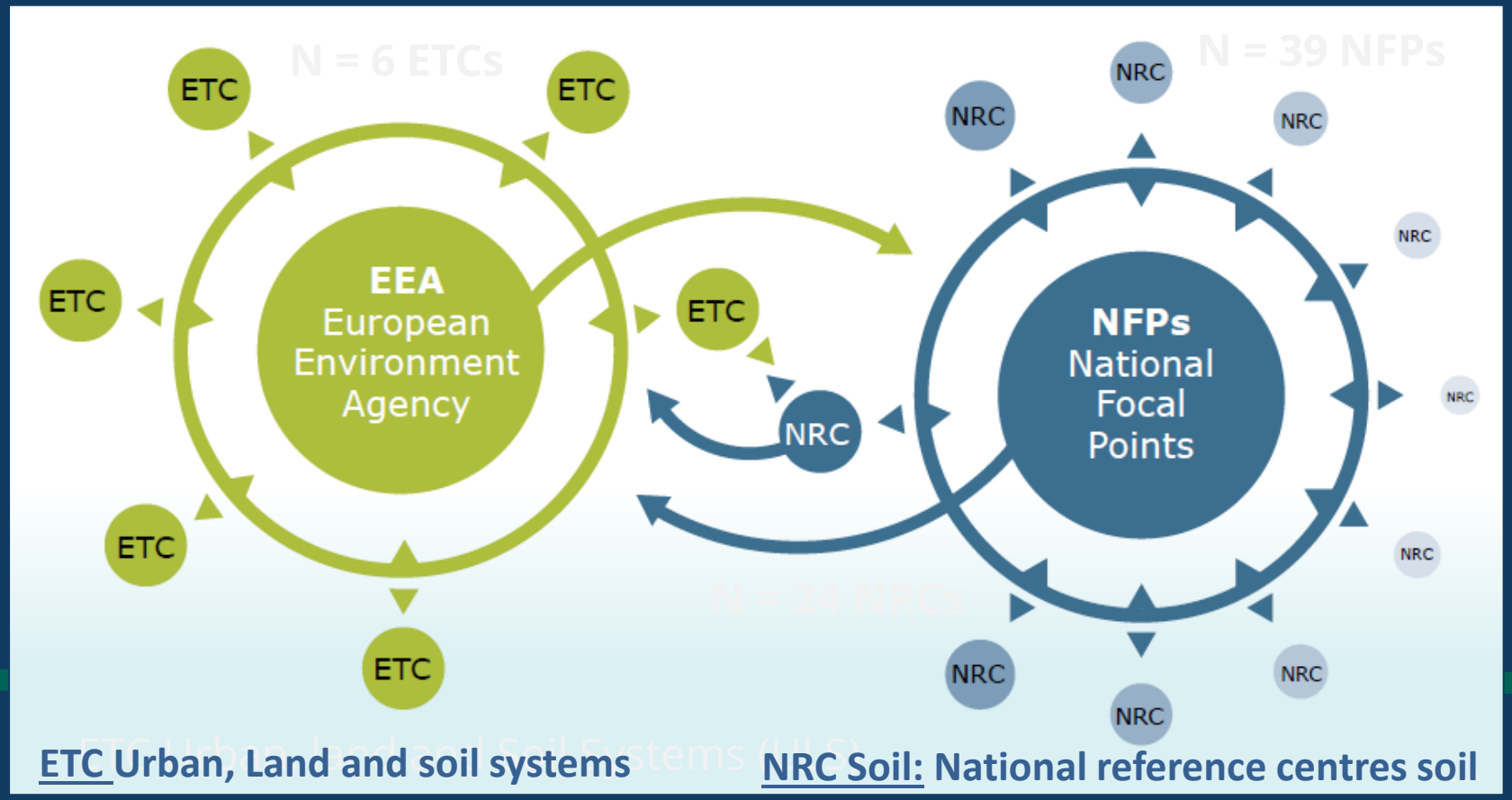
Rainer Baritz

Zustand der Böden Europas in 2021

The EEA and Eionet model

Eionet: European information and observation network
ETC/ULS: European topic centre urban land and soil systems

1800 experts (39 countries, > 400 national institutions)



ETC Urban, Land and soil systems **NRC Soil: National reference centres soil**

2022 ff:
EIONET Group Land Systems
Thematic Group Soil

Expert teams:
- **Soil Contamination**
- **Soil Monitoring** (link European Soil Observatory)

Environmental condition assessments: SOER 2020 – themes related to pollution

Air Pollution	Past trends (10-15 years)	Outlooks 2030
Emissions of air pollutants	Trends show a mixed picture	Developments show a mixed picture
Concentrations of air pollutants	Improving trends dominate	
Air pollution impacts on human health and wellbeing	Improving trends dominate	
Air pollution and impacts on ecosystems	Trends show a mixed picture	
Chemical Pollution		
Emissions of chemicals	Trends show a mixed picture	Deteriorating developments dominate
Impacts of chemical pollution on ecosystems		
Chemical pollution and risk to human health and well-being		
Industrial Pollution		
Pollutant emissions from industry	Improving trends dominate	Developments show a mixed picture
Clean industrial technologies and processes		
Freshwater		
Pollution pressures on water and links to human health	Developments show a mixed picture	Developments show a mixed picture
Land and Soil		
Soil condition	Deteriorating trends dominate	Deteriorating developments dominate

