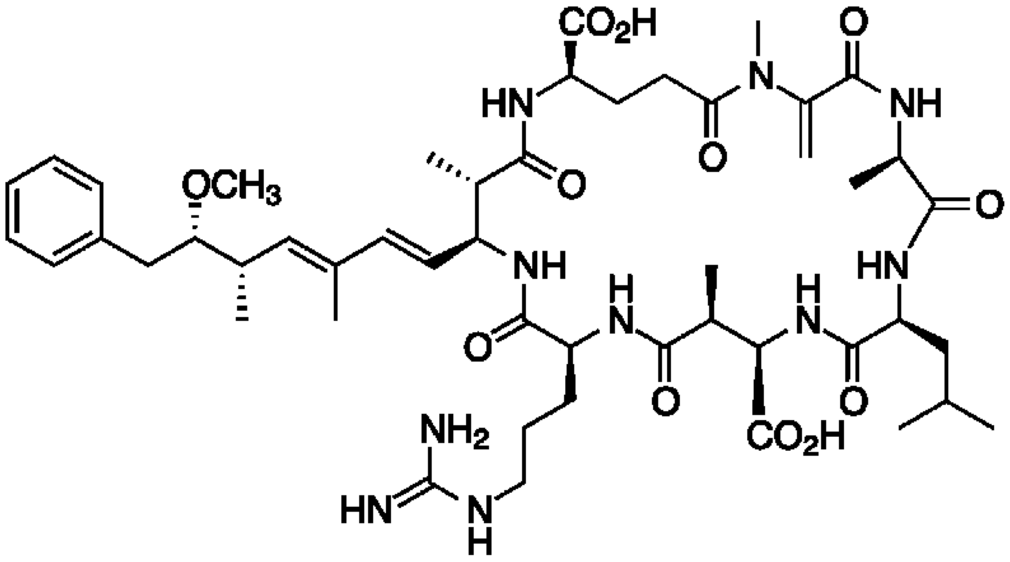
Proč uhynula tato ryba?





eutrofizace
saprobita

toxiny

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Jaké skupiny látek znečišťujících ŽP vás napadají?

Globální chemické znečištění

Průmyslové chemikálie

Pesticidy

Odpady

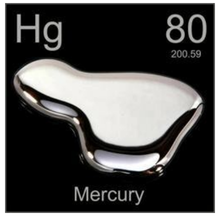
Léky

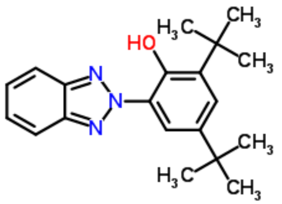
Plasty

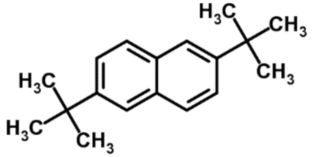
Vedlejší produkty činností

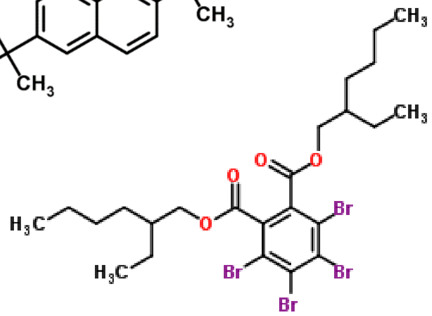
Produkty denní spotřeby

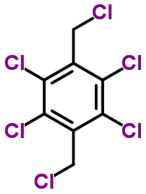
atd .....

