

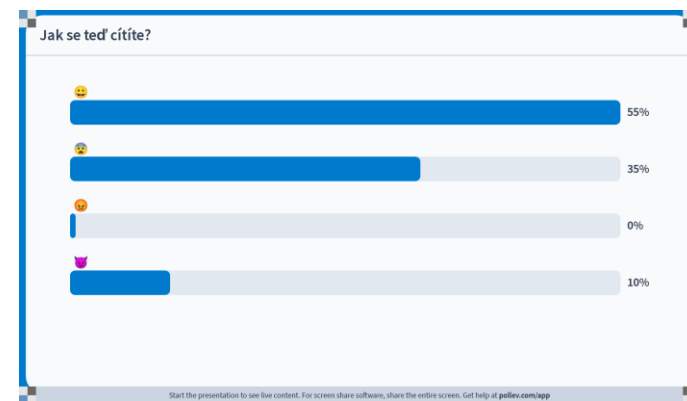
Kvalita půdy a její ohrožení

Jakub Hofman



http://soils.usda.gov/education/jan_lang/

Seminář
17.10.2022



<http://forum.xcitefun.net/living-grass-people-grassy-people-art-t54497.html>

Proč zkoumat a chránit půdu?

komplexní a složitý ekosystém, **klíčová složka suchozemských ekosystémů** a **nenahraditelný zdroj pro člověka**, poskytuje **cenné ekosystémové služby**

Jaké funkce/role plní půda pro člověka či pro ekosystém?

Top

Mahatmá Gándí:
"Zapomenout
pečovat o půdu
znamená
zapomenout sami
na sebe"

Proč zkoumat a chránit půdu?

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Mahatmá Gándí:
"Zapomenout pečovat o půdu znamená zapomenout sami na sebe"

[1]

Soil functions

Soils deliver ecosystem services that enable life on Earth



2015
International
Year of Soils
fao.org/soils-2015

Food and Agriculture
Organization of the
United Nations

with the support of
Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra
Swiss Confederation

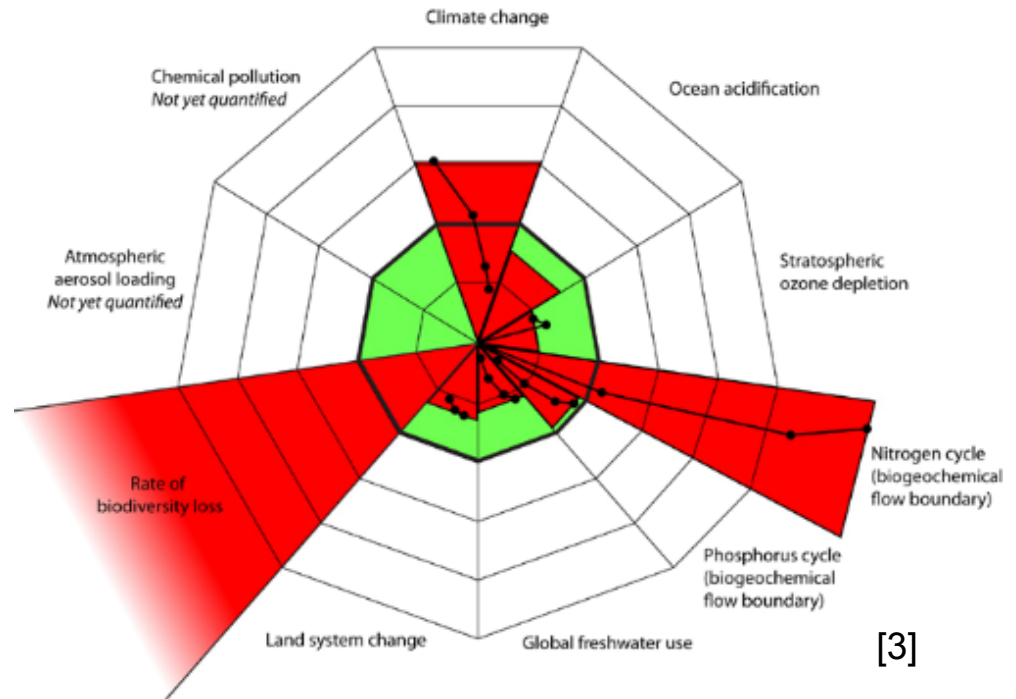
Federal Department of Economic Affairs,
Education and Research EAFN
Federal Office for Agriculture FOAG

Foundation
for human
infrastructure

Source of pharmaceuticals
and genetic resources

Proč zkoumat a chránit půdu?

součást **cílů udržitelného rozvoje** a **planetárních mezí**



[3]

např.

<https://www.osn.cz/sdg-2-vymytit-hlad-dosahnout-potravinove-bezpecnosti-a-zlepseni-vyzivy-prosazovat-udrzitelne-zemedelstvi/>

Které PŘÍMO souvisí s kvalitou půdy



SUSTAINABLE DEVELOPMENT GOALS
17 GOALS TO TRANSFORM OUR WORLD



Které NEPŘÍMO souvisí s kvalitou půdy



SUSTAINABLE DEVELOPMENT GOALS
17 GOALS TO TRANSFORM OUR WORLD





Soils and SDGs

Healthy soils perform/provide key functions and ecosystem services





Soil pollution jeopardizes the achievement of most of the SDGs

The prevention, control, and remediation of soil pollution are fundamental if we want to implement the 2030 Agenda for Sustainable Development.


10 REDUCED INEQUALITIES



10.1. Soil pollution disproportionately affects the poorest and most vulnerable populations, causing serious health impacts and reducing their ability to improve their economic circumstances.

1.1. About 79 per cent of people living in extreme poverty live in rural areas and depend heavily on agriculture for their livelihoods. Soil pollution reduces crop yields and quality, leading to reduced incomes for rural populations.

1 NO POVERTY



11 SUSTAINABLE CITIES AND COMMUNITIES



11.2.-11.6. Urban soil pollution poses a health risk to 55% of the world's population. Increased transport and waste production and mismanagement are two of the main causes of soil pollution in urban areas.

2.4. Soil pollution affects food security by reducing crop yields, hampering the quantity and the quality of the food produced.

2 ZERO HUNGER




12 RESPONSIBLE CONSUMPTION AND PRODUCTION




12.2.-12.4.-12.5. The world produces more than 2 billion tonnes of solid waste per year, exacerbated by modern production and consumption patterns based on rapid product obsolescence and over-extraction of raw materials. Industrial, activities, mining and unsustainable waste management represent the main sources of soil pollution in some countries, especially in the Global South.

3.4.-3.9. WHO estimates that about 16% of total global mortality is attributed to environmental pollution-related diseases (including water, air and soil pollution). The burden of disease attributed solely to soil pollution and soil-borne diseases remains largely unknown and may be greatly underestimated.

3 GOOD HEALTH AND WELL-BEING



13 CLIMATE ACTION




13.1. Soil pollution contributes to exacerbating climate change. The misuse of nitrogen fertilisers in agriculture contributes to the release of N₂O into the atmosphere, a potent greenhouse gas, leading to emissions of 700 000 CO₂ equivalents.

5.5. Around 45 per cent of the world's women work in vulnerable jobs, many in marginal agricultural areas, or as scavengers, and they tend to have less access to education and therefore have fewer resources and solutions to reduce their exposure to soil pollution.

5 GENDER EQUALITY



14 LIFE BELOW WATER



14.1. About 80 percent of marine pollution comes from land-based activities. Erosion of polluted soils contributes plastics, nutrients and organic chemicals which are contaminants of concern in marine ecosystems.

6.3. Soil pollution leads to groundwater pollution through contaminant leaching, and polluted soil erosion and runoff contribute to surface water pollution.

6 CLEAN WATER AND SANITATION



15 LIFE ON LAND



15.3. Soil pollution causes a chain reaction of degradation of terrestrial ecosystems. Contaminants in soil are taken up by plants and ingested by soil organisms and pass into the food chain, affecting the health and functioning of all terrestrial communities.

7.2. Around 65 percent of the world's energy production comes from the combustion of fossil fuels (coal, natural gas and oil), which are a major source of environmental contaminants.

7 AFFORDABLE AND CLEAN ENERGY



16 PEACE, JUSTICE AND STRONG INSTITUTIONS



16.3.-16.7 Ethnic minority groups and the poorest and most vulnerable are the most affected by soil pollution. Environmental inequalities exist in both developing and developed countries and are fostered by a lack of information and data on the state of the environment, which limits the ability of affected populations to react, act and decide.

8.4. Poorly managed stockpiles and diffusion of chemicals into the environment resulting from industrial activities are major sources of soil pollution, both on the industrial site, and also more widely through the transport of particles via air and water.

8 DECENT WORK AND ECONOMIC GROWTH



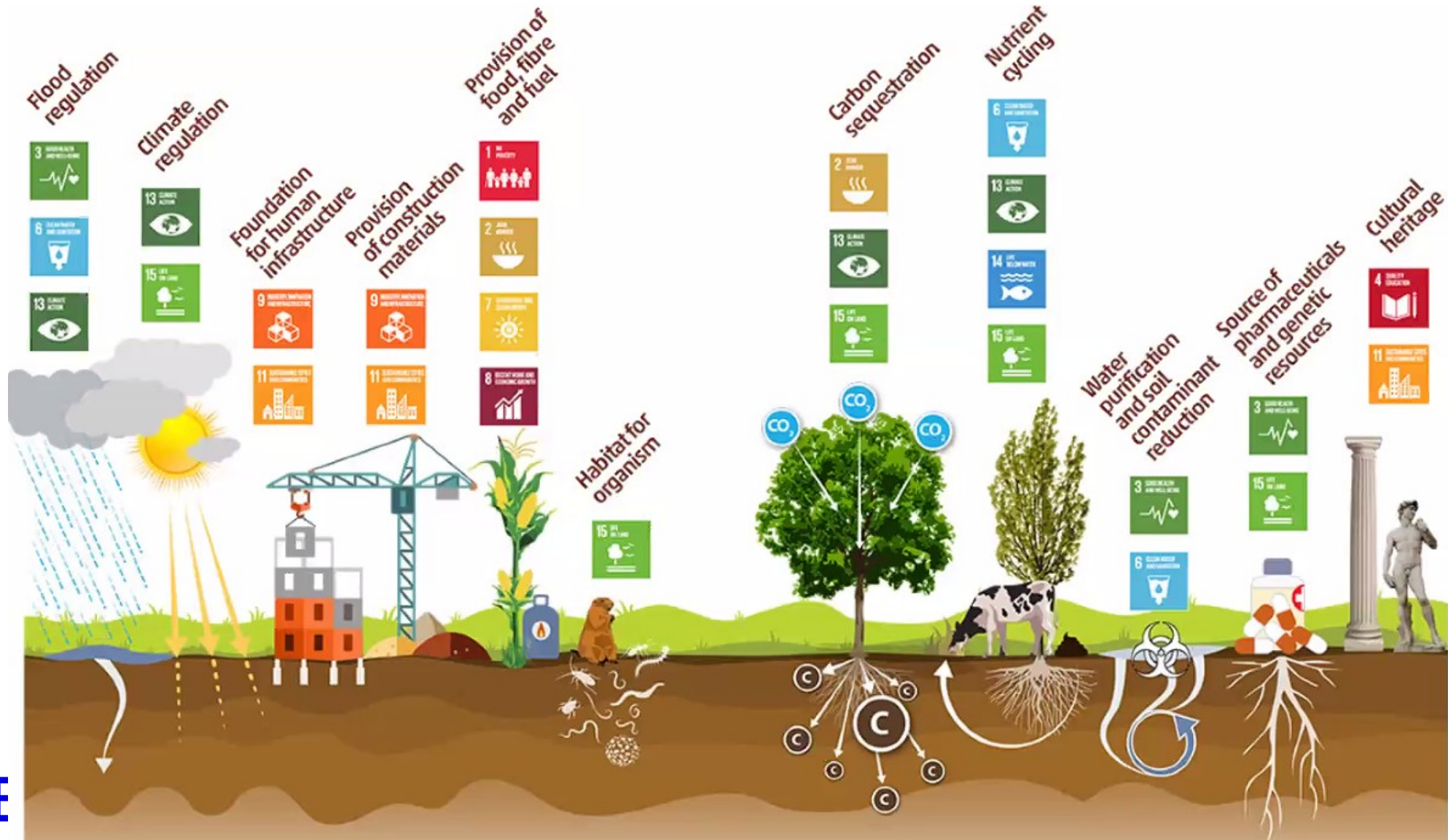
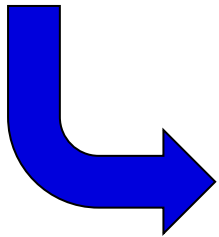
17 PARTNERSHIPS FOR THE GOALS