Key facts: soil condition and function

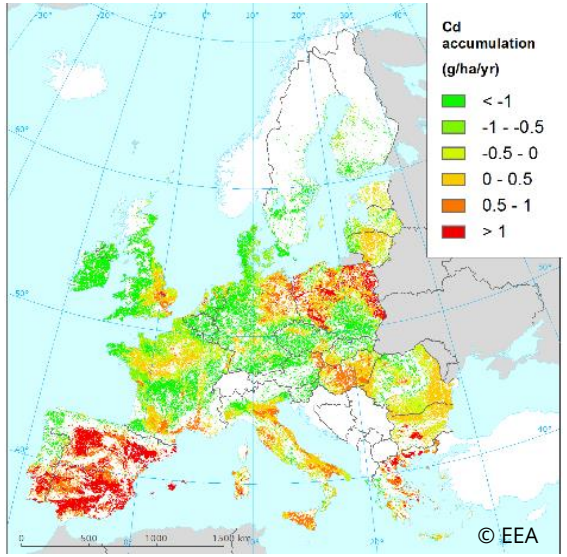
- 60-70% of our soils are unhealthy as a direct result of current management practices
- 21% of agricultural soils with Cd > limit for drinking water; 83% of an EU-wide representative soil sample have residual pesticides
- >2.8 Mio contaminated sites pose risk to drinking water quality, biodiversity and human healthsupports climate change mitigation and adaptation
- is lost by > 400 km²/yr (net) through land take in the EU between 2012 and 2018
- enables ~ EUR 47 billion/yr worth of ecosystem services of cropland and grasslands in the EU: less than half come from crop production
- suffers through soil degradation which is costing the EU several tens of billion euros/yr
- profits from halting and reversing current trends of soil degradation, which could generate up to EUR 1.2 trillion per year of economic benefits (globally)

Soil Condition

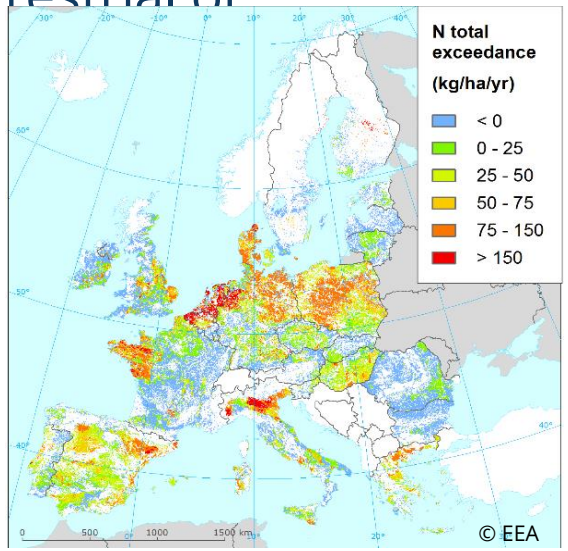
➢ Chemical degradation (…) increases (SOER 2020)

- **Contamination** at local level: municipal and industrial waste (37%), industrial emissions and leakages (33%) (Panagos et al. 2013)
- 2.8 million sites with potentially polluting activities; # sites currently under remediation seems to be low

- Some **metals** such as Cadmium (Cd) and Copper (Cu) are accumulating in arable soils. In 21% of the soils, the Cd concentration in the topsoil solution exceeds the limit for ground water



- There is increasing concern about the storage of **pesticide** residues and metabolites in soils (Silva et al. 2018)
- **Nutrient inputs** to soils through fertilizers: N inputs at EU-27 exceed critical N inputs in view of the protection of terrestrial or aquatic eco-systems by approximately 15-20%.