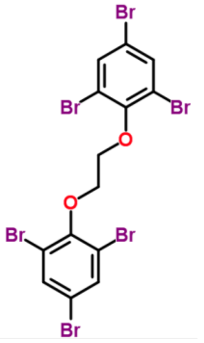


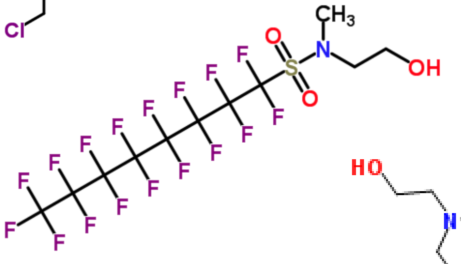


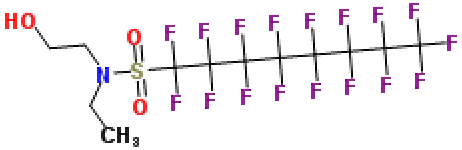








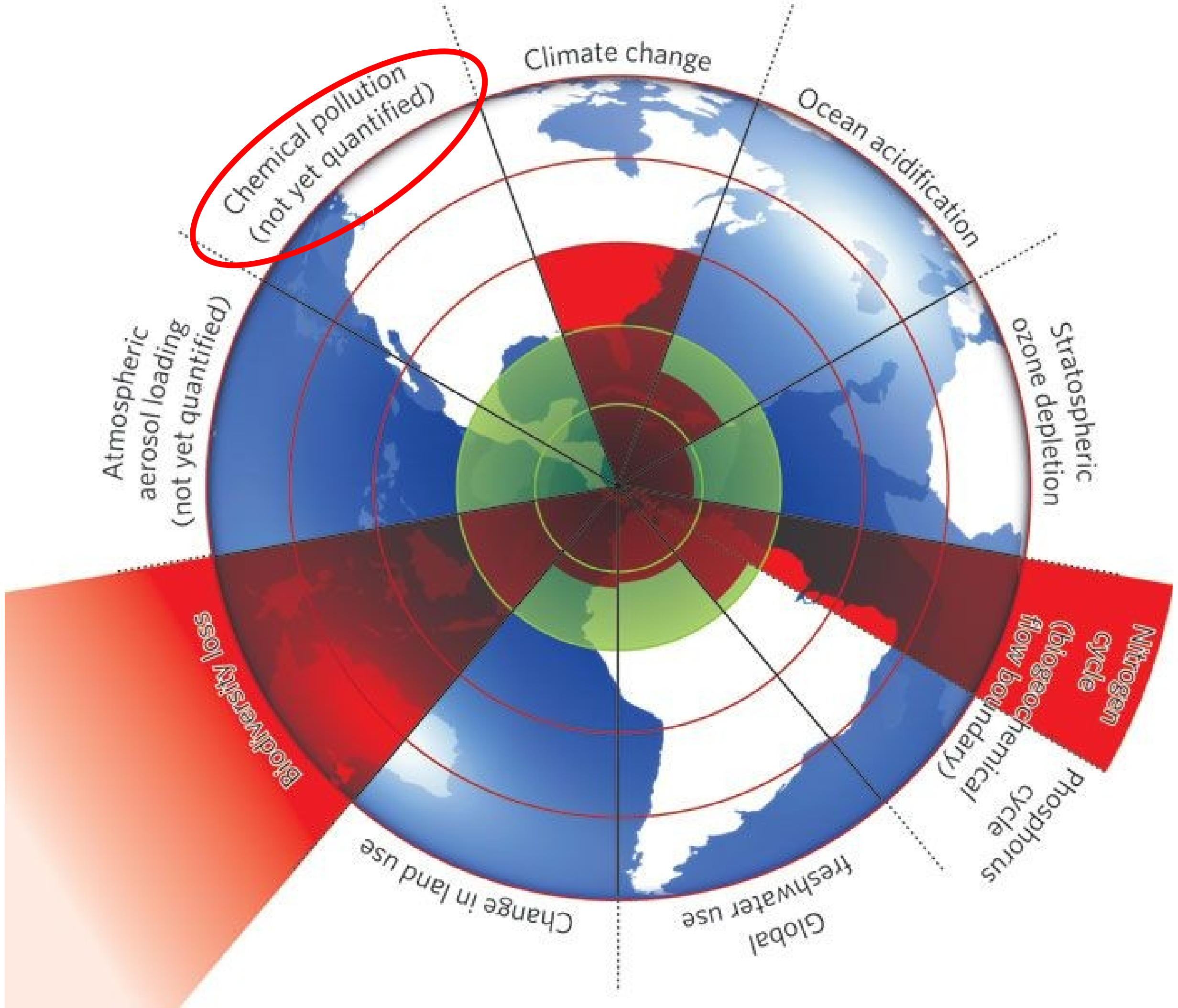


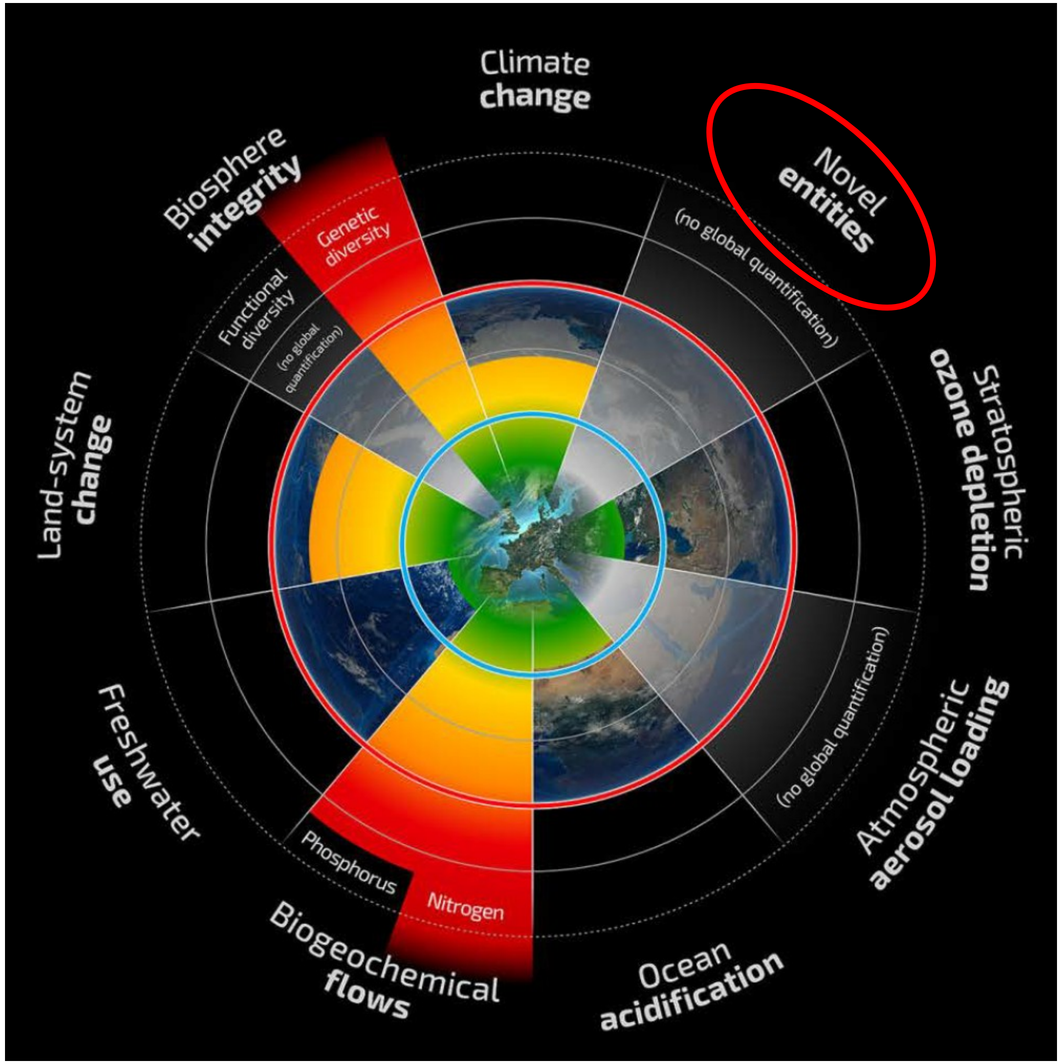


Skupiny znečišťujících látek

- anorganické plyny
- kovy
- průmyslové kyseliny
- radionuklidy
- nutrienty (živiny, anorganická hnojiva)
- organické (degradabilní, komunální, fekální) znečištění
- komunální chemie – PCPs, detergenty, mýdla, změkčovadla ...
- nehalogenovaná rozpouštědla (alkoholy, etery, BTEX ...)
- halogenované alifatické uhlovodíky (freony ...)
- látky průmyslu gumy a plastů (ftaláty, polybromované difenylethery, PFAS ...)
- persistentní organické látky (POPs), halogenované [produkty průmyslu (PCBs, PBBs) a vedlejší produkty (PCDD/Fs, PBDD/Fs)]
- pesticidy [insekticidy – nehalogenované vs. halogenované (patří mezi POPs), herbicidy]
- farmaka, léčiva
- produkty denní spotřeby (PCPs)
- PAHs – polycyklické aromatické uhlovodíky
- ...