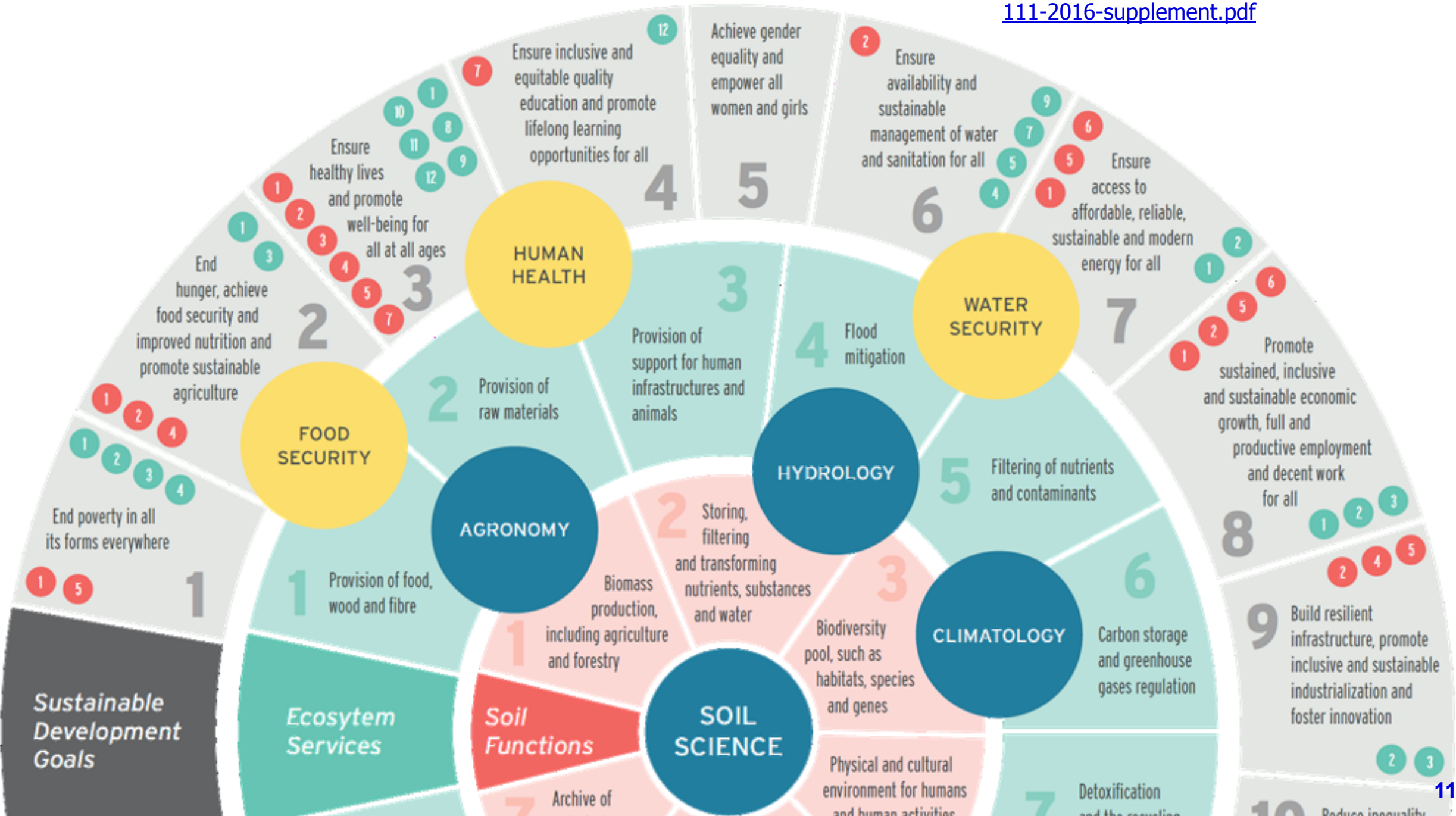


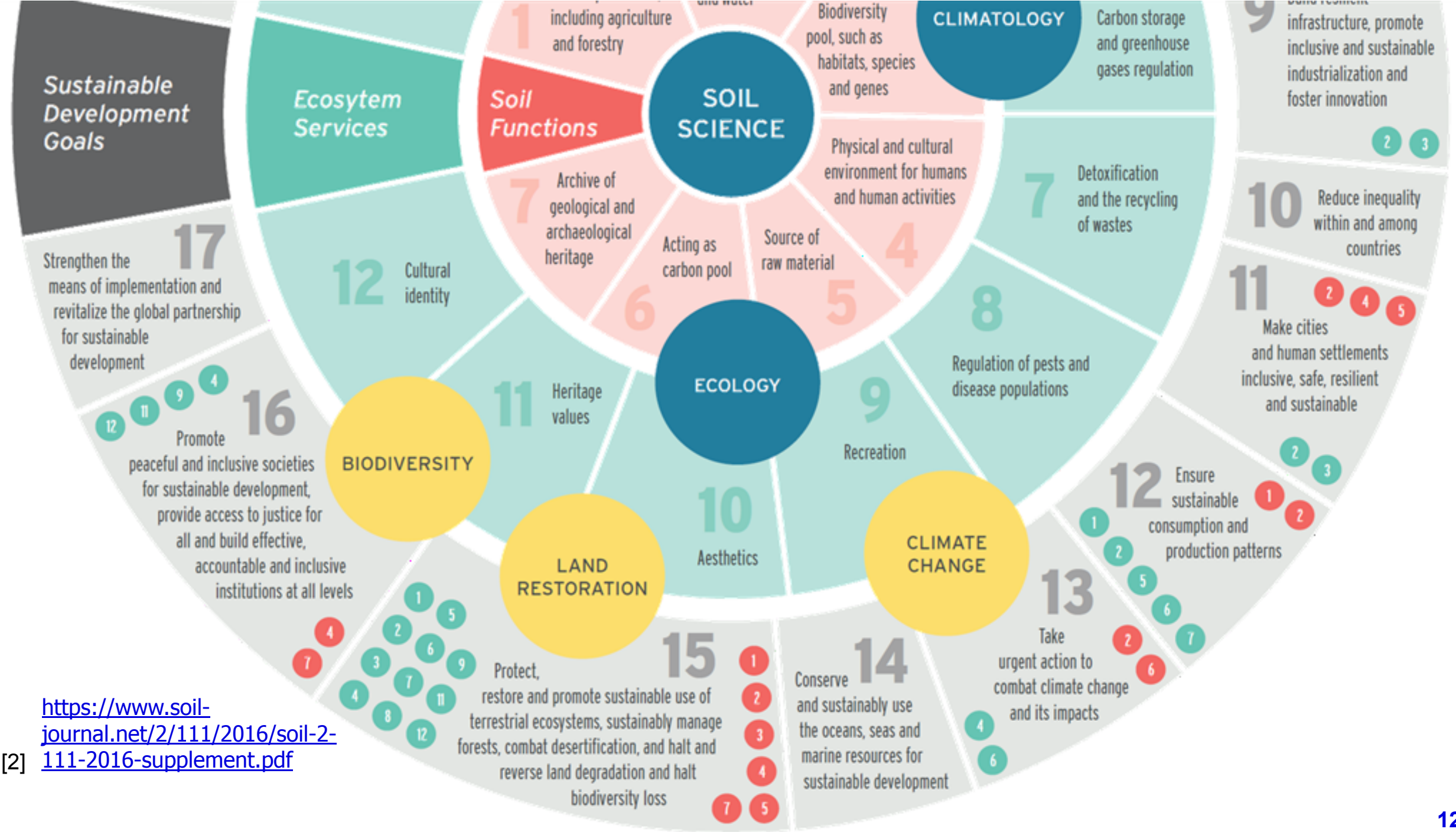
17.7.-17.9. Developed countries are more advanced in the development of technologies to detect emerging contaminants, innovative environmentally friendly industrial production and soil pollution remediation technologies, and therefore need to actively collaborate in the transfer of knowledge.



Význam půdy







<https://www.soil-journal.net/2/111/2016/soil-2-111-2016-supplement.pdf>

[2]





EEA (2020): The European environment - state and outlook 2020 - Knowledge for transition to a sustainable Europe. Chapter 05: Land and soil. ISBN 9789294800909.

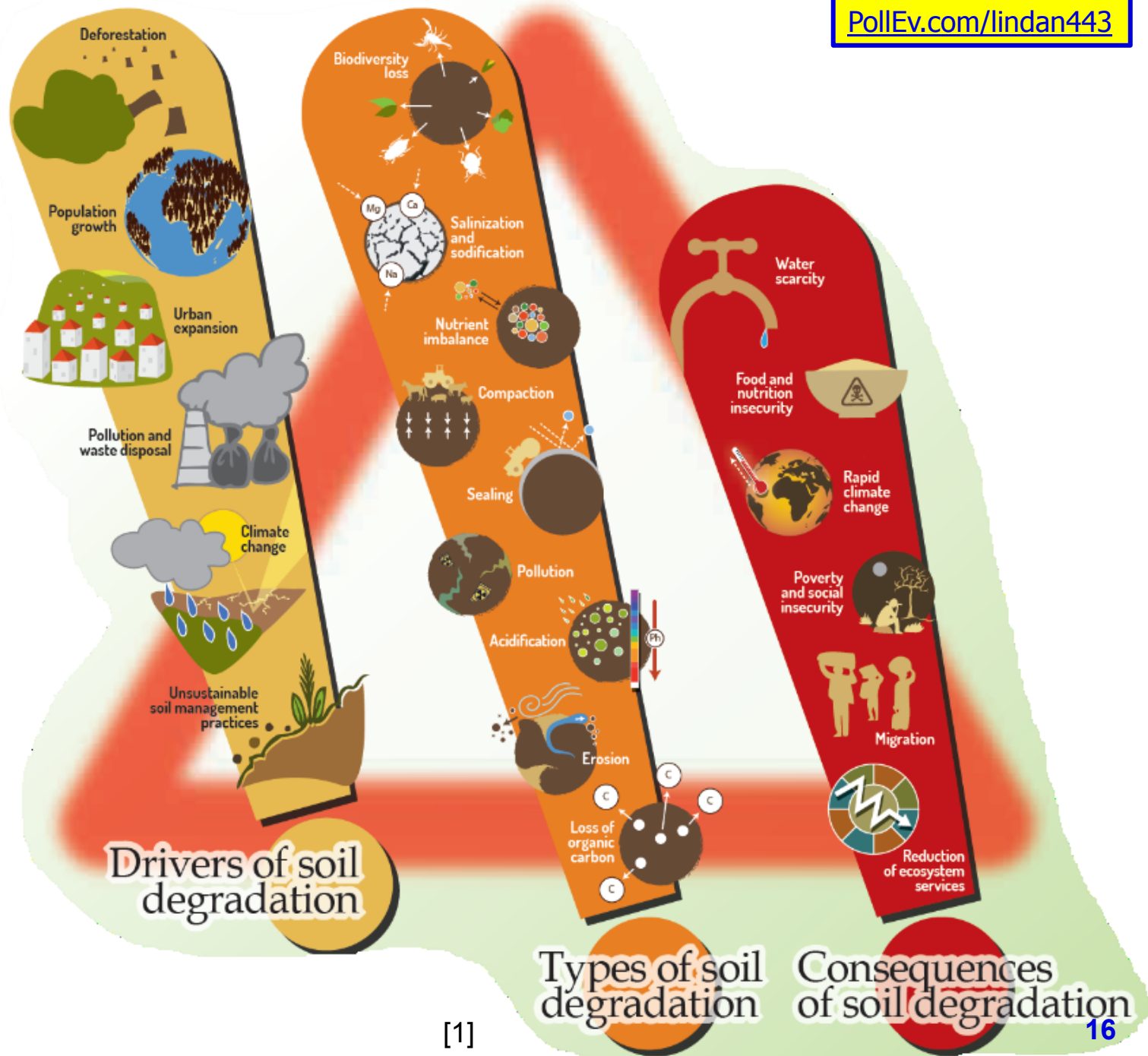
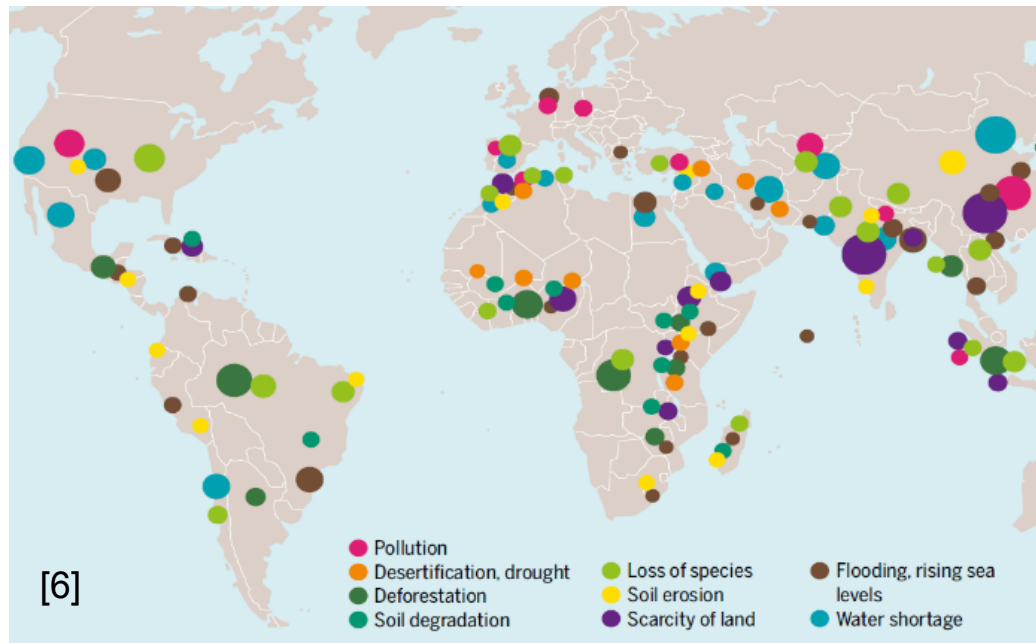
<https://www.eea.europa.eu/soer/2020>