Policy needs for soil monitoring

Thematic Strategy for Soil Protection COM(2006)232

Proposal for a Soil Framework Directive

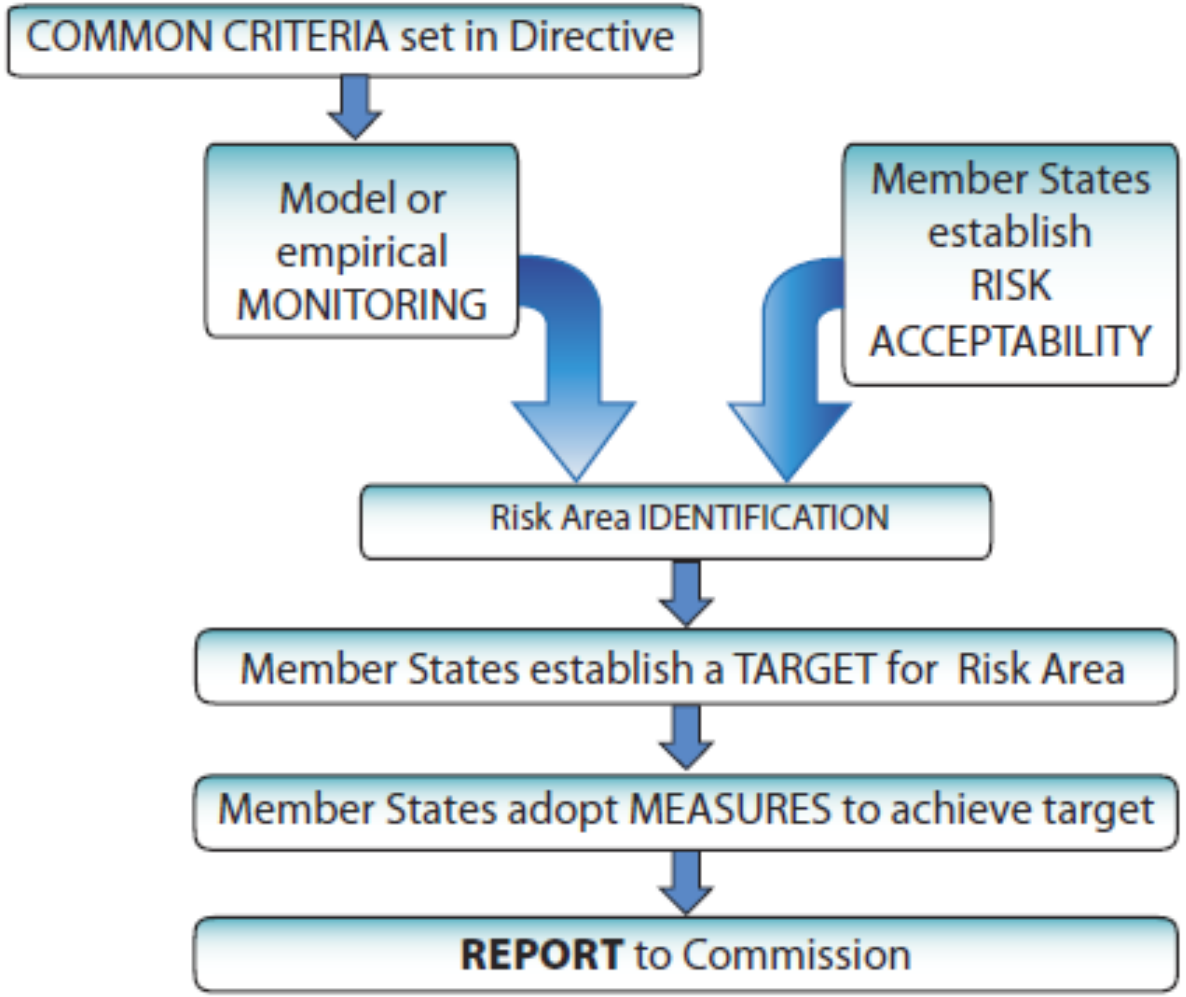
- **Protection of soil functions and sustainable use of soil**:
  - Prevention of soil degradation
  - Restoration of degraded soils
- Four pillars

EU Soil Strategy for 2030 COM(2021) 699

Announcing effort towards a Soil Health Law

- **By 2050, all EU soil ecosystems are in healthy condition**:
  - Land degradation neutrality
  - GHG removal
  - Reduce nutrient loss
  - Achieve good water quality
  - Remediate contaminated sites
  - No net land take
  - Reduce soil pollution
  - Climate resilience

Conceptual basis of the soil strategies (2006/2021)



Target: 50% healthy soils by 2050

EU Monitoring framework
- Soil functional & soil threat indicators
- EU monitoring grid (LUCAS Soil)

Member States' criteria & monitoring
- Regionalized risk-based reference values
- National monitoring

MS identify extend of unhealthy soils

MS identify/adopt restauration measures

National Healthy Soil Reports*)