Globální chemické znečištění - dopady





Rockström et al. (2009)

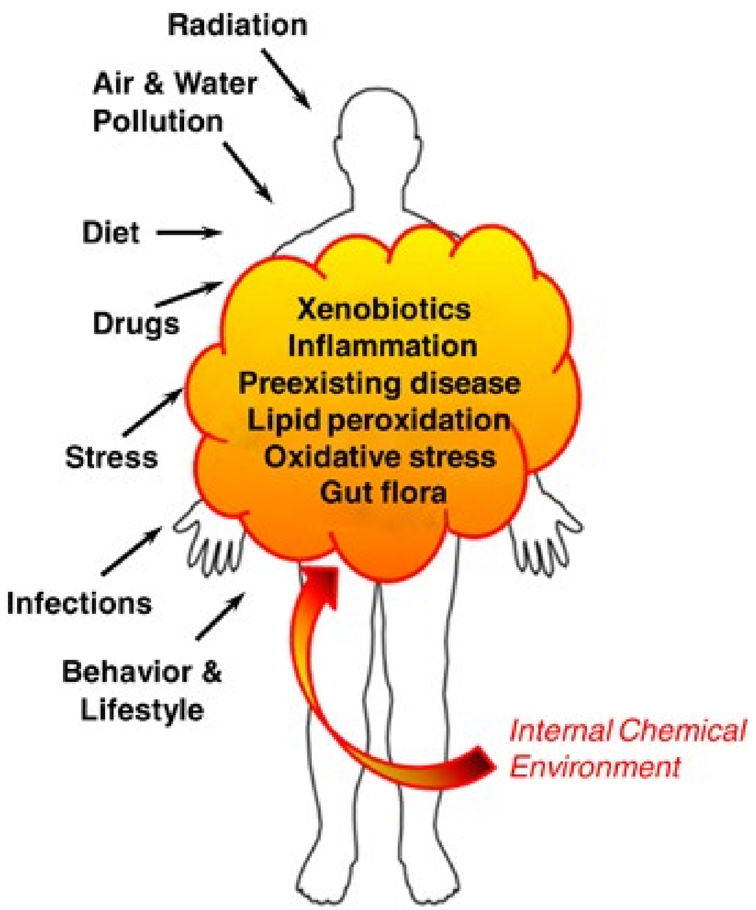
Globální chemické znečištění - dopady

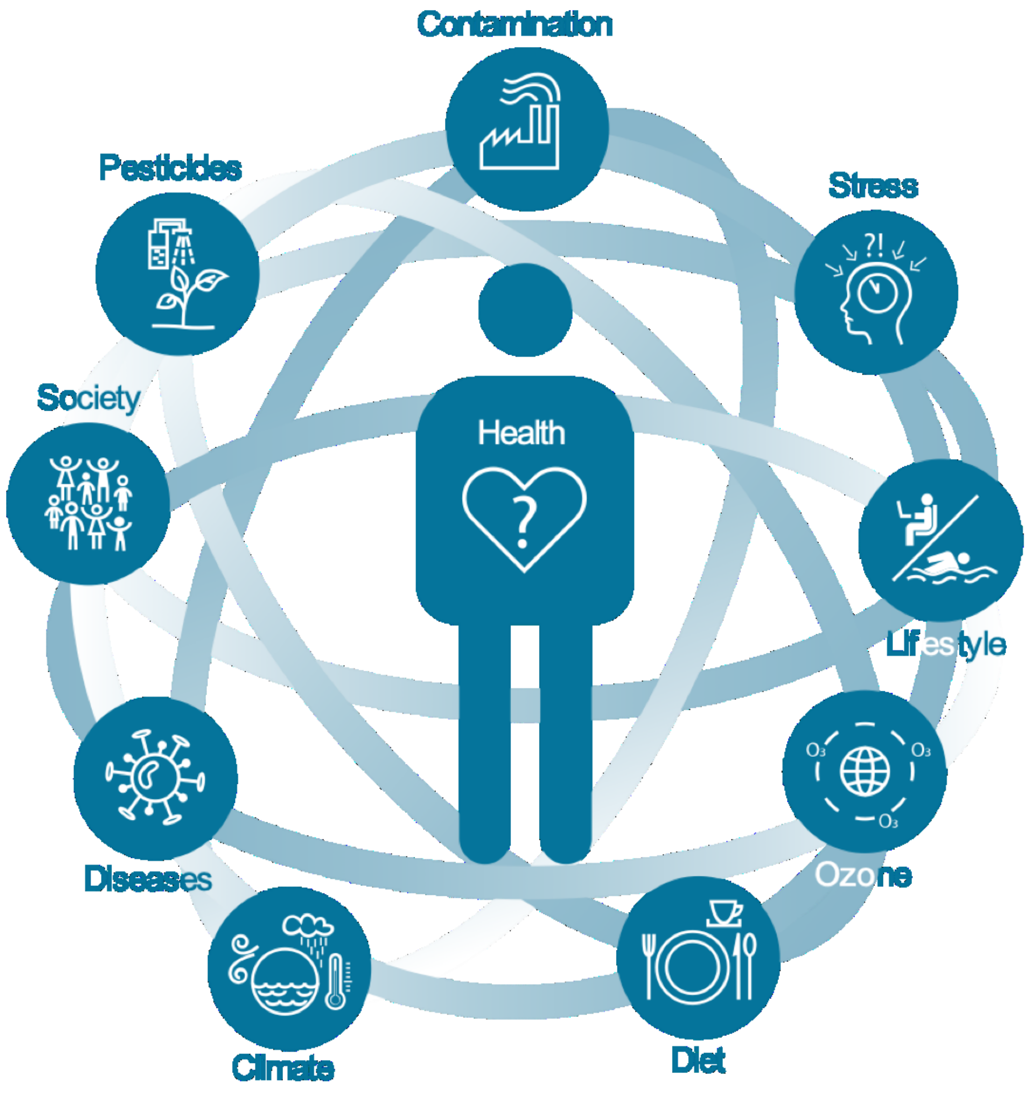
Které SDG souvisí s chemickým znečištěním PŘÍMO

Které SDG souvisí s chemickým znečištěním NEPŘÍMO

Expozom

SMĚSI + spolupůsobení faktorů = EXPOZOM





Dopady chemického znečištění na člověka

Table 1: Some major health impacts associated with environmental exposures to chemicals and other environmental stressors. *Source: Adapted from EEA (2005)*