Jakými degradačními faktory je půda ohrožena ?

Top

Degradace půdy



Science

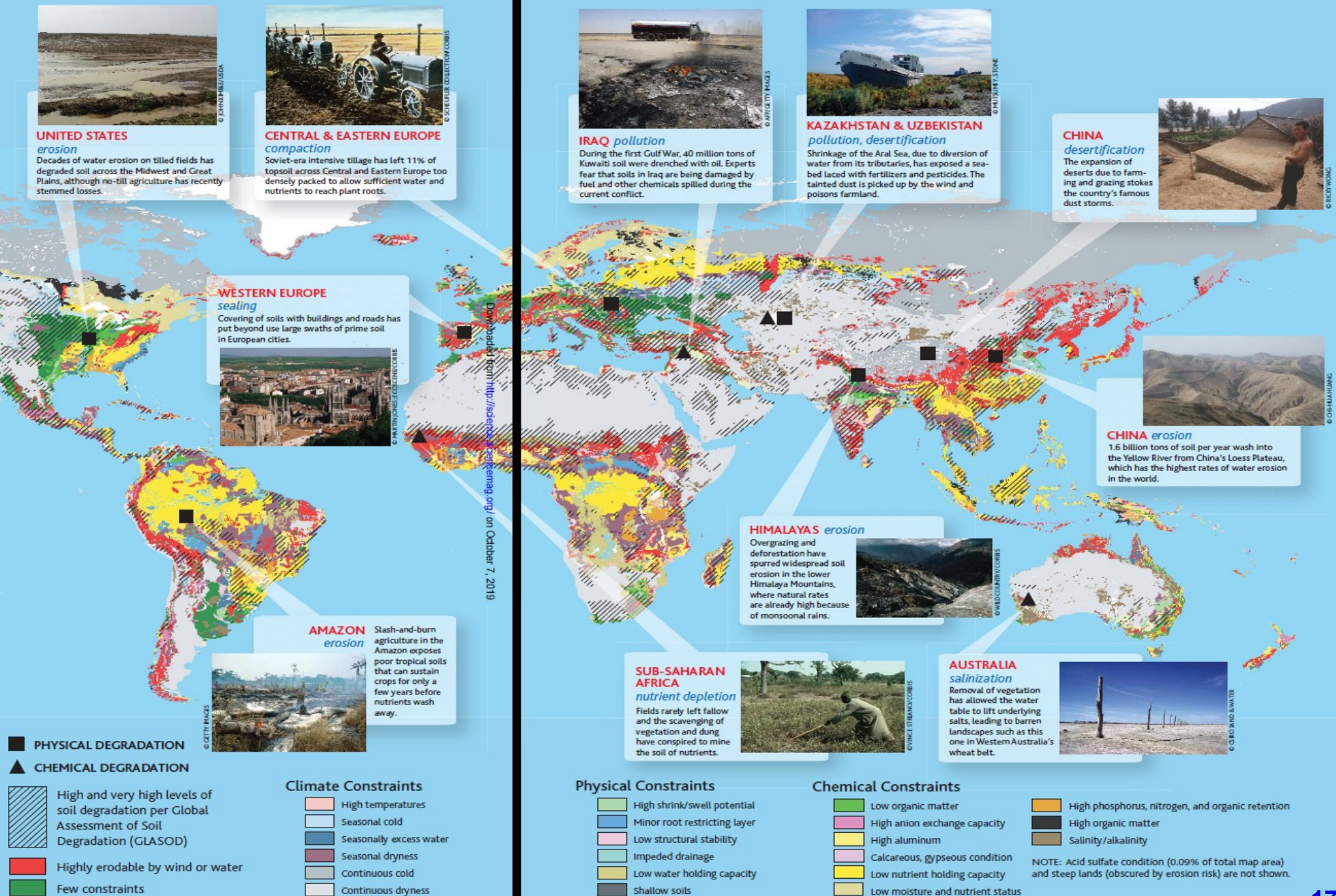
Soil and Trouble

WHEN PEOPLE INTENSIVELY TILL FIELDS and clear-cut forests, they can damage or destroy topsoil that took centuries to accumulate. Just how vulnerable soils are depends on underlying conditions. Mismanaged soils in windswept lands can easily turn into desert, for example, and saline soils can become salt-encrusted wastelands.

This map shows the main barriers to productive farming, along with erosion risk, derived from climatic and soil conditions. Overlaid as cross-hatching are regions reported to be highly or very highly degraded according to a global survey of soil experts published in 1990. The hot spots illustrate examples of the worst soil degradation, from the most common physical type—water erosion—to chemical forms, such as that caused by pollution from industrial chemicals and war.

An interactive version of this map appears online at www.sciencemag.org/cgi/content/summary/304/5677/1614.

SOURCES: Adapted from Major Land Resource Constraints map created April 2004 by P. Reich and H. Eswaran of USDA/NRCS Soil Survey Division, World Soil Resources, Washington, D.C., from WSR Soil Climate Map and FAO Soil Map of the World, 1995; GLASOD data (L. R. Oldeman et al., 1991) provided by K. Sebastian, IFPRI. Data on compaction in Europe from SOVEUR/ISRIC (2000).



Downloaded from <http://science.sciencemag.org/> on October 7, 2019

Downloaded from <http://science.sciencemag.org/> on October 7, 2019

Jak dlouho vzniká v našich klimatických podmínkách vznik úrodné půdy (cca 100 cm) z původní zvětralé horniny?

10 let

100 let

1000 let

10 000 let

100 000 let

Půda - neobnovitelný přírodní zdroj

Hornina	Autor údaje	Místo stanovení	Rychlost tvorby půd [mm·rok ⁻¹]	Doba vzniku 1 cm půdy [roků]
Hydrické nezpevněné sedimenty	E. Z. Harrison – – A. L. Bloom, 1977	USA, Connecticut	2,0–6,6	1,5–5,0
Eolické písčité sedimenty	A. Bertrand, 1959	USA	1,75–2,5	4,0–5,7
Vrchovištní rašelina	E. Firbas	Švábsko	1,0–1,8	5,5–10,0
Morénové sedimenty	A. Bertrand, 1959	USA, Indiana	0,01–1,0	10,0–1000
Pyroklastika	J. Van Baren	Indonézie	0,7	14,3
Vulkanický popel	R. L. Hay, 1960	Indonézie	0,4	25,0
Jezerní sedimenty	Z. Kukal, 1990	Švédsko	0,2–0,4	25,0–50,0
Nezpevněné sedimenty (průměrná hodnota)	H. W. Menard, 1974	USA, Severní Karolina	0,26	38,5
Vápenec	V. V. Dokučajev, 1885	Rusko, Petrohradská oblast	0,13–0,16	62,5–76,9
Vápenec	J. G. Goodchild, 1890	Velká Británie	0,05– 0,1	100,0–200,0
Morénové sedimenty	H. Kohnke	USA	0,055	181,8
Žula	D. C. Barton, 1916	Egypt	0,001–0,002	5000,0–10 000,0
Žula	H. F. Garner, 1974	Výhodné klimatické podmínky	0,0015	6666,7
Průměrně příhodné substrátové poměry	E. Zeuner, 1958	Evropské mírné pásmo	0,1	100,0
Průměrně příhodné substrátové poměry	H. H. Bennet, 1955	USA	0,02–0,15	66,7–500,0
Průměrně příhodné substrátové poměry	Z. Kukal, 1984	Česká republika	0,1	100,0
Průměrně příhodné substrátové poměry	J. Drbal, 1965	Česká republika	0,125–0,2	50,0–80,0
Průměrně příhodné substrátové poměry	V. Veselý, 1970	Česká republika	0,05	200,0

Hauptman, I., Kukal, Z., Pošmourný, K. (2009): Půda v České republice. Ministerstvo životního prostředí ČR, Ministerstvo zemědělství ČR. ISBN 8090348246

Eroze

- eroze – základní ohrožení
- 85% všech degradací
- **nevratný nenapravitelný proces ztráty půdy**
- **celosvětově až 25 – 75 mld. tun ročně**
- v EU je erozí postiženo 16% plochy EU



<http://croptgenebank.wordpress.com/2009/06/11/going-south/soil-erosion/>

FAO, ITPS, GSBI, SCBD and EC. 2020. State of knowledge of soil biodiversity - Status, challenges and potentialities, Report 2020. Rome, FAO.
<https://doi.org/10.4060/cb1928en>