*) requires legislative framework

European Environment Agency

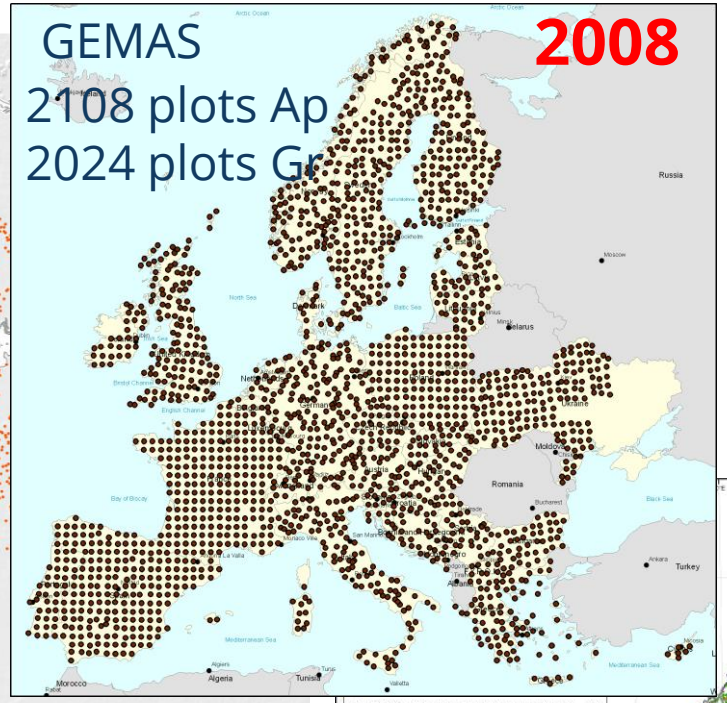
Surveys and monitoring in Europe

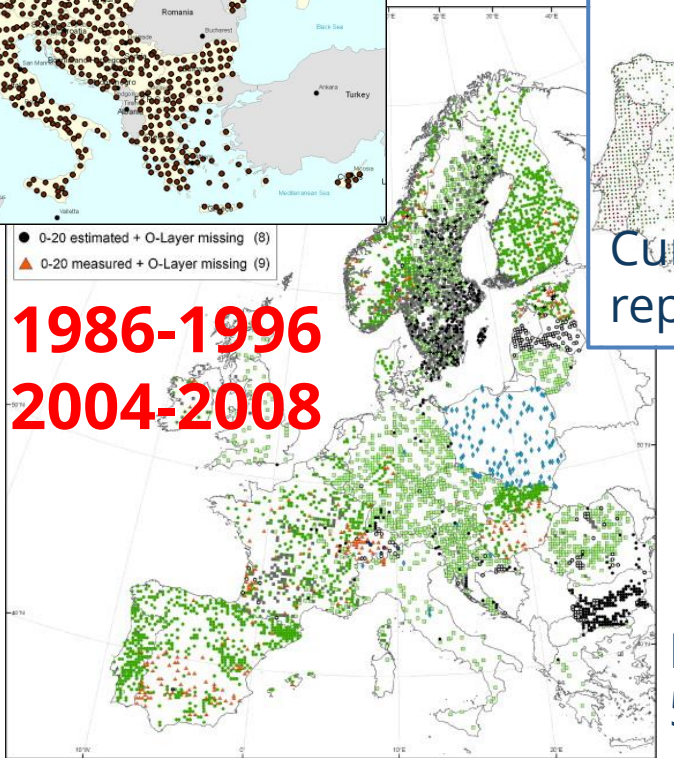
LUCAS Soil
22,000+ plots

2009/12
2015
2018
2021…

GEMAS
2108 plots Ap
2024 plots Gr

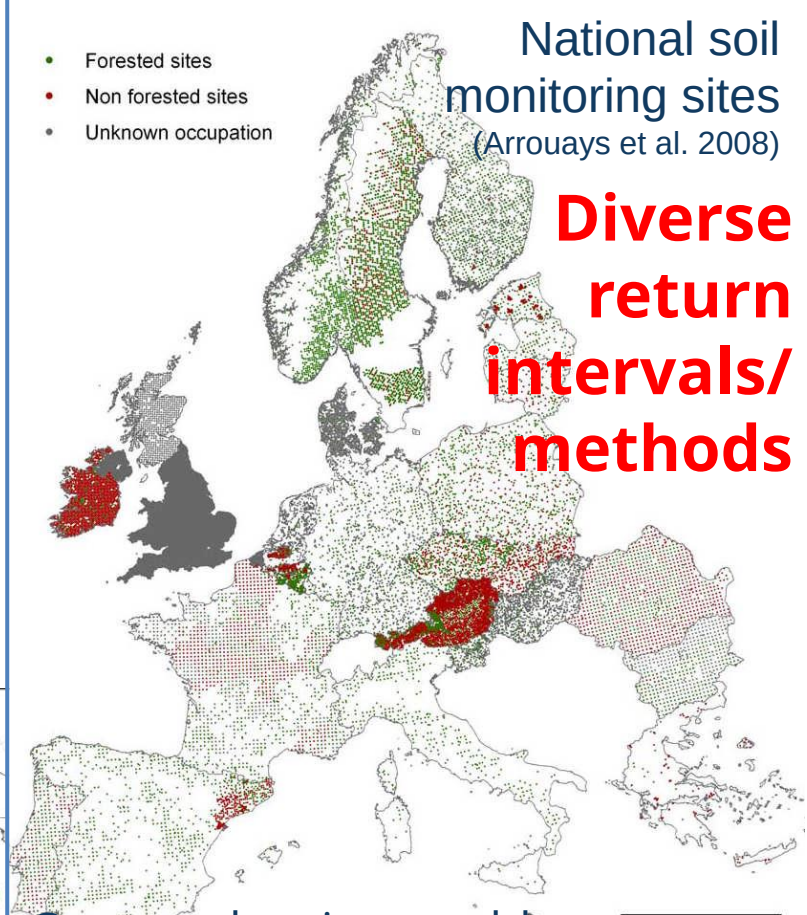
2008





1986-1996