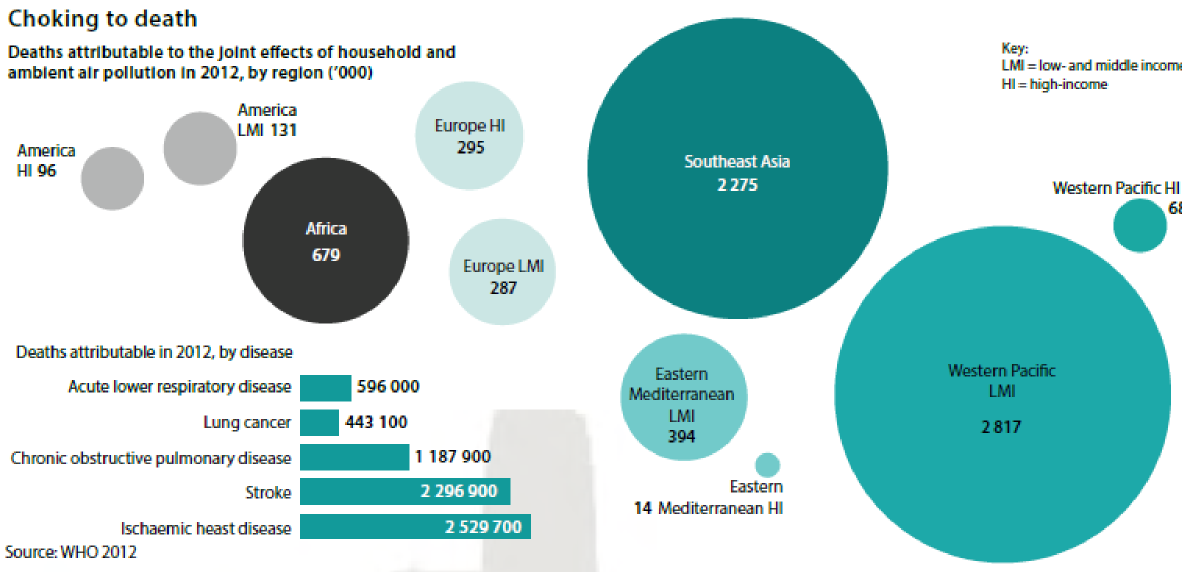
Health impact	Associations with some environmental exposures
Infectious diseases	Water, air and food contamination Climate change-related changes in the lifecycle of pathogens
Cancer	Air pollution Some pesticides Asbestos Natural toxins (aflatoxins) Polycyclic aromatic hydrocarbons Some metals, e.g. arsenic, cadmium, chromium Benzene Dioxins
Cardiovascular diseases	Air pollution Carbon monoxide Lead
Respiratory diseases, including asthma	Sulphur dioxide Nitrogen dioxide Inhalable particles Ground-level ozone Fungal spores Dust mites Pollen
Skin diseases	UV radiation Some metals, e.g. nickel Pentachlorophenol Dioxins
Reproductive dysfunctions	Polychlorinated biphenyls (PCBs) DDT Cadmium Phthalates and other endocrine disruptors Pharmaceuticals
Developmental (foetal and childhood) disorders	Lead Mercury Cadmium Some pesticides Endocrine disruptors
Nervous system disorders	Lead PCBs Methylmercury Manganese Some solvents Organophosphates
Immune response	Some pesticides

UNEP (2013)

Dopady chemického znečištění na člověka

- malárie + AIDS + tuberkulóza 3,4 mil
- 8-9 mil lidí ročně zemře na následky znečištění
  - znečištěné venkovní ovzduší 3,7 mil
  - znečištěné vnitřní ovzduší (pece, kamna) 4,2 mil
  - znečištěná půda a voda 1 mil

https://ensia.com/voices/leading-cause-death-developing-countries

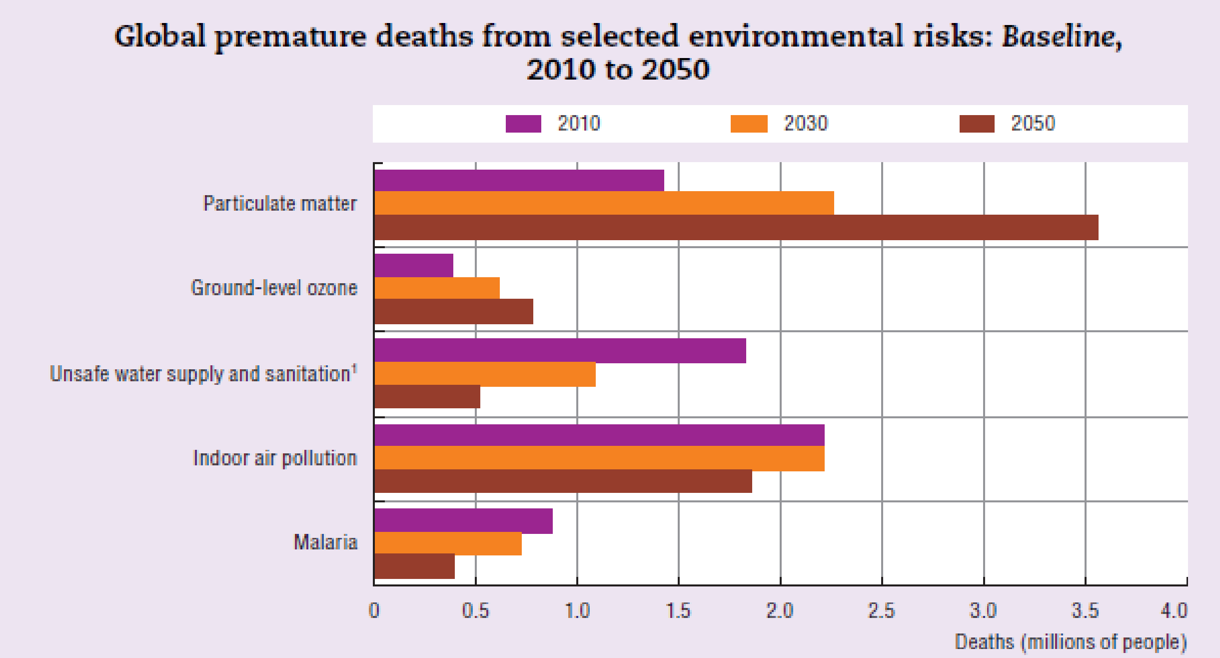


UNEP (2014)

The economic cost of air pollution

The cost of air pollution to the world's most advanced economies plus India and China is estimated to be US$3.5 trillion per year in lives lost and ill health. In OECD countries the monetary impact of death and illness due to outdoor air pollution in 2010 is estimated to have been US$1.7 trillion.