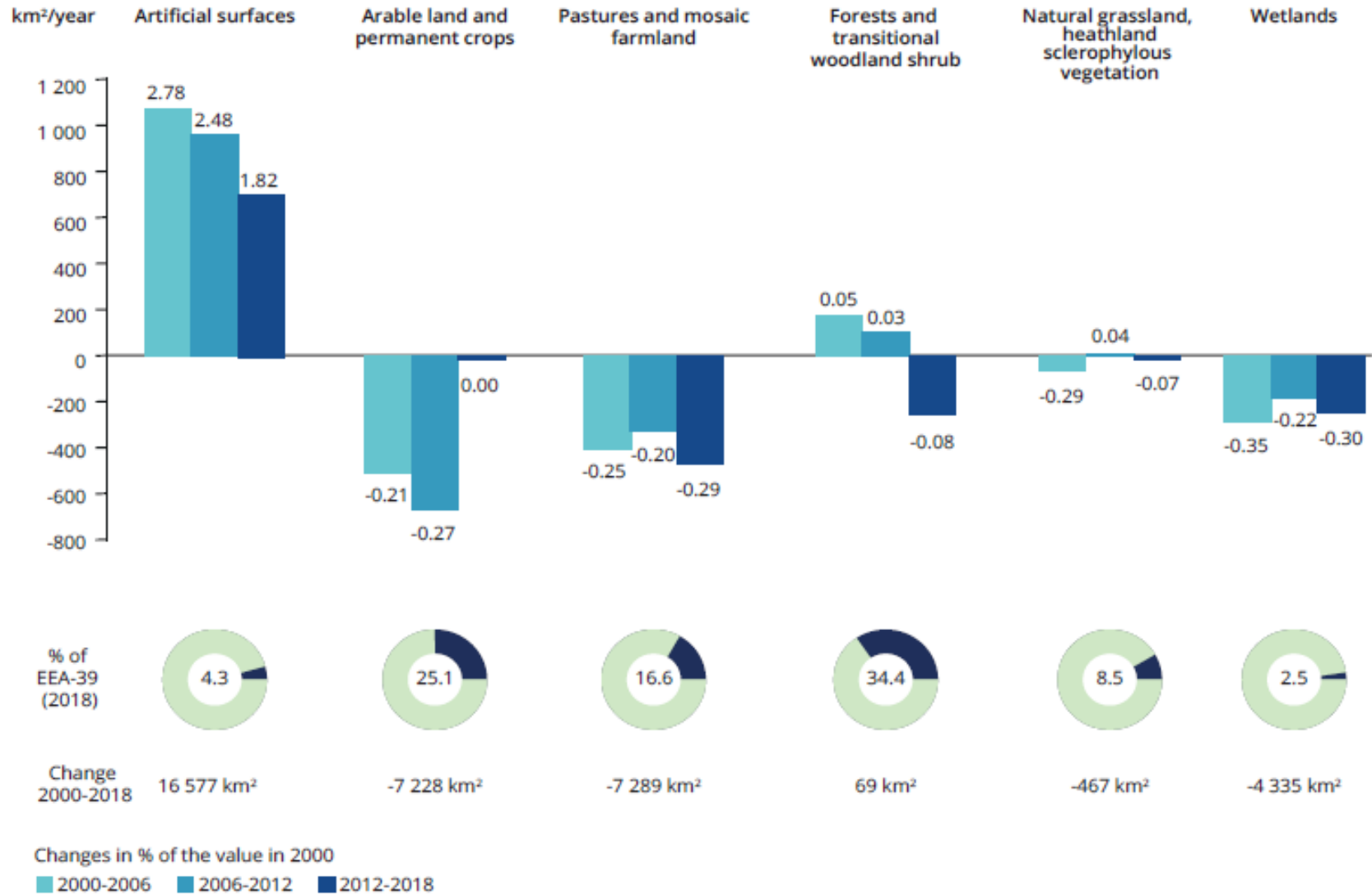


Zábory



FAO, ITPS, GSBI, SCBD and EC. 2020. State of knowledge of soil biodiversity - Status, challenges and potentialities, Report 2020. Rome, FAO. <https://doi.org/10.4060/cb1928en>

FIGURE 5.1 Change in six major land cover types in the EEA-39 during the period 2000-2018

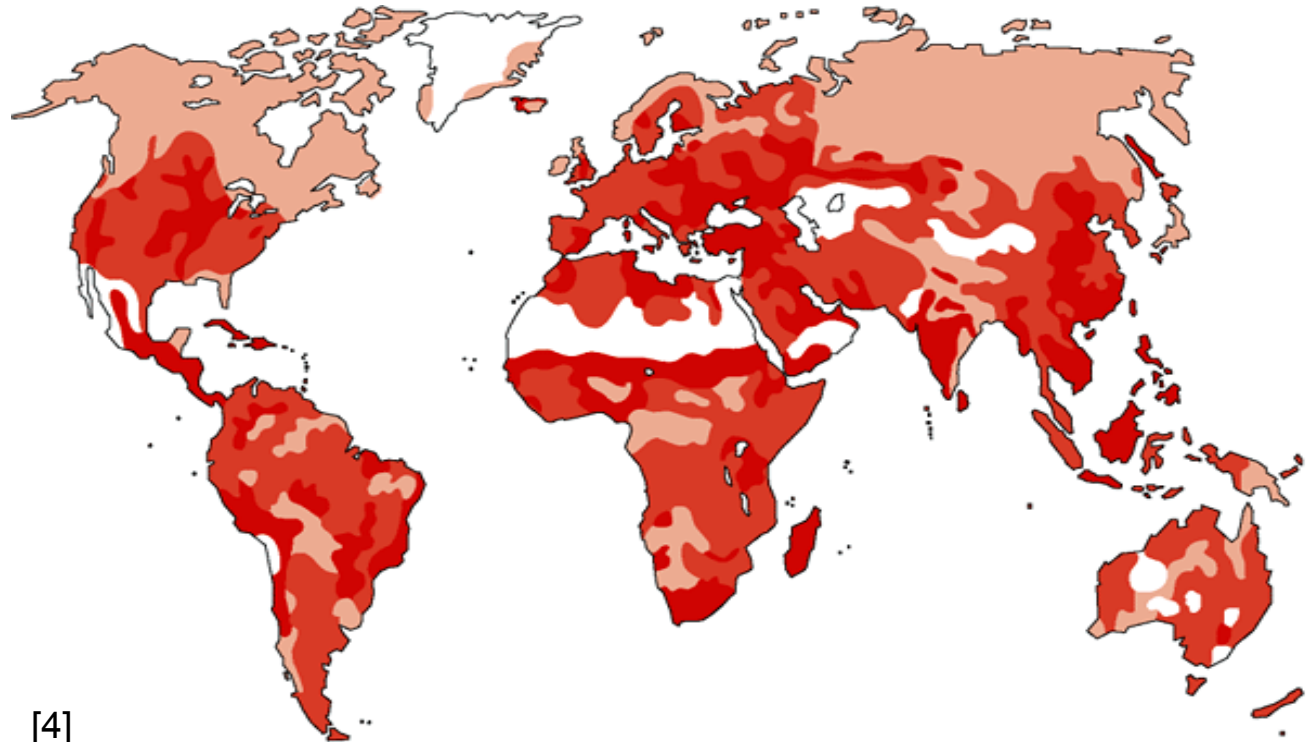


Note: Open spaces and water bodies are not shown, which is why the percentages do not add up to 100 %.

Source: EEA.

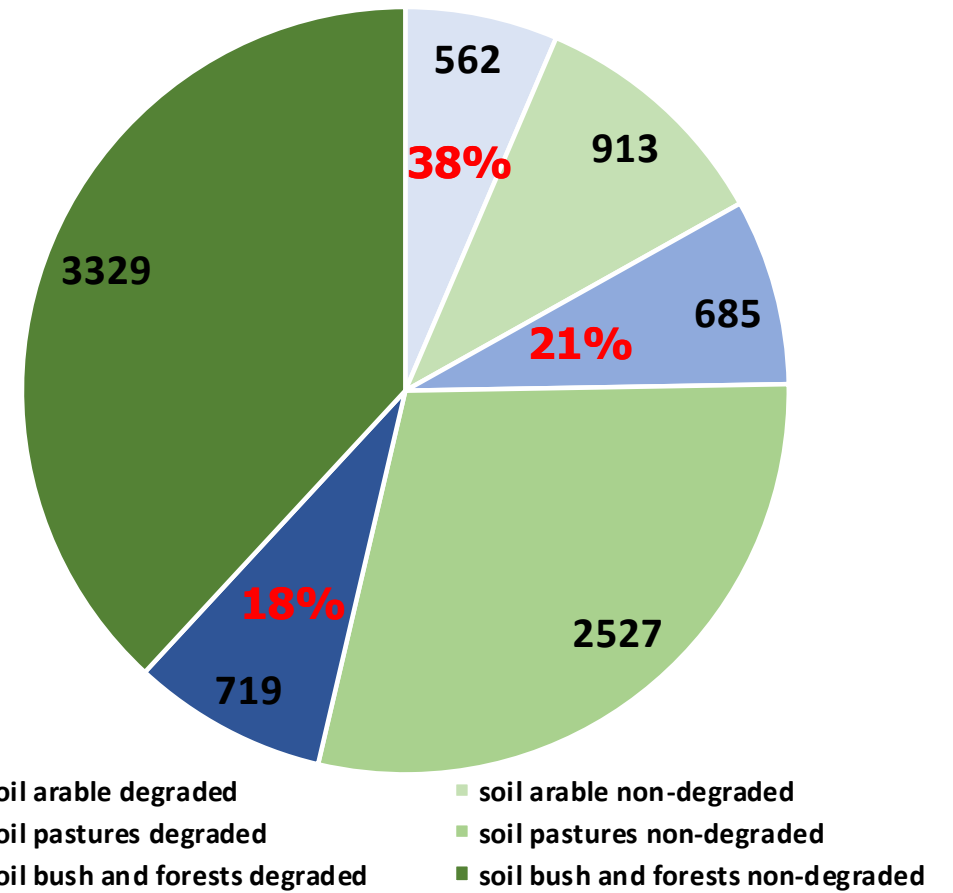
EEA (2020): The European environment - state and outlook 2020 - Knowledge for transition to a sustainable Europe. Chapter 05: Land and soil. ISBN 9789294800909. <https://www.eea.europa.eu/soer/2020>

Degradace půdy



[4]

■ Very degraded soil
 ■ Degraded soil
 ■ Stable soil
 Without vegetation



world = 8 700 Mha soil
 2 000 Mha degraded (23%)

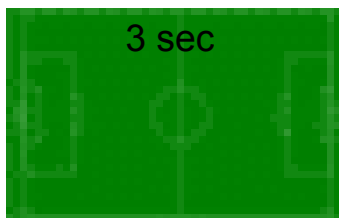
data dle [5]

Globální degradace půdy

Za jaký časový úsek přijdeme o úrodnou půdu o velikosti fotbalového hřiště?



Globální degradace půdy



ztráta půdy
konzervativní odhad dle FAO
2015
(pouze eroze a zábory)