2004-2008

Tests for monitoring integration:
France, Germany (forest soils), Austria



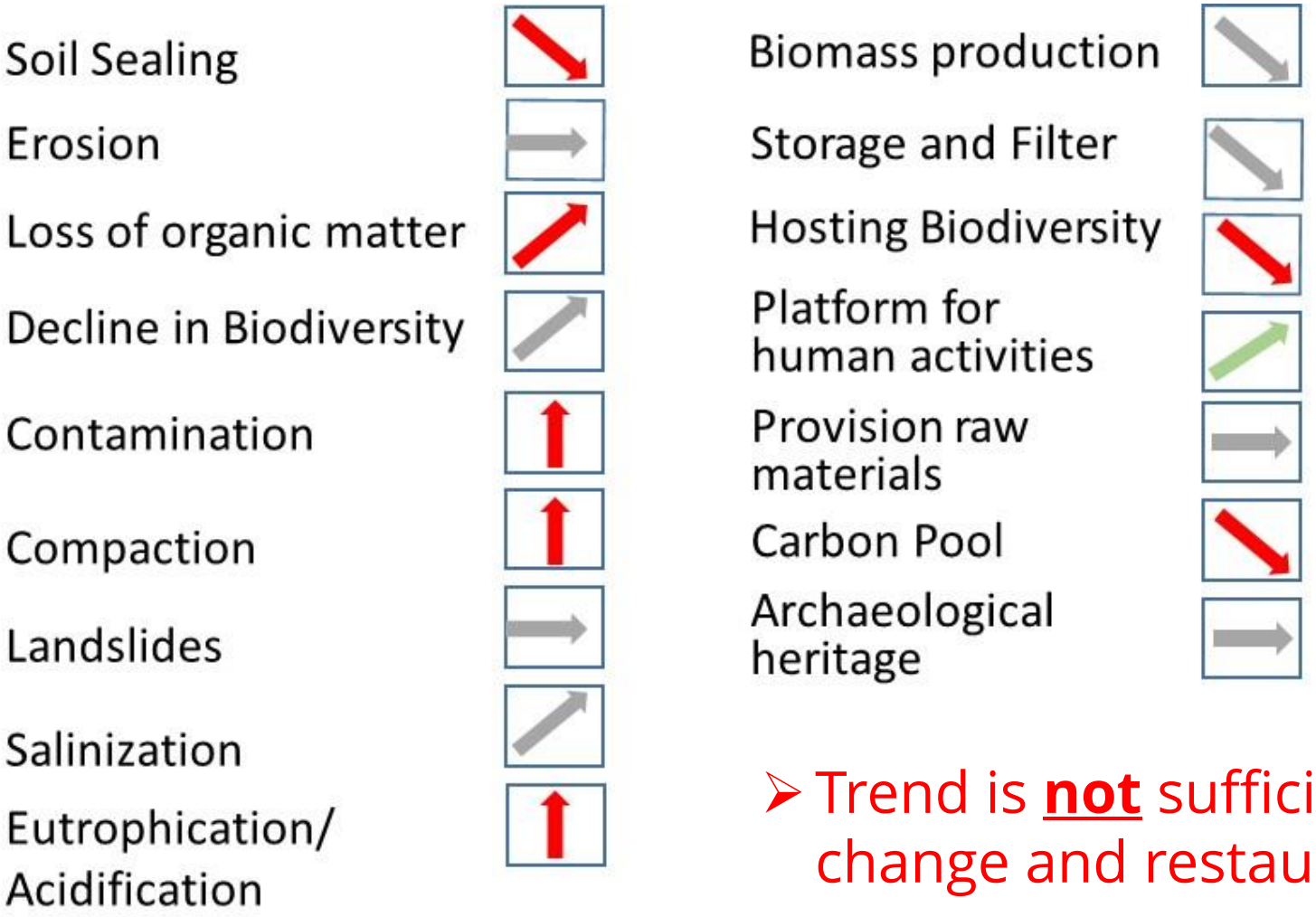
National soil monitoring sites
(Arrouays et al. 2008)

Diverse return intervals/ methods

Current density roughly represents a 17 km x 17 km grid

ICP Forests/Biosoil
5289 plots (738 Level II)