UNEP (2014)

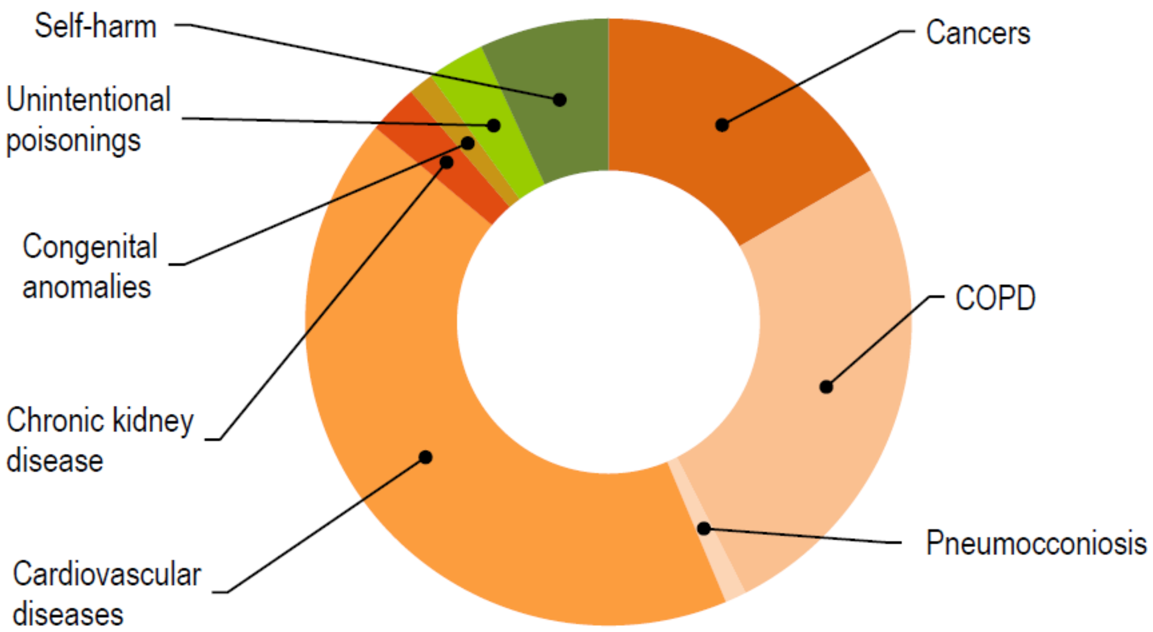


OECD (2012)

Dopady chemického znečištění na člověka

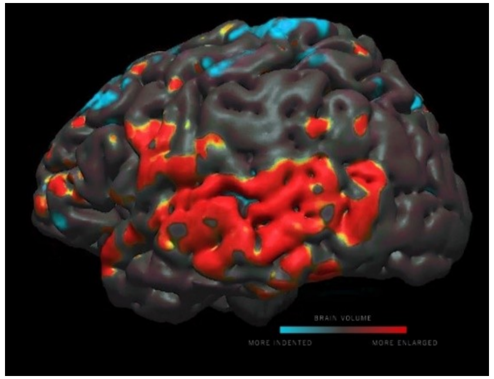
Chemicals/ Groups of chemicals	Disease outcomes considered (population attributable fraction of DALYs)	Deaths	DALYs	Method
Chemicals in acute poisonings				
Chemicals involved in unintentional acute poisonings (methanol, diethylene glycol, kerosene, pesticides etc.)	Unintentional poisonings (73%)	61,523	3,489,814	Expert survey/ qualitative evidence synthesis
Chemicals involved in unintentional occupational poisonings (already included in the above poisonings)	Unintentional poisonings (occupational) (9.8%)	8,608	470,082	CRA
Pesticides involved in self-inflicted injuries	Self-inflicted injuries (20%)	137,831	6,245,500	Limited epidemiological data
Chemicals involved in congenital anomalies	Congenital anomalies (5.0%)	26,643	2,589,832	Expert survey/ qualitative evidence synthesis
Single chemicals with mostly longer term effects				
Lead	Cardiovascular diseases (CVD) (4.6%); chronic kidney diseases (CKD) (3.0%); idiopathic intellectual disability (IID) (30%)	901,716 (CVD: 848,778, CKD: 52,938)	21,676,385 (CVD: 17,734,898, CKD: 1,225,202, IID: 2,716,285)	CRA
Chemicals in occupational exposures (longer term effects)				
Occupational carcinogens (arsenic, asbestos, benzene, beryllium, cadmium, chromium, diesel engine exhaust, formaldehyde, nickel, silica, sulphuric acid, trichloroethylene)[b]	Cancers (2.9%); pneumoconiosis (79%)	350,325 (cancers: 333,867; pneumoconiosis: 16,458)	7,691,763 (cancers: 6,964,775, pneumoconiosis: 726,988)	CRA
Occupational particulates (dusts, fumes, gas)	COPD (16%); pneumoconiosis (21%)	524,290 (COPD: 517,734, pneumoconiosis: 6,556)	11,788,178 (COPD: 11,596,089, pneumoconiosis: 192,089)	CRA
Total	Considered diseases: poisonings, self-inflicted injuries, congenital anomalies, cardiovascular diseases, chronic kidney diseases, idiopathic intellectual disability, cancers, pneumoconiosis, COPD	2,002,328 (3.6% of total deaths)	53,481,472 (2.1% of total DALYs)	

Data sources: CRA: IHME (2021), disease statistics: WHO (2021a and 2021b); "expert survey" and "limited epidemiological data": Prüss-Ustün et al. (2016).
[a] without counting the effect of chemicals in general ambient air pollution, [b] excludes second-hand tobacco smoke.
Notes: DALYs: disability-adjusted life years, CRA: comparative risk assessment, COPD: chronic obstructive pulmonary disease, CVD: cardiovascular diseases, CKD: chronic kidney diseases, IID: idiopathic intellectual disability.



WHO (2021): The public health impact of chemicals: knowns and unknowns - 2021 data addendum.
https://www.who.int/publications/i/item/WHO-HEP-ECH-EHD-21.01

Dopady chemického znečištění na člověka



Special issue: Perspectives on the technosphere

THE ANTHROPOCENE REVIEW

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Toxic chemicals as enablers and poisoners of the technosphere

Miriam L Diamond

„Neurobehavioural effects caused by toxic chemical exposure have profound **implications for society and its ability to self-perpetuate**. Not only does society have to shoulder associated health and management costs, but a five point decrease in IQ related to neurotoxicant exposure could also **decrease the number gifted individuals needed to solve complex problems in the technosphere**."