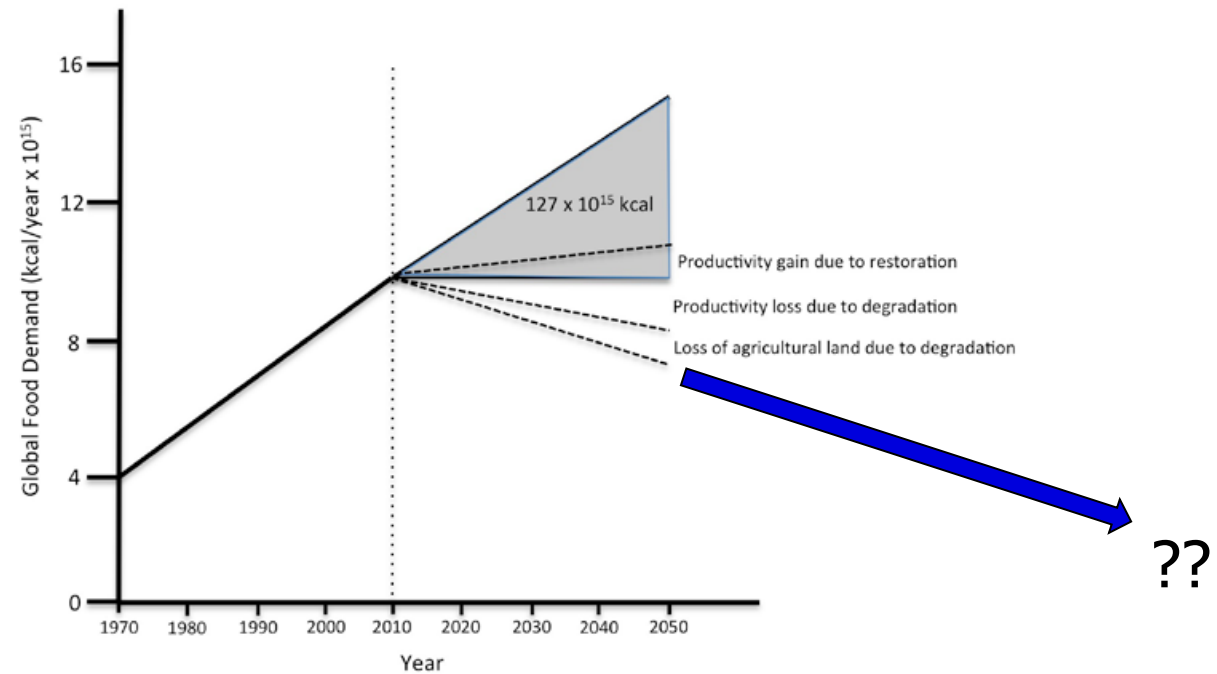
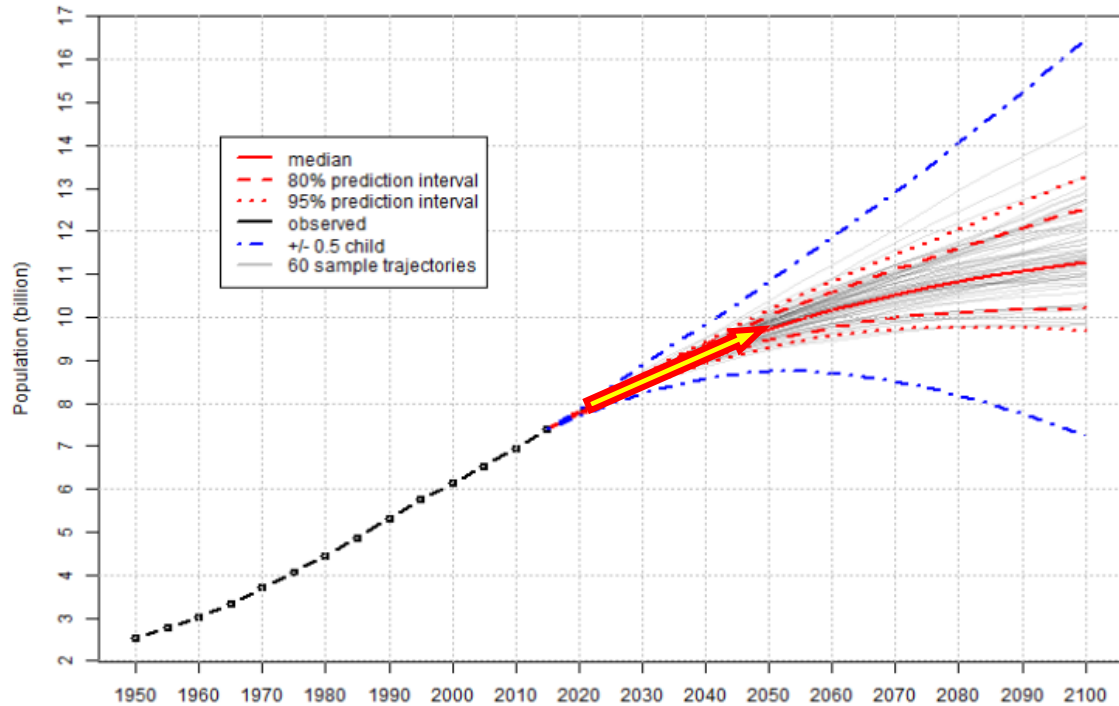


rychlost ztrát půdy (10 Mha/r) výrazně (5-57x, AU-CN) převyšuje její tvorbu/obnovu

→ za sto let na světě pravděpodobně nebude žádná zemědělská půda !!

total crop yield losses to 2050 - equivalent to removing 150 Mha from crop production – corresponds to all arable land in India

Food security



Do roku 2050 musíme globálně zvýšit produkci potravin o 50-60% a v rozvojových zemích o 100% jen na pokrytí potřeby potravin (úbytek půdy není započítán)

Food security

Figure 3.1 Agricultural and forest land use 1961-2013

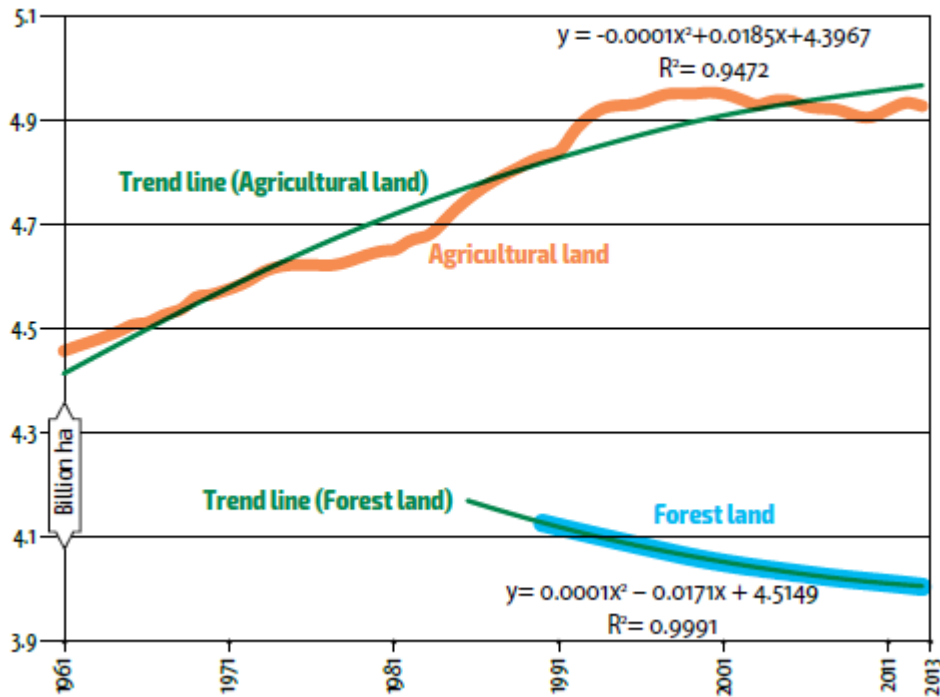
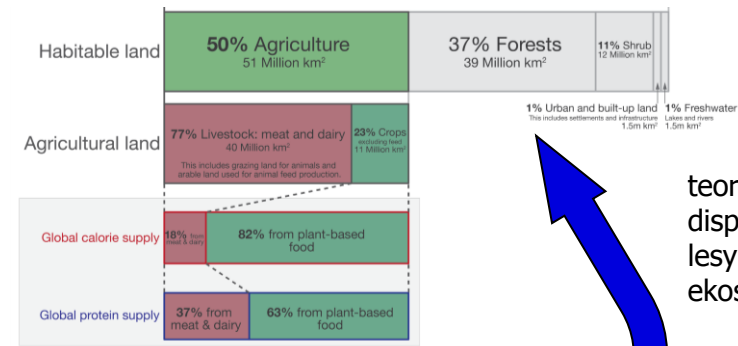
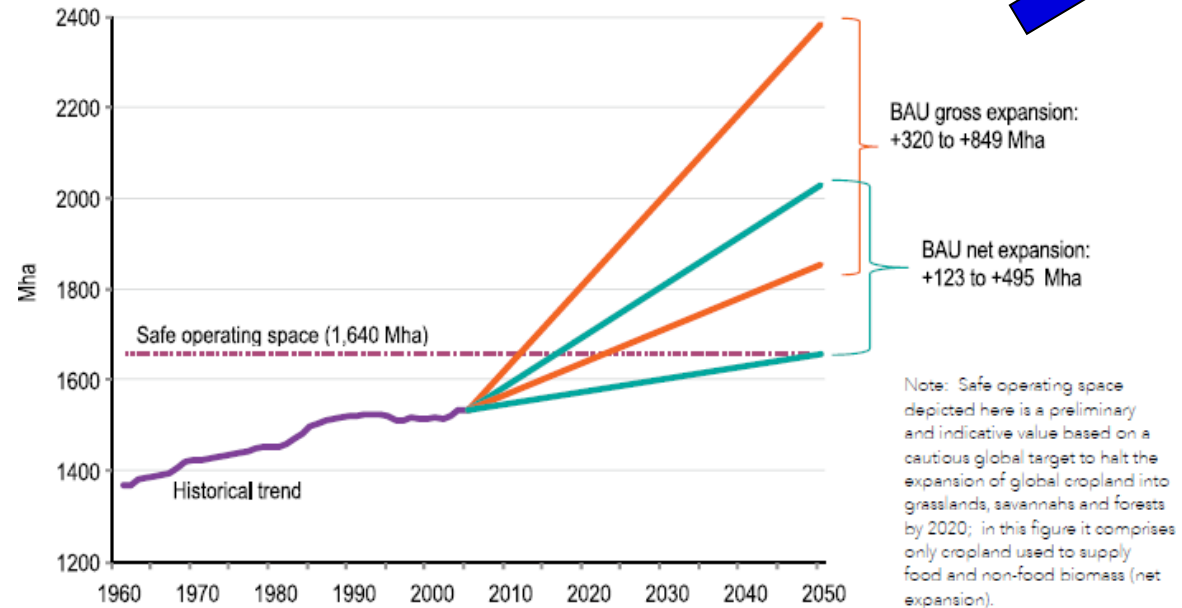


Figure 9 Expansion of global cropland under business-as-usual conditions: overshoot of safe operating space



teor. 5000 Mha k dispozici (všechny lesy a ostatní ekosystémy)

Under business-as-usual conditions until 2050, the expected range of cropland expansion would overshoot the safe operating space in all cases.

Food security

Úbytek úrodné půdy / obyvatelé rychle klesá:

1. nárůst světové populace (cca 70 mil ročně) → 9.2 mld v 2050
2. degradace dostupných půd → pokles jejich produkční kapacity či rozlohy
3. zábory kvalitní půdy pro jiné účely

v roce 2050 potřeba potravin vzroste o 50%, ale bude o 20-30% méně úrodné půdy = čelíme opravdu velkému problému.

→ **obavy z nedostatku potravin = food security**



<http://www.fao.org/soils-2015/en>

Prognóza do roku 2050

- poptávka po potravinách (o 50% větší světové populace)
- na zemědělství převedeno 10^9 ha přírodních ekosystémů
- doprovázeno 2,4 - 2,7 -násobným nárůstem eutrofizace terestrických, sladkovodních a pobřežních mořských ekosystémů v důsledku používání N a P hnojiv
- nárůst použití pesticidů
- bezprecedentní degradace ekosystémů a ztráta ekosystémových služeb a vyhynutí druhů

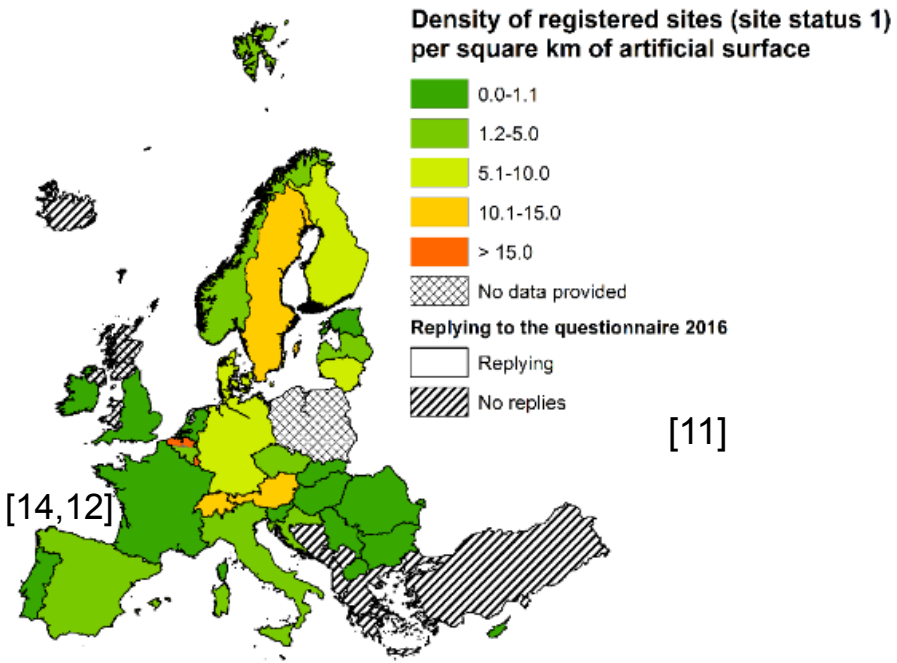
	Fertilizer (10^6 MT)		Irrigated land (10^6 ha)	Pesticide		Crop land (10^9 ha)	Pasture land (10^9 ha)
	N	P		Produced (10^6 MT)	Imported (10^9 1996 U.S.\$)		
Value in 2000	87.0	34.3	280	3.75	11.8	1.54	3.47
	<i>Mean projections</i>						
Forecast 2020	135	47.6	367	6.55	18.5	1.66	3.67
Forecast 2050	236	83.7	529	10.1	32.2	1.89	4.01