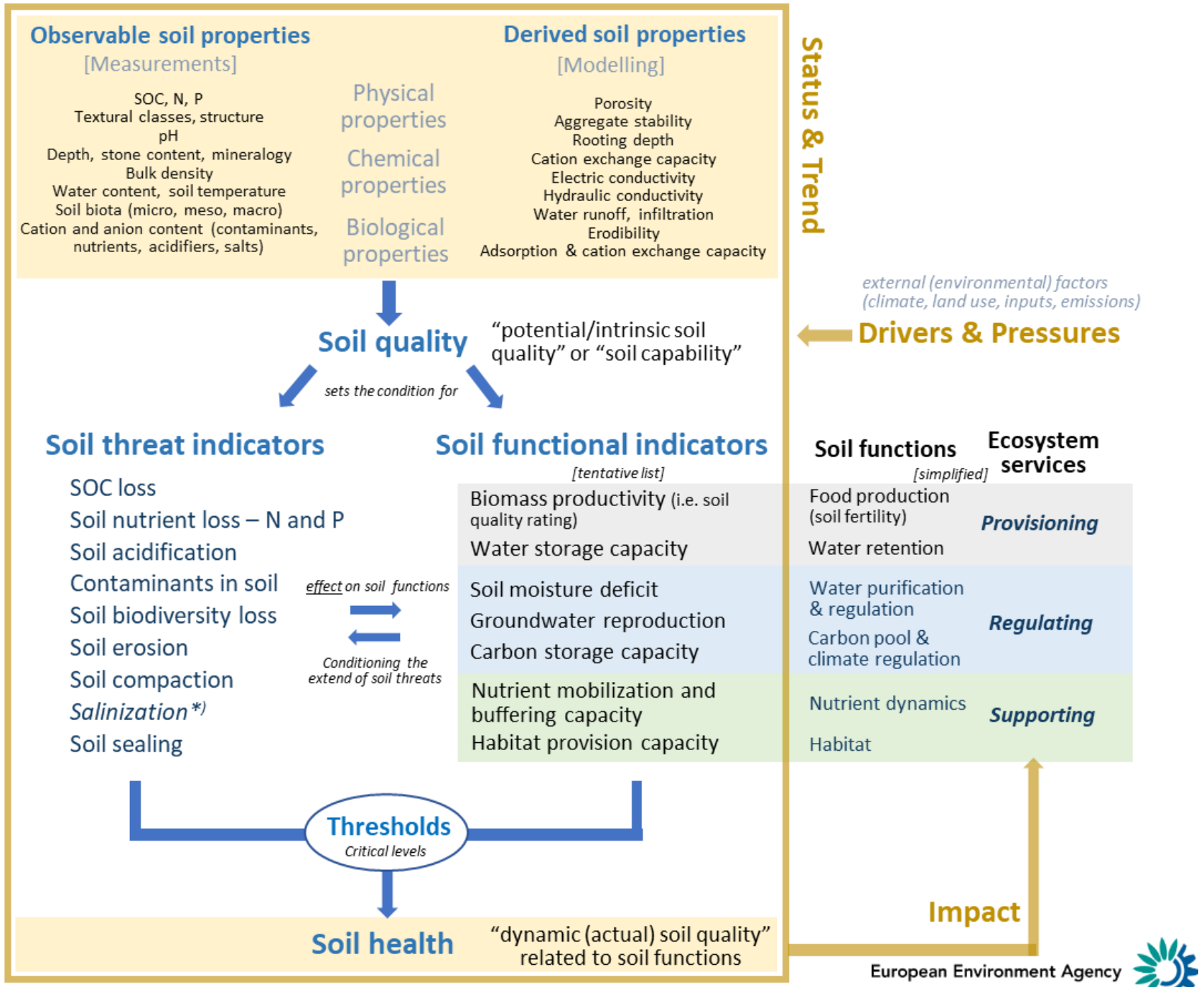
Soil status in Europe? Impact?



- Trend is **not** sufficient to guide where land use change and restaurative measures are needed!

European Environment Agency

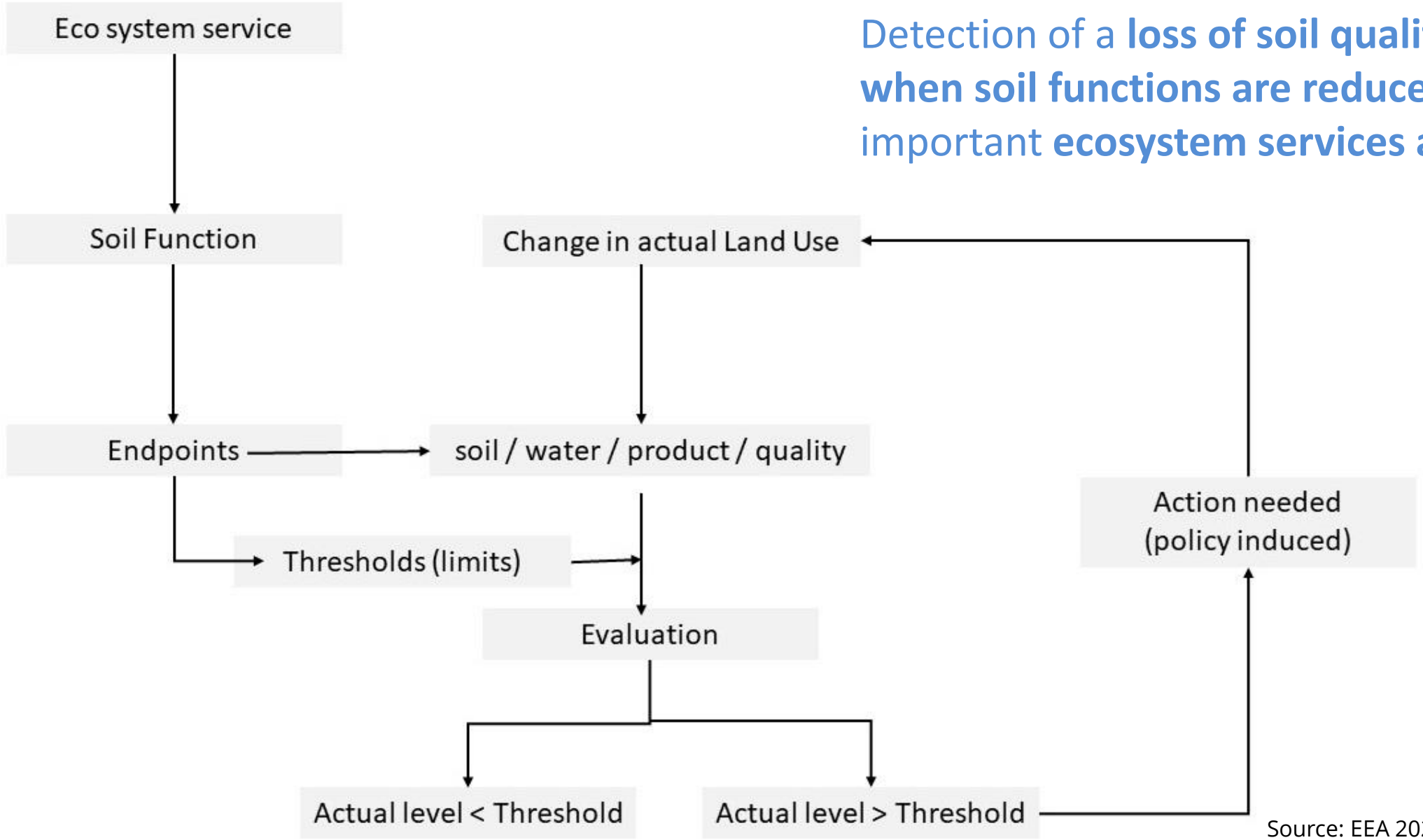
Soil health indicator conceptual framework