Diamond et al. (2017)

Neurobehavioral Deficits, Diseases, and Associated Costs of Exposure to Endocrine-Disrupting Chemicals in the European Union

Martine Bellanger, Barbara Demeneix, Philippe Grandjean, R. Thomas Zoeller, and Leonardo Trasande

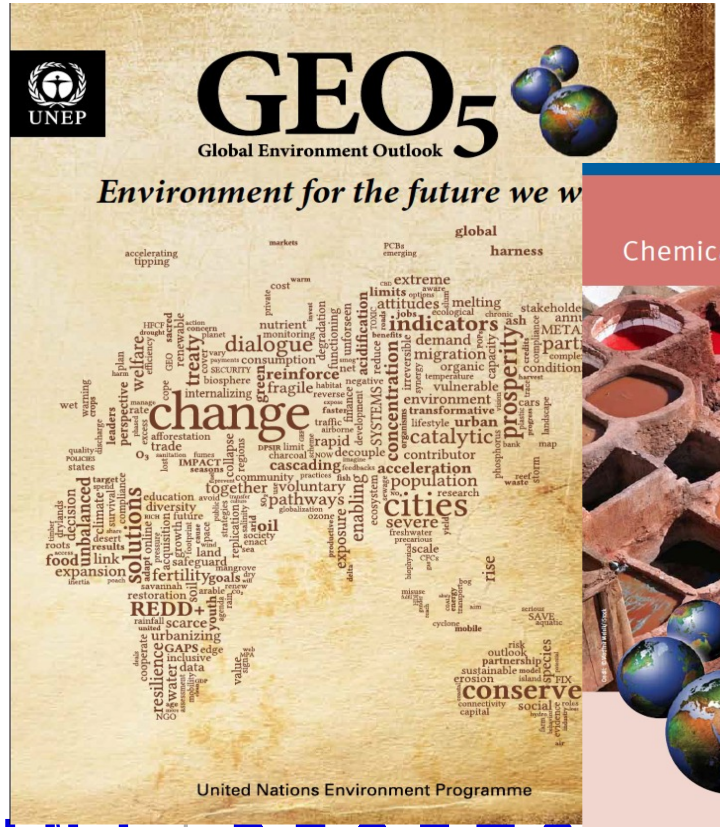
Results: The panel identified a 70–100% probability that polybrominated diphenyl ether and organophosphate exposures contribute to IQ loss in the European population. Polybrominated diphenyl ether exposures were associated with 873 000 (sensitivity analysis, 148 000 to 2.02 million) lost IQ points and 3290 (sensitivity analysis, 3290 to 8080) cases of intellectual disability, at costs of €9.59 billion (sensitivity analysis, €1.58 billion to €22.4 billion). Organophosphate exposures were associated with 13.0 million (sensitivity analysis, 4.24 million to 17.1 million) lost IQ points and 59 300 (sensitivity analysis, 16 500 to 84 400) cases of intellectual disability, at costs of €146 billion (sensitivity analysis, €46.8 billion to €194 billion). Autism spectrum disorder causation by multiple EDCs was assigned a 20–39% probability, with 316 (sensitivity analysis, 126–631) attributable cases at a cost of €199 million (sensitivity analysis, €79.7 million to €399 million). Attention-deficit hyperactivity disorder causation by multiple EDCs was assigned a 20–69% probability, with 19 300 to 31 200 attributable cases at a cost of €1.21 billion to €2.86 billion.

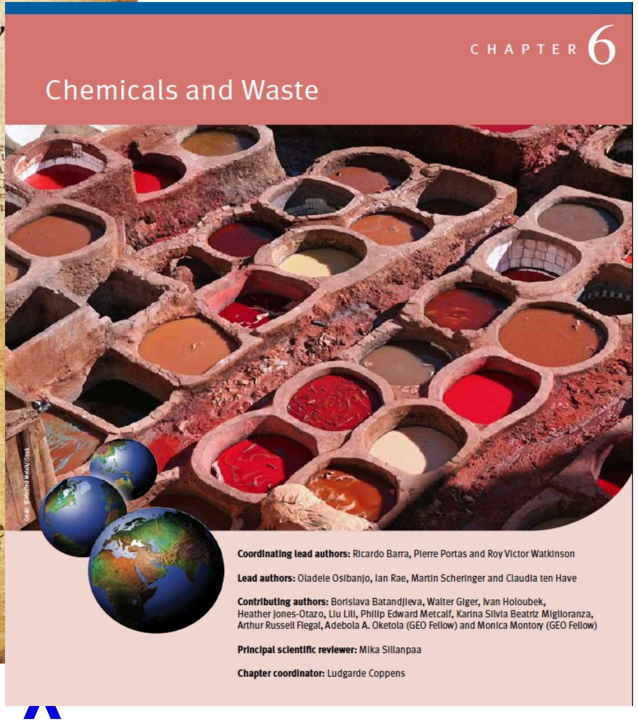
Conclusions: EDC exposures in Europe contribute substantially to neurobehavioral deficits and disease, with a high probability of >€150 billion costs/year. These results emphasize the advantages of controlling EDC exposure. (*J Clin Endocrinol Metab* 100: 1256–1266, 2015)

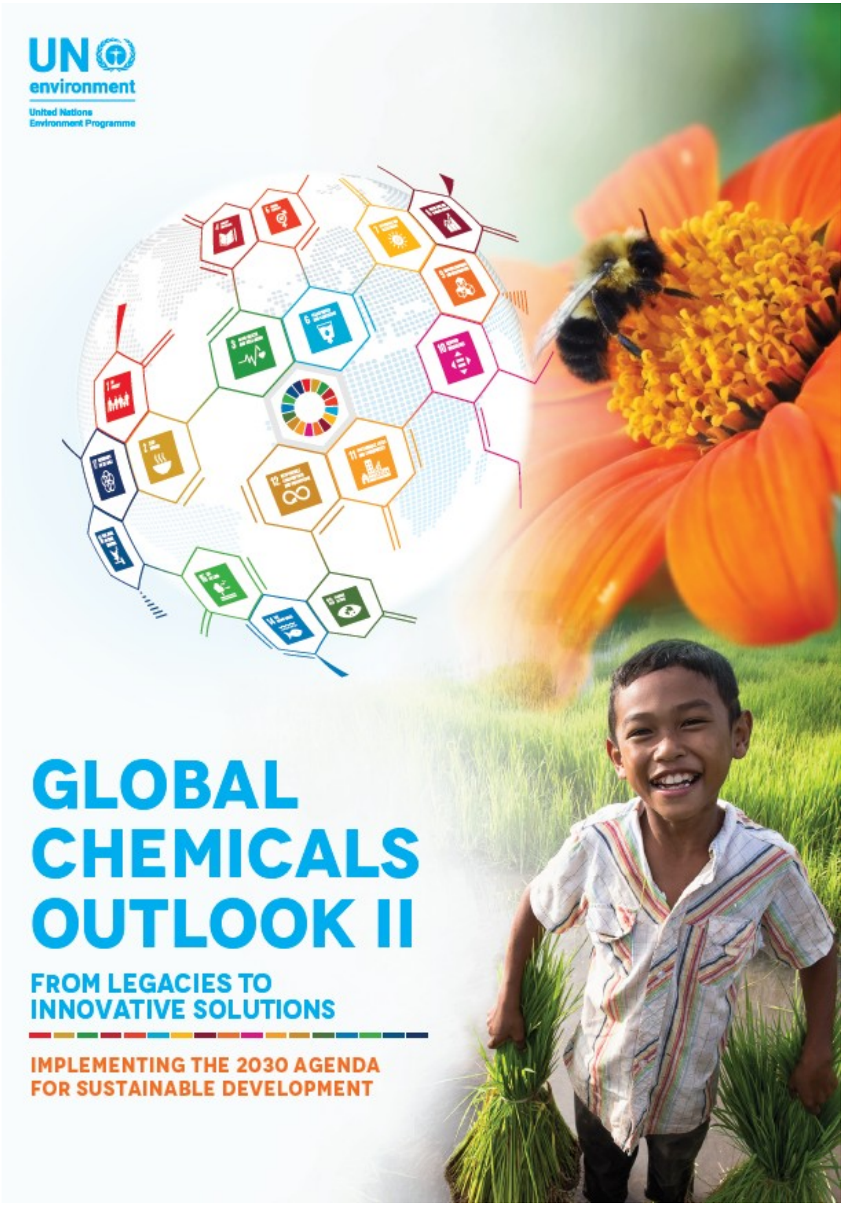
Bellanger et al. (2015)