Tilman D. et al. (2001): Forecasting Agriculturally Driven Global Environmental Change. Science 292: 281-84. DOI:[10.1126/science.1057544](https://doi.org/10.1126/science.1057544)

Kontaminace půdy

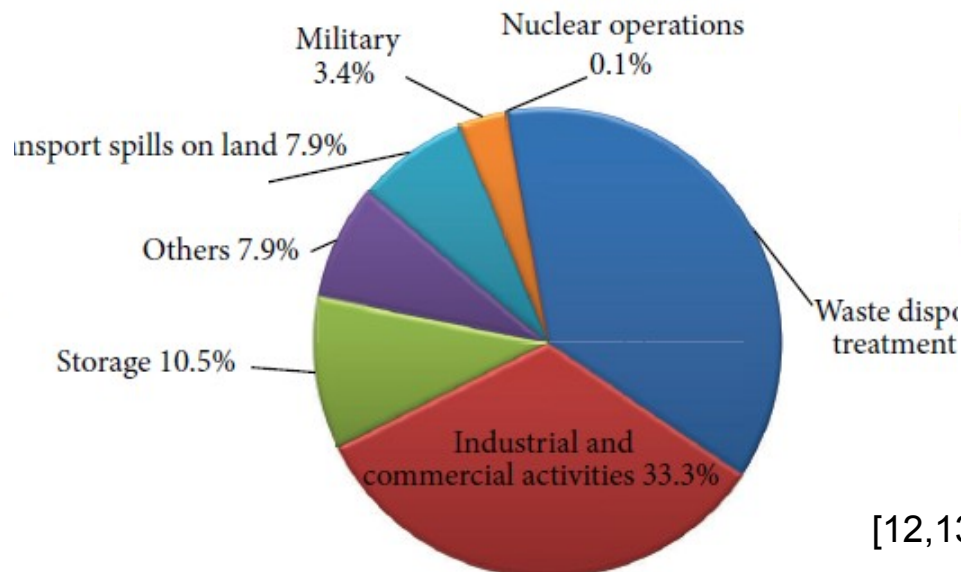
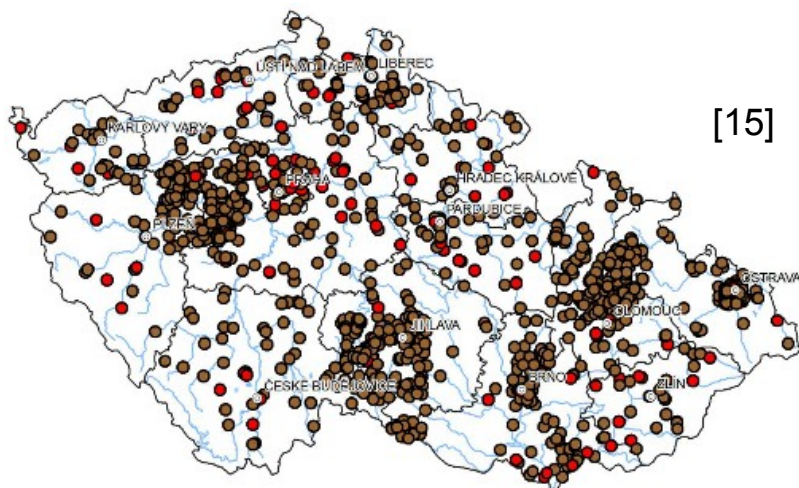
Evropa [10,11,12,13] :

- 2,5 – 3,5 mil. míst se znečišťujícími aktivitami
- 250 000 – 350 000 potřebuje remediaci
- náklady: 2,4-17,3 mld. EUR/r + 2 mld. EUR/r na remediaci [14,12]

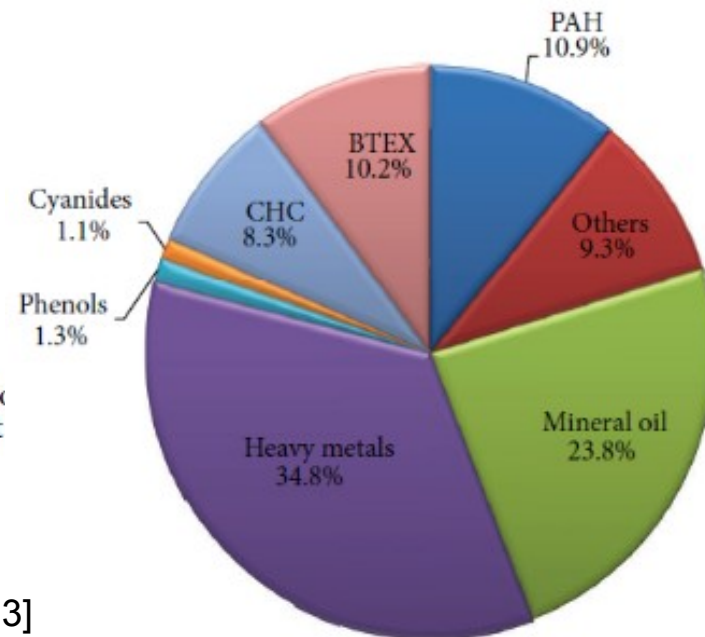


ČR [15]

- 7 000 - 10 000 kontaminovaných míst



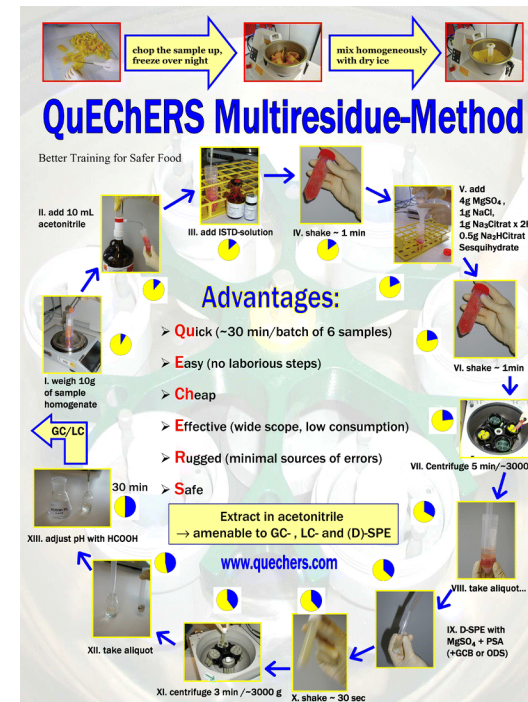
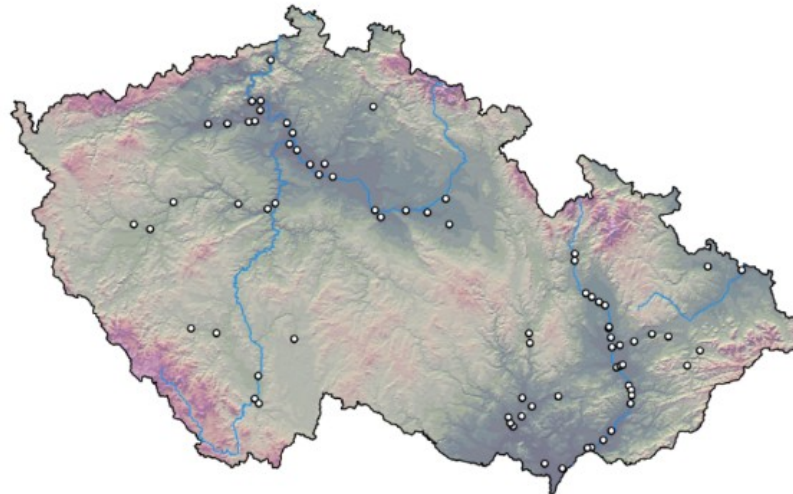
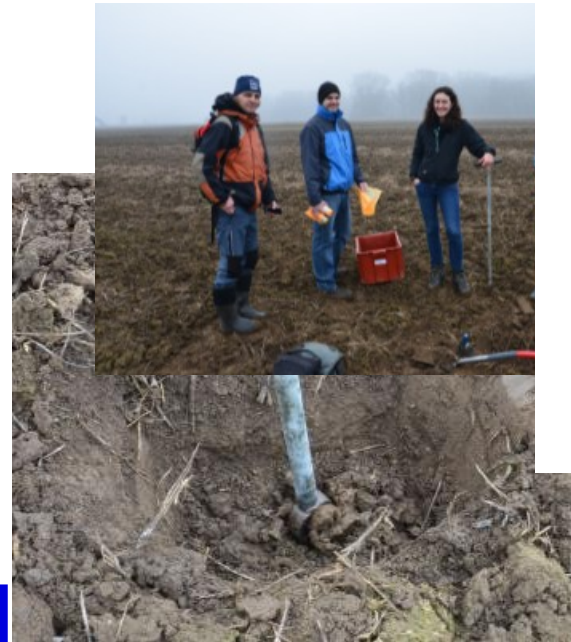
Overview of contaminants affecting soil



[12,13]

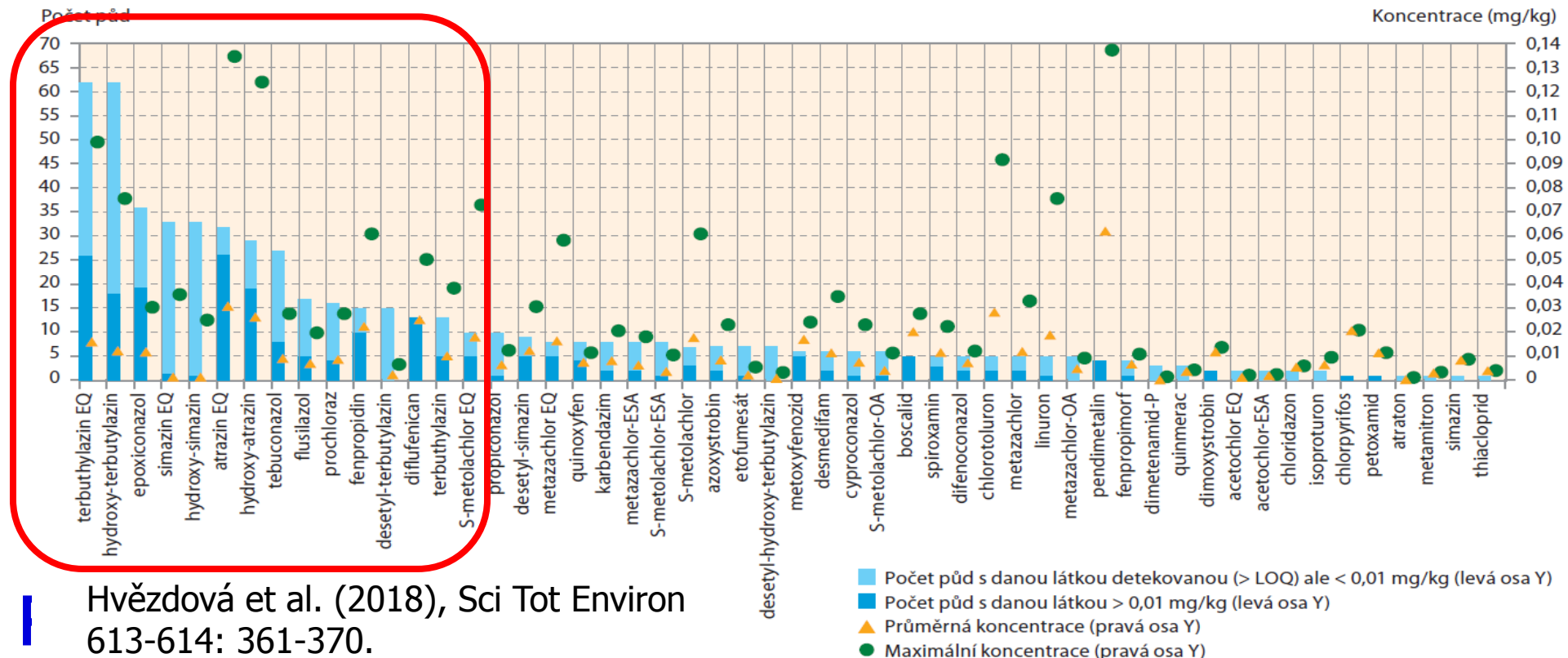
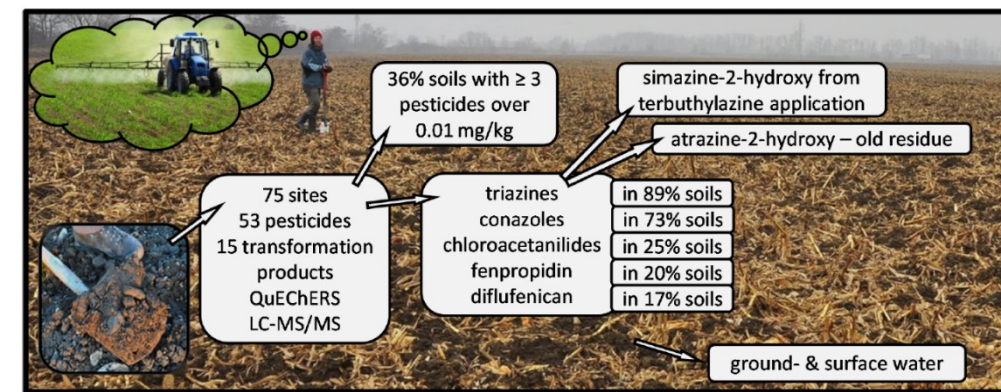
Pesticidy v orné půdě ČR