*) salinization is not covered by this report

Healthy soils/degraded soils: risk-based thresholds

Detection of a **loss of soil quality** to a level **when soil functions are reduced** so that important **ecosystem services are affected**.



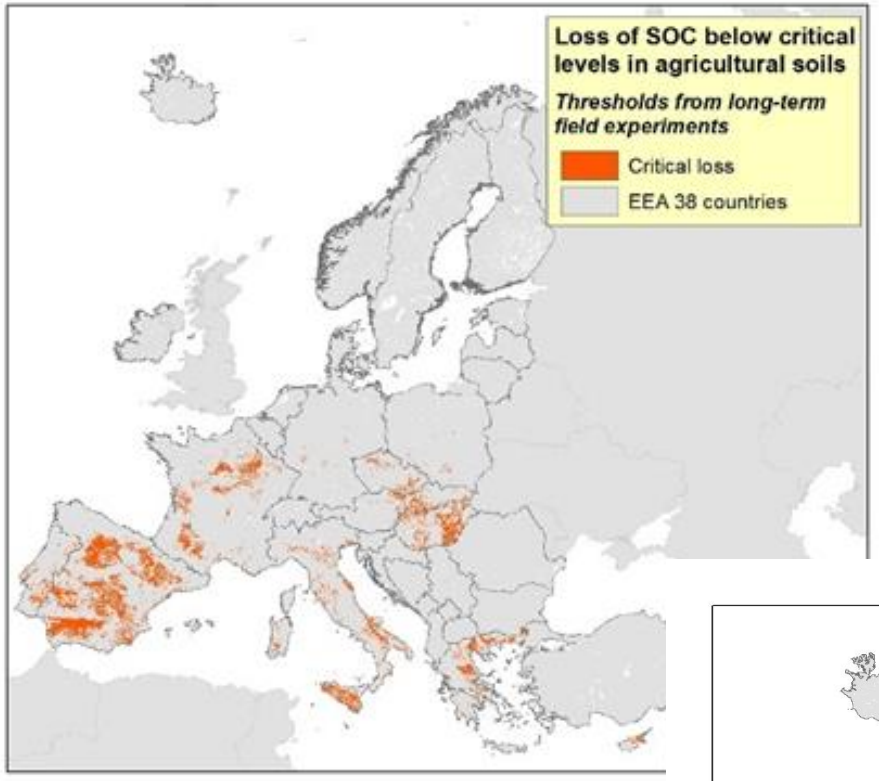
Source: EEA 2022 (Figure by P. Roemkens)