Chemicals at UNEP

- 2012: Global Environment Outlook 5
- 2019: Global Chemical Outlook II







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Příloha

Přehled hlavních skupin polutantů

Holoubek (2018)

Chemical (substance or mixtures)	Source		Context	Main environmental problems	Main compartment	Scale of effects		
	Natural	Anthropogenic				Global	Regional	Local
Carbon dioxide (CO_2)	+	+	Product of combustion (power generation, transport), aerobic fermentation, industrial processes.	Global warming (Greenhouse effect)	A	+		

Explanation of abbreviations

Definition of chemicals:

The Context column gives information about the applications of chemicals and sources of release to the environment.

Source: ++ predominant, + source of

Main environmental problems:

Brief overview of main problems in all parts of environment connected with this substances or mixture

Main compartment:

Connected with this effect – can be one or one predominant or more (for example acidification affected all abiotic and biotic compartments) (A – air, W – water, S – soil, B – biota including man or can be B – wildlife, H – human)

Scale of effects: Main level(s) of effect(s)

Přehled hlavních skupin polutantů

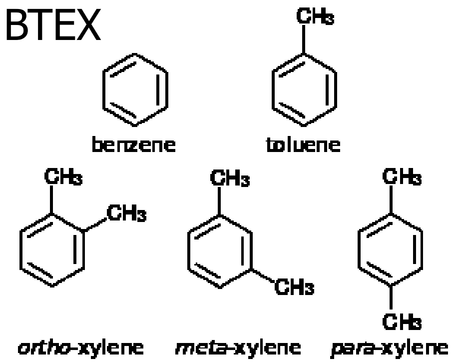
Holoubek (2018)

Chemical (substance or mixtures)	Source		Context	Main environmental problems	Main compartment	Scale of effects		
	Natural	Anthropogenic				Global	Regional	Local
Carbon dioxide (CO_2)	+	+	Product of combustion (power generation, transport), aerobic fermentation, industrial processes.	Global warming (Greenhouse effect)	A	+		
Methane (CH_4)	++	+	Anaerobic fermentation, emissions of natural gas, coal-seam emissions.	Global warming (Greenhouse effect)	A	+		
Carbon monoxide (CO)	++	+	Product of incomplete combustion, for example in transport vehicles	Tropospheric ozone formation, indirect effects on CH_4 and O_3				+
Sulfur dioxide (SO_2)	+	+	Results from sulfur present in fuels.	Acidification, aerosols formation, short term cooling (SO_4^{2-})	A, W, S, B, H		+	+
Nitrogen oxides NO_X (NO + NO_2)	+	+	Produced from atmospheric nitrogen in combustion processes, and released from some industrial processes.	Acidification, eutrophication, greenhouse effects, smog, tropospheric ozone formation, short term cooling (NO_3^-), aerosols formation	A, W, S, B, H		+	+
Nitrous oxide (N_2O)	++	+	Produced by soil bacteria notably from nitrogenous fertilizers.	Ozone depletion, greenhouse effects, smog	A	+	+	+
Ammonia (NH_3)	++	+	Produced by anaerobic respiration, for example in sewage treatment.	Acidification, eutrophication, aerosols formation			+	+

Přehled hlavních skupin polutantů

Holoubek (2018)

Chemical (substance or mixtures)	Source		Context	Main environmental problems	Main compartment	Scale of effects		
	Natural	Anthropogenic				Global	Regional	Local
Ozone (O_3)	++	+	Produced from nitrogen oxides and volatile organic compounds in the troposphere.	Smogs, troposheric formation	A, B, H	+	+	+
Particulate matter	++	+	Industrial processes and transport emissions.	Short-term cooling, aerosols formation, health effects, long-range transport	A, H		+	+
Volatile Organic Compounds (VOC)	++	+	Solvent emissions, products on incomplete combustion, vegetation emissions	Smogs, aerosols formation, indirect effects on CH_4 and O_3	A, H	+	+	+
Chlorofluoro-carbons (CFCs)	(+)	++	Formerly in wide use as refrigerants, foaming agents and aerosols, now largely phased out and replaced by hydrochlorofluorocarbons (HCFCs) and hydrofluorocarbons (HFCs).	Ozone depletion, long-range transport, global warming	A, B, H	+	+	
Nitrate (NO_3^-)	+	++	Sourced from nitrate fertilizers and released into the environment.	Acidification, eutrophication	W, H		+	+
Phosphate (PO_4^{3-})	+	++	Sourced from phosphate fertilizers and released into the environment.	Eutrophication	W, H		+	+



Přehled hlavních skupin polutantů

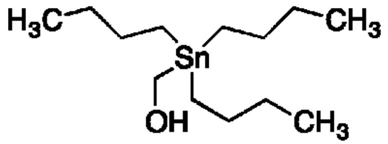
Holoubek (2018)

Chemical (substance or mixtures)	Source		Context	Main environmental problems	Main compartment	Scale of effects		
	Natural	Anthropogenic				Global	Regional	Local
Heavy metals	++	+	Released from industrial processes including mining and processing of metal ores.	Health and wildlife effects, long-range transport	A, W, S, B, H	+	+	+
Mercury	+	++	Mercury metal released during coal combustion, also artisanal mining, and converted to fat-soluble methyl and dimethyl mercury in the environment.	Health and wildlife effects, long-range transport	A, W, S, B, H	+	+	+
Cadmium	+	++	See heavy metals (above). Also present in some phosphate fertilizers, and taken up by crops such as potatoes.	Health and wildlife effects	W, S, B, H		+	+
Lead	+	++	Leaded fuels phased out, and 85% of lead-acid batteries are recycled, but some sues persist. Contaminated sites remain. Lead paints still used in some places.	Health and wildlife effects	(A), W, S, B, H		+	+
Arsenic	+	++	Formerly widely used as pesticides, resulting in contaminated legacy sites. Released in mining and smelting operations.	Health and wildlife effects	W, S, B, H		+	+