- únor–březen 2015 = dlouhodobá rezidua CUPs
- 75 orných půd, 0-25 cm, vysušení, mělnění, přesátí, archivování, analýzy ...
- půdní vlastnosti (TOC, CEC, pH, textura, HA/FA ...)
- QuEChERS extrakce + LC/MS/MS analýza 53 CUPs a 15 TPů včetně 2 zakázaných t ... tovaným výskytům ve vodách



Pesticidy v orné půdě ČR

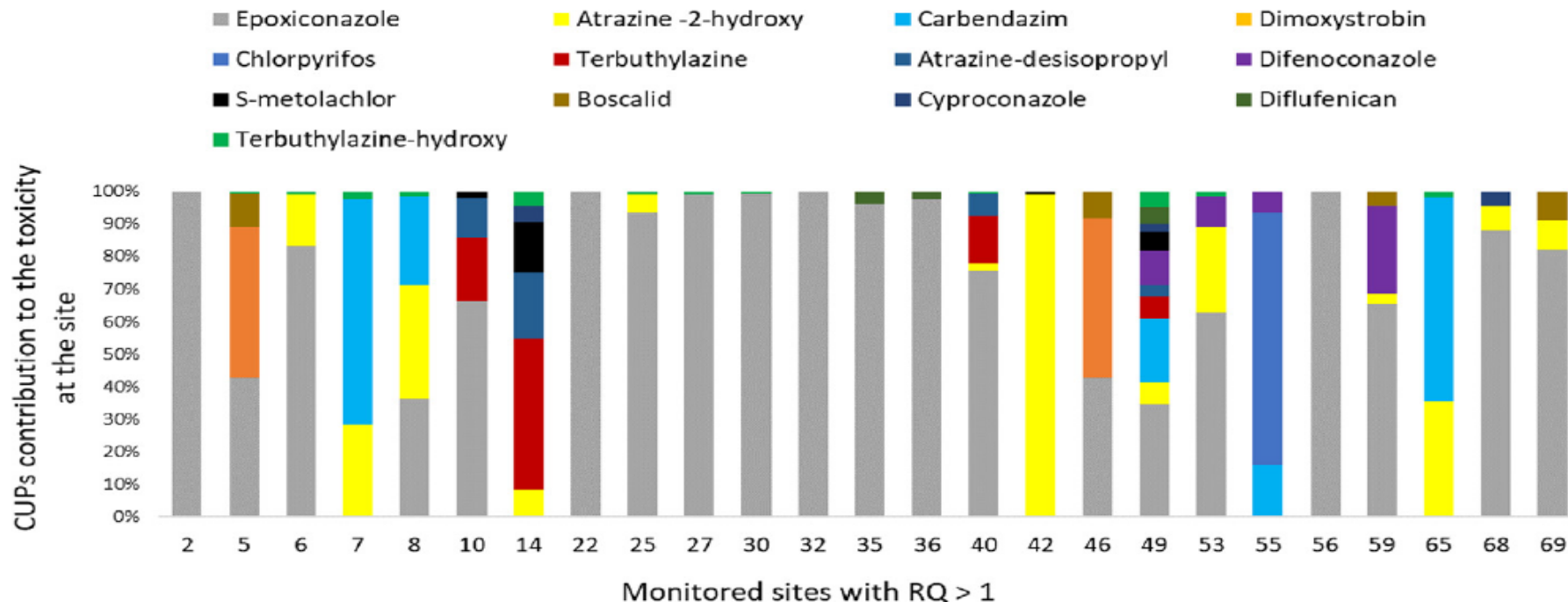
- 99% půd s alespoň jedním pesticidem > LOQ
- 51% půd s ≥ 5 pesticidy > LOQ
- 81% půd s alespoň jedním pesticidem nad 0.01 mg/kg**
- 36% půd s ≥ 3 pesticidy nad 0.01 mg/kg**



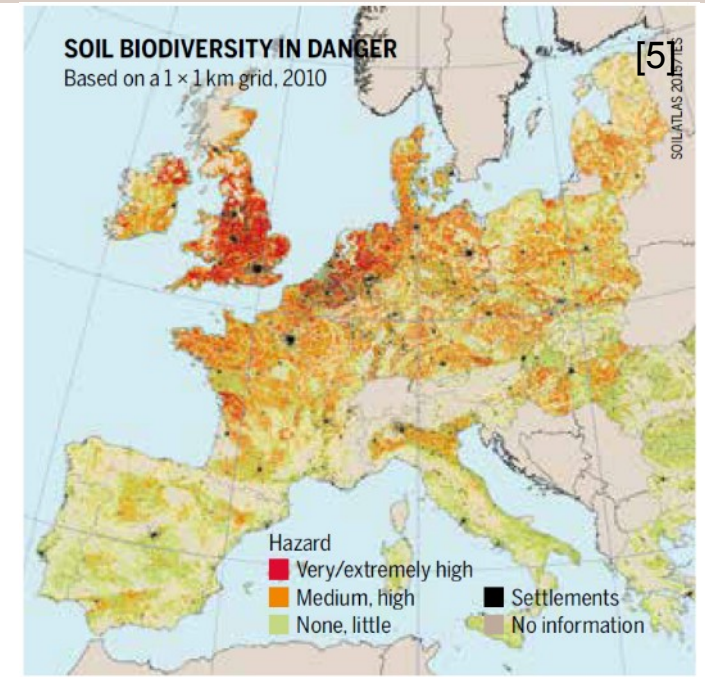
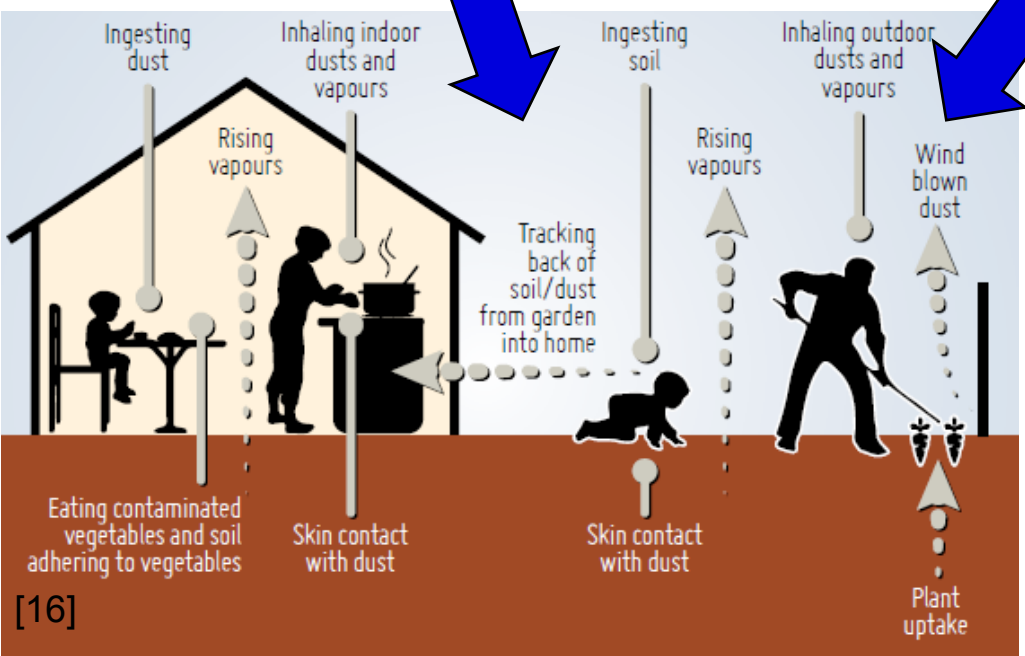
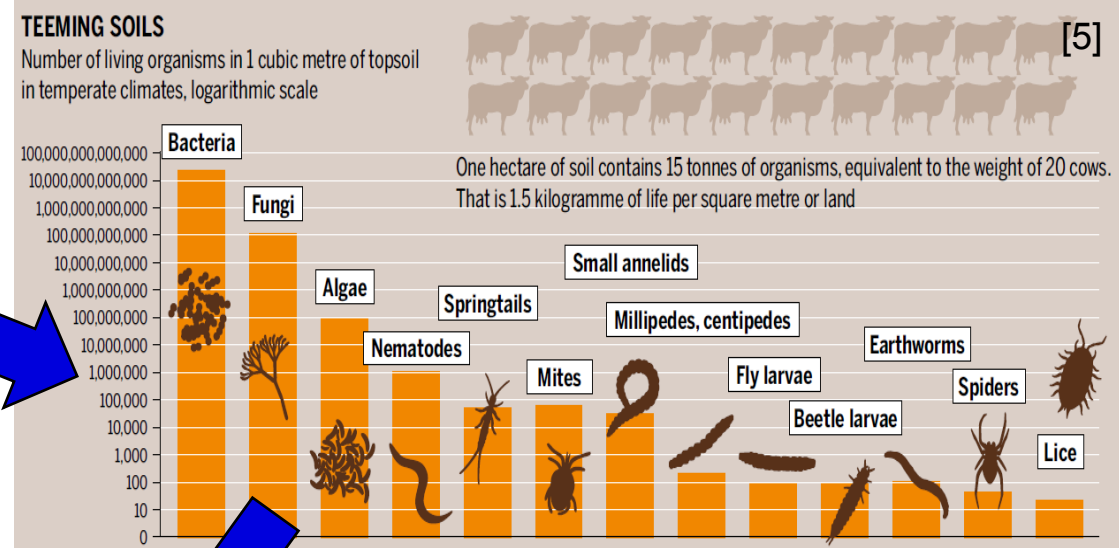
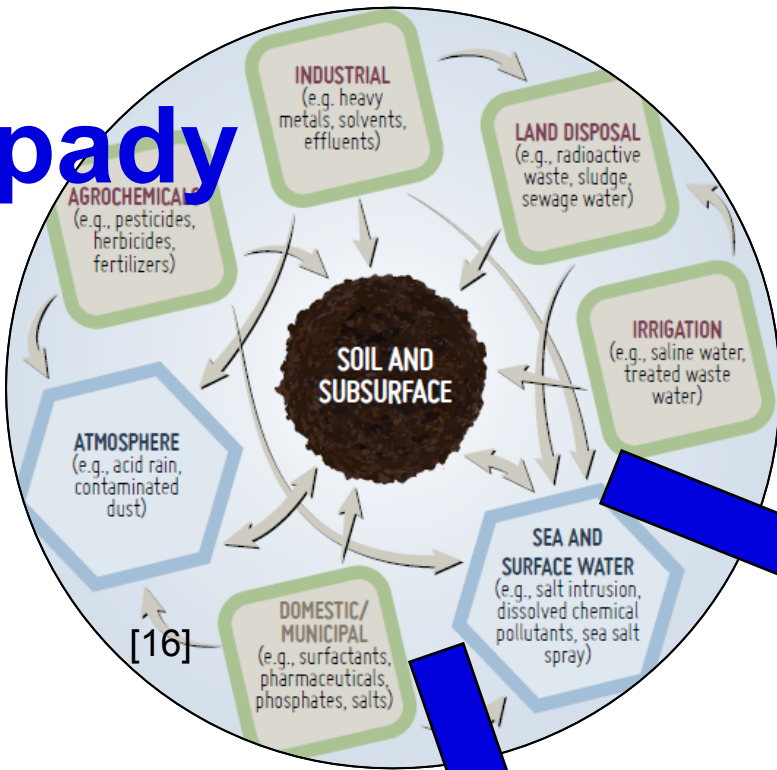
Hvězdová et al. (2018), Sci Tot Environ
613-614: 361-370.