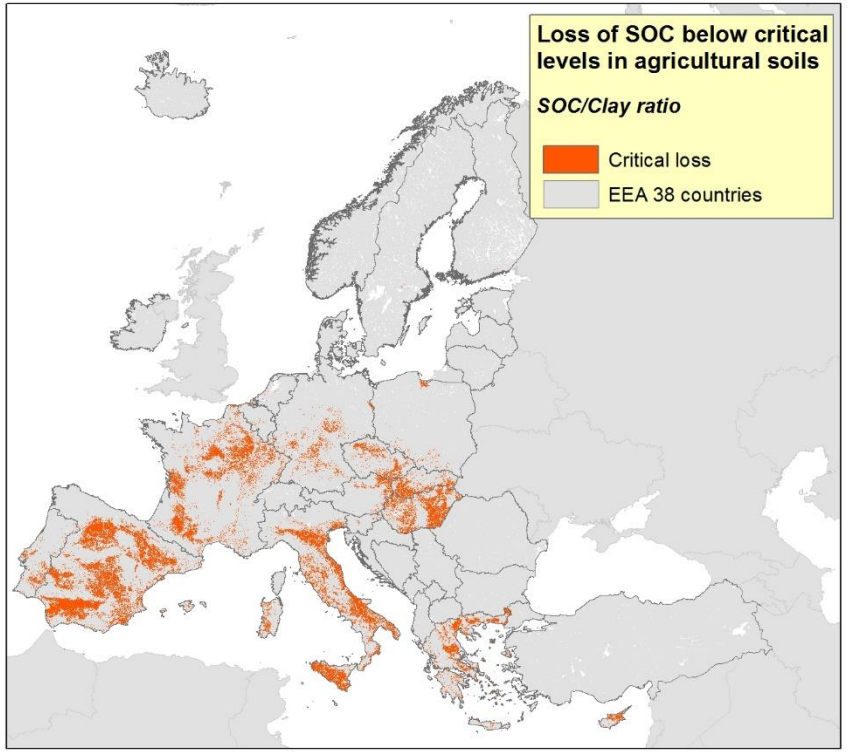
Soil threat	Land use	Indicator	Thresholds
Soil organic carbon loss	Agriculture	Deceedance of optimal SOC	Sand: 1,5 (1,0-2,0) [% SOC] Silt: 1,9 (1,4-2,4) Loam and clay: 1,6 (1,0-2,8)
Nutrient loss	Agriculture	Exceedance of critical levels of mineral nitrogen	NH_3 in air: 1 – 3 [mg NH_3 m^{-3}] NO_3 in ground water: 50 [mg NO_3 l^{-1}] N in surface water: 1.0 to 2.5 [mg N l^{-1}]
	Forest	N limitation based on exceedance of C/N ratio	C/N 20-25 leakage from forests: 1 [mg N l^{-1}]
	Agriculture	Deceedance of optimal phosphorus	P concentration 25-35 (optimal P fertility class)
	Forest	P limitation based on exceedance of N/P ratio	N/P ratio > 18 (coniferous forests) N/P ratio > 25 (deciduous forests)
Acidification	Agriculture	Critical pH levels	pH < 4.5 - 4.7
	Forest	Critical inorganic Al levels	base cation/aluminium ratio = 1 (0.5-2.0)
Soil pollution	Agriculture	Exceedance of screening values for critical risk from heavy metal pollution	Cd, Cu, Pb and Zn by country [mg/kg] (Arsenic still to be added; review of organic pollutants ongoing)
Soil erosion	Agriculture	Actual rate of soil loss by water erosion	2 [t ha^{-1} yr^{-1}] (soil loss tolerance)
Soil biodiversity loss		Loss of soil biodiversity (subindicators) *to be developed*	a) safe minimum standard of conservation b) Operating Ranges (OR) for specific soil animals and microorganisms
Soil compaction	Agriculture	Harmful subsoil compaction (subindicators) *priority (sub) indicators*	Saturated hydraulic conductivity (Ks) < 10 [cm/d] Air capacity (AC) < 5 [%]
Soil sealing		Sealed area per total area	National targets to achieve No Net Land Take

Example: SOC thresholds

	Definition
Reference values	Site-specific, typical SOC or SOM values under current management
	Benchmark SOC values
	– Natural soils (forest soils with low historic disturbance)
	– 25 quartile of the SOC median for permanent grassland
	– Modelled SOC steady state (25 yrs) for grassland
	Optimal SOC content for soil functioning (based on the role of SOC in soil functional PTF, combined with data from long term field experiments)
Soil vulnerability index based on the SOC/clay ratio	
Reciprocal SOC sequestration potential	
Thresholds from long-term field experiments	
Farmers perspective on deficient SOC	

Indicator “Functional SOC deficiency” for arable land





Climatic regions	Long-term field experiments	SOC/Clay ratio
Alpine	1,5%	13,9%
Atlantic	12,3%	27,3%
Boreal	0,0%	0,2%
Continental	13,6%	23,8%
Mediterranean	59,7%	75,9%
EU25	25,2%	37,1%

Outlook: Soil erosion functional indicators

Define target soil quality: minimum good status of potential ecosystem service supply

Threshold: **site-specific limits** for tolerable erosion rates are needed

Steinhoff-Knopp et al. (2020)

Ecosystem service	Indicator	Specifi-cation	Status ecosystem service supply					
			0 no	1 very low	2 low	**3 medium**	4 high	5 very high
Crop provision	potential arable yield	Potential yield winter barley [t/ha]	0	≤ 2500	2500 - 2875	**2875 - 3250**	3250 - 3625	≥ 3625
Water filtration	Nitrate leaching vulnerability	Water exchange rate [%/a]	0	≥ 250	150 - 250	**100 - 150**	70 - 100	< 70
Water flow regulation	Water storage capacity	potential storable water [mm]	0	< 50	50 - 90	**90 - 140**	140 - 200	≥ 200
Fresh water provision	Percolation rate	Percolated water [mm/a]	0	< 200	200 to < 250	**250 to < 300**	300 to < 350	≥ 350

Schlussargumente

- **Interdisziplinaere Verbindung von Bodenmonitoring**: Luftschadstoffe, Landnutzung (einschl. urbane Boeden, Moore, Kuesten,…), Hydro(geo)logie, Agrarmeteorologie, etc.
- **Erfahrungen** im Bodenmonitoring Deutschlands: Qualitaetssicherung,Trend, Interpretation
- Aktuelle Fragestellungen in **Einzelfaellen** in BDF behandelt, allerdings **nicht representativ**: organische Schadstoffe, Bodenbiodiversitaet, Verbindung Wasserkreislauf
- **Herausforderungen**: **Bewertung** im Hinblick auf bodenschutzrelevante Fragestellungen; Regionalisierung; Nutzungseffekte; Klimawandel, Oekosystemzustand
- Fach- und Institutionen-uebegreifende **Kooperationen** (Behoerden, Forschung)
- Ausreichende und stabile **Finanzierung** (Synergieeffekte, Bund-Laender)