Přehled hlavních skupin polutantů

Holoubek (2018)

Chemical (substance or mixtures)	Source		Context	Main environmental problems	Main compartment	Scale of effects		
	Natural	Anthropogenic				Global	Regional	Local
Radionuclides	+	++	Released in mining and processing of uranium ores, nuclear power station operation and disestablishment. Some medical uses .	Health and wildlife effects	W, S, B, H	+	+	+
Organometallic compounds	+	++	The most common examples are butyl tin compounds used as marine anti-foulants.	Health and wildlife effects	W, S, B, H		+	+
Nutrients	+	+	Commonly released from food processing operations and poorly-managed food wastes leading to landfill leachates.	Eutrophication	W, S, B, H	+	+	+
Biologically easy degradable chemicals	+	+	Detergents and other surfactants, for example.	Eutrophication	W, S, B, H		+	+
Oil pollution	+	++	While major spills draw attention, there is ongoing leakage of petroleum hydrocarbons into the environment from oil-recovery operations, and uses such as lubrication of transport vehicles.	Health, wildlife, ecosystems effects, exchange of surface properties	W, S, B, H	+	+	+



Přehled hlavních skupin polutantů

Holoubek (2018)

Chemical (substance or mixtures)	Source		Context	Main environmental problems	Main compartment	Scale of effects		
	Natural	Anthropogenic				Global	Regional	Local
Surfactants		++	Resistant ('hard') detergents and other surfactants.	Health and wildlife effects, alteration of surface properties	W, B, H		+	+
Pesticides		++	Agricultural uses release pesticides into the environment, and domestic use can also expose people to hazardous material.	Health, wildlife and ecosystems effects	A, W, S, B, H	+	+	+
Persistent Organic Pollutant pesticides		++	Chemicals such as dieldrin, heptachlor, hexachlorocyclohexane (HCH) and other organochlorines have been banned under the Stockholm Convention but legacy quantities remain. Use of DDT is restricted under the Convention.	Health, wildlife and ecosystems effects, long-range transport	A, W, S, B, H	+	+	+
Polycyclic aromatic hydrocarbons (PAH)	+	+	These substances are components of natural petroleum but are also produced from other hydrocarbons during combustion processes. Many are carcinogenic.	Health, wildlife and ecosystems effects, long-range transport	A, W, S, B, H		+	+

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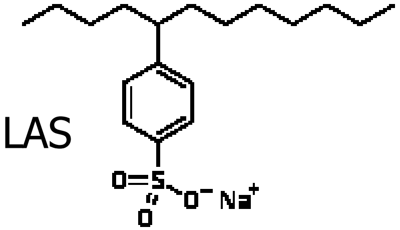
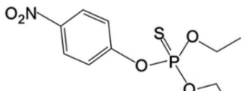
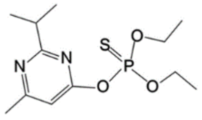


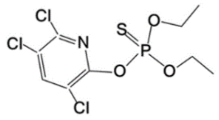
OPs



Ethyl-parathion

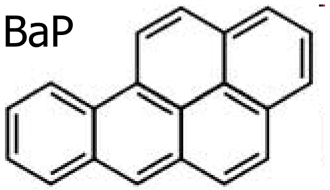


Diazinon



Chlorpyrifos

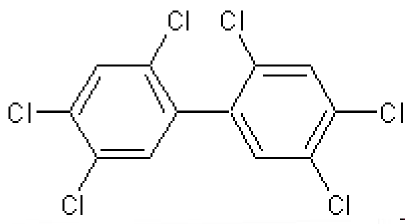
BaP



Přehled hlavních skupin polutantů

Holoubek (2018)

Chemical (substance or mixtures)	Source		Context	Main environmental problems	Main compartment	Scale of effects		
	Natural	Anthropogenic				Global	Regional	Local
Polychloro-biphenyls (PCBs)		++	Used as insulating and heat transfer fluids and plasticizers, now being phased out under the Stockholm Convention on Persistent Organic Pollutants.	Health, wildlife and ecosystems effects, long-range transport	A, W, S, B, H	+	+	+
Polychlorodibenzodioxins and –furans (PCDDs/Fs)	+	++	Produced during many combustion processes, released to the environment and bioaccumulated mainly from foods. Steps taken under the Stockholm Convention have seen great reductions in emissions.	Health, wildlife and ecosystems effects, long-range transport	A, W, S, B, H	+	+	+
Brominated flame retardants (BFRs)		++	Many such compounds in use. Some are problematic because of transport, bioaccumulation and toxicity and have been banned under the Stockholm Convention.	Health, wildlife and ecosystems effects, long-range transport	A, W, S, B, H	+	+	+
Perfluoro-octane sulfonic acid (PFOS)		++	Major use in electroplating of metals but also released during environmental degradation of other industrial products such as surface active agents.	Health, wildlife and ecosystems effects, long-range transport	A, W, S, B, H	+	+	+



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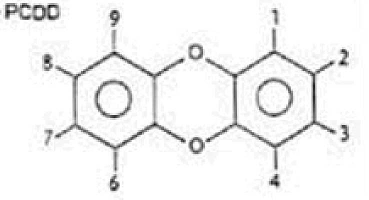

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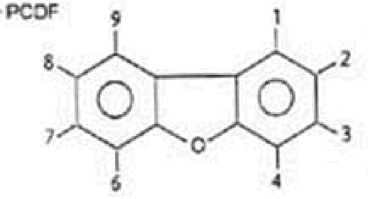

Přehled hlavních skupin polutantů

Holoubek (2018)

Chemical (substance or mixtures)	Source		Context	Main environmental problems	Main compartment	Scale of effects		
	Natural	Anthropogenic				Global	Regional	Local
Pharmaceuticals		++	Many pharmaceuticals are discharged with human wastes into sewage systems and have been detected in water ways and water treated for drinking.	Health, wildlife and ecosystems effects	W, S, B, H		+	+
Veterinary drugs		++	Veterinary drugs are released to the environment in the same ways as pharmaceuticals.	Health, wildlife and ecosystems effects	W, S, B, H		+	+
Personal care products		++	Chemicals in personal care products, like pharmaceuticals, are discharged to wastewater and sewage systems.	Health, wildlife and ecosystems effects	W, S, B, H		+	+
Endocrine disrupting agents		++	Chemicals such as phthalate plasticizers, bisphenol A (plastic component) and alkylphenols (in detergents) have been shown in laboratory studies to disrupt endocrine hormone systems.	Health, wildlife and ecosystems effects	W, S, B, H	+	+	+