Pesticidy v půdě ČR

- výsledky zaslouží pozornost z hlediska možných dopadů
 - dle provedené analýzy ekologických rizik je v **35% půd významné riziko pro půdní biotu** (RQ > 1)
 - také zahraniční limity založené na výpočtu rizik byly často překročeny



Dopady



Impact Assessment Report

- vyčíslení škod v EU-25 způsobených degradačními faktory (v těchto škodách nejsou zahrnuty škody na ekologických funkcích půdy)

Eroze	€0.7 – 14 mld
Ztráty organické hmoty	€3.4 – 5.6 mld
Zhutnění	Odhad není možný
Salinizace	€158 – 321 million
Sesuvy	až €1.2 mld na jeden případ
Kontaminace	€2.4 – 17.3 mld
Zábory	Odhad není možný
Ztráty na biodiverzitě	Odhad není možný

European Commission (2006c): Commission staff working document accompanying the communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the regions. Thematic strategy for soil protection. **Impact assessment of the thematic strategy on soil protection**. SEC (2006) 260. <https://eur-lex.europa.eu/legal-content/FI/TXT/?uri=CELEX:52006SC0620>

- tedy celkové náklady až 38 mld. ročně
- **GEO6**: globální roční ztráty na ekosystémových službách díky půdní degradaci 6300-10600 mld dolarů

Pilíře ochrany půdy

- **politika**
strategie, deklarace, charty ... národní, mezinárodní
- **legislativa**
rámcová – ochrana půdy nebo určité půdy /ZPF/, konkrétní – limity, regulace procesů/dějů, hospodaření ...
- **ekonomické nástroje**
dotace, poplatky, pokuty, daně
- **praktická opatření chránící půdu**
před erozí, zábory, kontaminací; postupy hospodaření ...
- **výzkum a vývoj**
monitoring, poznání dějů, vývoj nástrojů (vč. těch legislativních), jak na to ...
- **osvěta**
vzdělávání, výchova, informace

Ochrana půdy

současné legislativní, ekonomické a etické prostředí je velmi nepříznivé pro zachování kvality půdy

- soukromé vlastnictví půdy → obtížné prosazování legislativních nástrojů ochrany + stav, kde zisky jdou do korporací a ztráty hradí společnost
- na úrovni EU není zatím žádný předpis pro její ochranu (pro biodiverzitu 3, pro vodu 5, pro ovzduší a klima 5)
- Evropská směrnice na ochranu půdy (2006) zamítnuta
- v ČR zákon na ochranu zemědělského půdního fondu (334/1992 Sb.)
- ... další kontext viz. ŽP a zemědělství ...
- **nyní ale SOIL MISSION !!!!!**



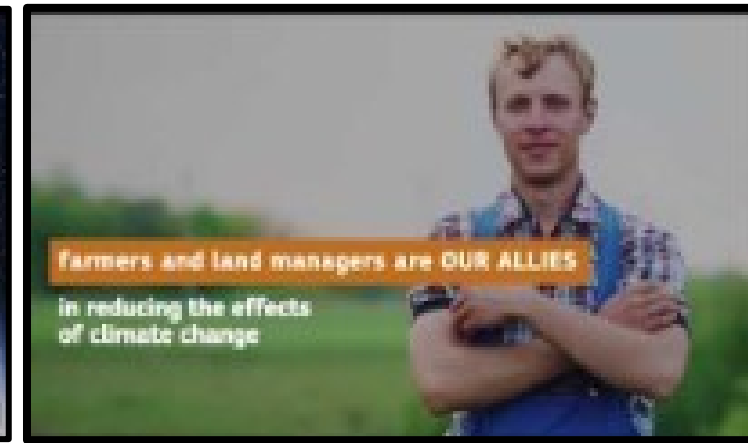
EU Missions: Soil Deal for Europe

- 60-70% of EU soils are unhealthy
- soil is fragile resource that needs protection for future generations
- the Mission leads the transition towards healthy soils by:
 - R&I programme
 - 100 living labs and lighthouses
 - harmonised soil monitoring
 - people's awareness

• **the 8 Mission objectives** → → →

<https://mission-soil-platform.ec.europa.eu/>

MUNI | RECETOX



“75% of European soils as healthy or significantly improved by 2030”

1. Reduce desertification

2. Conserve **soil organic carbon stocks**

3. Stop **soil sealing** and increase re-use of **urban soils**

4. Reduce **soil pollution** and enhance **restoration**

5. Prevent erosion

6. Improve soil structure to enhance **soil biodiversity**

7. Reduce the EU global footprint on soils

8. Improve **soil literacy** in society

ABOUT SOIL AND THE WORLD

1 Land and soil have a multitude of **SOCIAL, ECOLOGICAL, CULTURAL, SPIRITUAL AND ECONOMIC** functions worldwide.

2 Fertile soil is vital. It forms just a thin layer on the Earth's surface. **IT TAKES 2,000 YEARS TO CREATE 10 CENTIMETRES OF TOPSOIL.**

3 Millions of hectares of land are lost every year through inappropriate farming techniques, for the construction of cities and roads, and through deforestation. **CITIES EAT INTO FIELDS,** and fields expand at the expense of forest and pastureland.

4 **WITHOUT PROTECTING THE SOIL, IT WILL BE IMPOSSIBLE TO FEED A GROWING WORLD POPULATION,** keep global warming below 2 degrees Celsius, or halt the loss of biodiversity.

5 Land ownership is distributed inequitably – even more so than income. **ACCESS TO LAND IS FUNDAMENTAL IN THE FIGHT AGAINST HUNGER AND POVERTY.** In many countries, women are disadvantaged compared to men.

6 **LAND PRICES ARE RISING ALMOST EVERYWHERE.** If individual or communal rights are not assured, local people are forced off the land.

7 **COMPETITION FOR LAND IS GROWING.** The causes include the spread of fodder crops, and the growing use of crops to produce "green" biofuels.

Global trade has turned arable land into a mobile resource. **DEVELOPED AND EMERGING ECONOMIES ARE EXPORTING THEIR HUNGER FOR LAND TO THE DEVELOPING WORLD.** They import land in the form of products grown abroad.

9 Despite the fact that chemical fertilizer is being used, yields are not increasing as rapidly as expected. **ORGANIC FARMING STIMULATES SOIL ORGANISMS** and improves soil fertility in the long term – something that mineral fertilizers fail to do.

10 **MODERN CITY PLANNING MUST INCLUDE SOIL CONSERVATION.** Infrastructure and housing must use less fertile land, especially in countries with declining populations.

11 **AN INTERNATIONAL REGULATORY FRAMEWORK BASED ON HUMAN RIGHTS** must ensure that the distribution of land is equitable and that fertile soils are not monopolized by the rich.

12 Protecting the soil is a global task. **BUT INDIVIDUALS CAN MAKE A SIGNIFICANT CONTRIBUTION** by purchasing local products and eating less meat.

Díky za pozornost

Literatura

1. <http://www.fao.org/soils-2015/en>
2. Keesstra S.D., Bouma J., Wallinga J., Tiftonell P.A., Putten W.H.v.d., Mol G., Jansen B., Fresco L.O. (2016): The significance of soils and soil science towards realization of the United Nations Sustainable Development Goals. *Soil* 2, 111-128.
3. Rockström J., Steffen W., Noone K., Persson Å., Chapin Iii F.S., Lambin E., Lenton T.M., Scheffer M., Folke C., Schellnhuber H.J. (2009): Planetary boundaries: exploring the safe operating space for humanity. *Ecology and society* 14
4. UNEP (2002): *Global Environment Outlook 3. Past, present and future perspectives*. United Nations Environmental Programme. ISBN 9280720872
5. Oldeman L.R. (1994): The global extent of land degradation. In Greenland D.J., Szabolcs I. (eds.): *Land resilience and sustainable land use*. p. 99–118. Wallingford: CAB
6. Heinrich-Böll-Stiftung, Institute for Advanced Sustainability Studies (2015): *Soil Atlas: Facts and figures about earth, land and fields*.
7. FAO and ITPS (2015): *Status of the World's Soil Resources (SWSR) – Main Report*. Food and Agriculture Organization of the United Nations and Intergovernmental Technical Panel on Soils, Rome, Italy. ISBN ISBN 978-92-5-109004-6
8. <https://population.un.org/wpp/Graphs/Probabilistic/POP/TOT/>
9. Český úřad zeměměřický a katastrální (2018): *Souhrnné přehledy o půdním fondu z údajů katastru nemovitostí České republiky*. ISSN 1804-2422
10. EEA (2007): *CSI 015 - Progress in management of contaminated sites - Assessment published Aug 2007*. European Environmental Agency. www.eea.eu
11. Pérez A.P., Rodríguez Eugenio N. (2018): *Status of local soil contamination in Europe: Revision of the indicator "Progress in the management Contaminated Sites in Europe*, EUR 29124 EN, Publications Office of the European Union, Luxembourg, 2018, ISBN 978-92-79-80072-6.
12. Panagos P., Van Liedekerke M., Yigini Y., Montanarella L. (2013): *Contaminated Sites in Europe: Review of the Current Situation Based on Data Collected through a European Network*. *Journal of Environmental and Public Health* 2013:158764
13. <https://www.eea.europa.eu/data-and-maps/indicators/progress-in-management-of-contaminated-sites-3/assessment>
14. European Commission (2006): *Commission staff working document accompanying the communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the regions. Thematic strategy for soil protection. Impact assessment of the thematic strategy on soil protection*. SEC (2006) 620.

Literatura

15. MŽP (2016): Zpráva o životním prostředí České republiky. ISBN 978-80-87770-29-0
16. Rodríguez-Eugenio N., McLaughlin M., Pennock D. (2018): Soil Pollution: a hidden reality. FAO. 142 pp.
17. <http://www.fao.org/faostat/en/#data/RP>
18. Popp J. & Hantos K. (2011) The impact of crop protection on agricultural production. *Studies in Agricultural Economics* 113: 47-66.
19. Oerke E.C. (2005) Crop losses to pests. *Journal of Agricultural Science* 144: 31–43.
20. Pimentel, D., 1995. Amounts of pesticides reaching target pests: environmental impacts and ethics. *J. Agric. Environ. Ethics* 8, 17e29
21. <https://sitem.herts.ac.uk/aeru/iupac/index.htm>

Hvězdová, M., Kosubová, P., Košíková, M., Scherr, K.E., Šimek, Z., Brodský, L., Šudoma, M., Škulcová, L., Sáníka, M., Svobodová, M., Krkošková, L., Vašíčková, J., Neuwirthová, N., Bielská, L., Hofman, J. (2018): Currently and recently used pesticides in Central European arable soils. *Science of The Total Environment* 613-614: 361-370. <https://doi.org/10.1016/j.scitotenv.2017.09.049>

Vašíčková J., Hvězdová M., Kosubová P., Hofman J. (2019): Ecological risk assessment of pesticide residues in arable soils of the Czech Republic. *Chemosphere* 216, 479-487. <https://doi.org/10.1016/j.chemosphere.2018.10.158>

Další odkazy

- <https://www.youtube.com/watch?v=Z5rMheOnaec>
- <http://www.casopisveronica.cz/obsahcisla.php?rok=2018&cislo=1>