



The complexity of evaluating soil health and good soil management practices

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Introduction

Presenters



Julie Estival

- Project leader agro-environment
- Specialized in multi dimensional remediation projects, phytoremediation
- CoP leader “Soil as natural capital”
- Environmental impact assessment



Ellen Verboom

- Consultant soil and groundwater
- Specialized in contaminated site remediation and vital soils

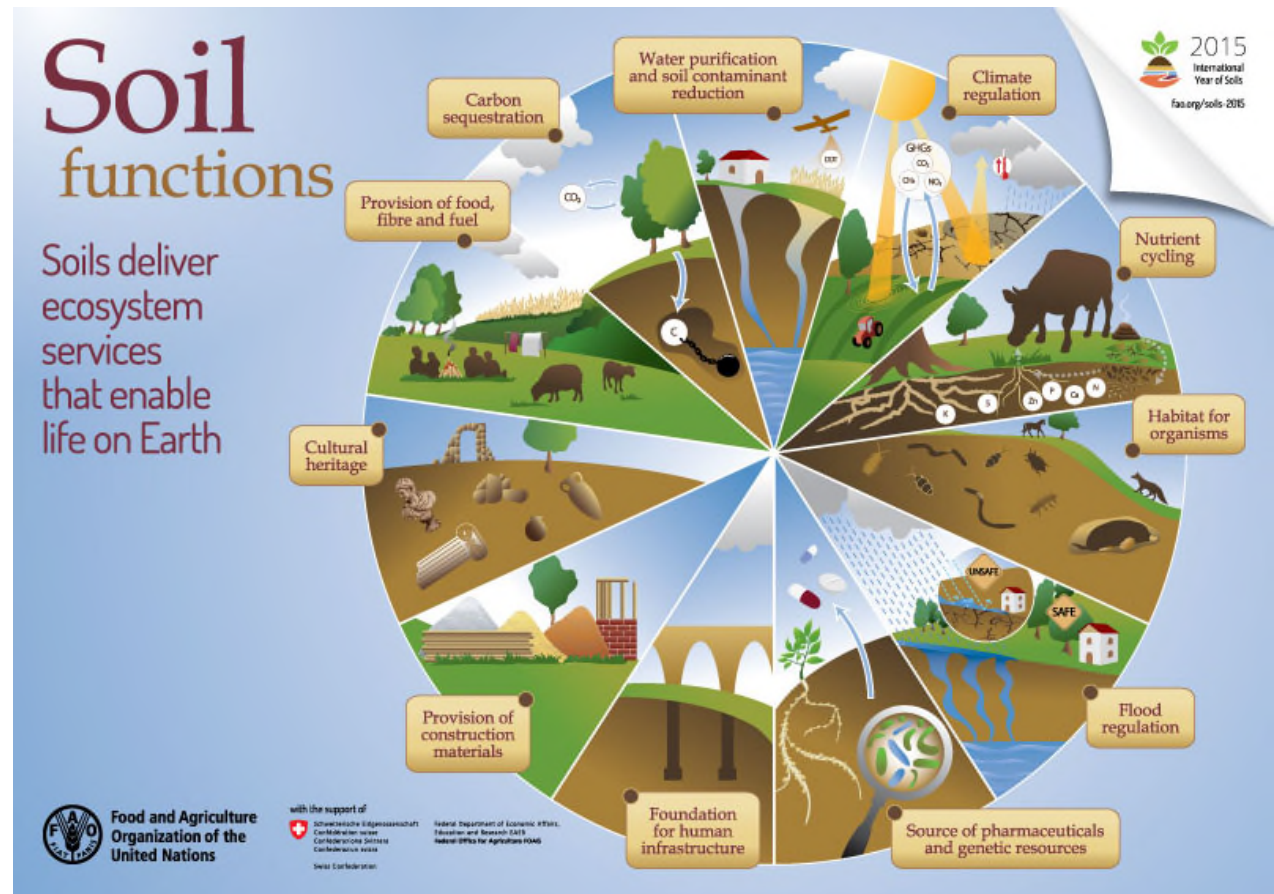
Introduction

Definition of Soil Ecosystem Services (SES)

*“Healthy soils are in good chemical, biological and physical condition so that **they can provide ecosystem services** that are vital to humans and the environment, such as safe, nutritious and sufficient food, biomass, clean water, nutrients cycling, carbon storage and a habitat for biodiversity.”*

- Soil Monitoring Law -

- All SES cannot be at the maximum level at the same time, as they are sometimes contradictory
- One's can approach soil health by selecting some SES that are vital on a specific pedoclimatic and sociologic context



Introduction

2 different projects, 2 different focus

- **City Parks Deventer**
 - Focus on SES :
 - Recreational use
 - (Habitat for organisms)
 - (Climate regulation)
 - Focus on soil functions related to soil compaction and fertility (good health and growth of the plants in green areas)
- **Brownfield, former industrial site**
 - Focus on SES:
 - Soil and groundwater purification
 - Flood regulation
 - Habitat for organisms
 - (Carbon sequestration)
 - Selection guided by contaminated site and revitalization project





City Parks Deventer

City Parks Deventer

Introduction

- Objective of assignment: Determine soil health in two city parks in Deventer
 - Rijsterborgherpark
 - Initial construction in 1887, new development after bombings in WWII
 - Worpplantsoen
 - Oldest public city park in the Netherlands (1578)
 - Part of the floodplains of the river IJssel
 - Both park are home to various monumental trees
- The municipality of Deventer has concerns about soil compaction because of activities in the parks



City Parks Deventer

Research approach

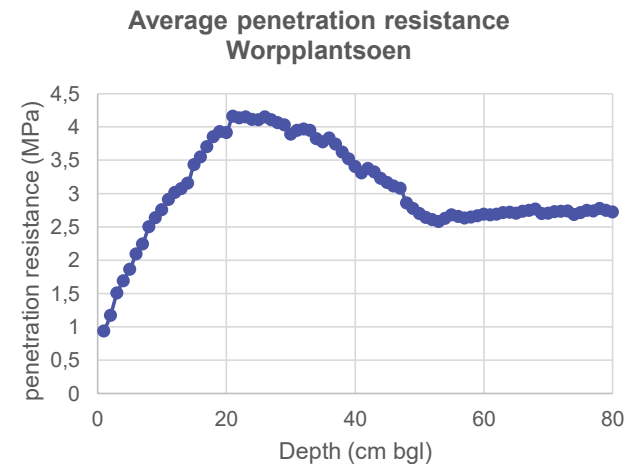
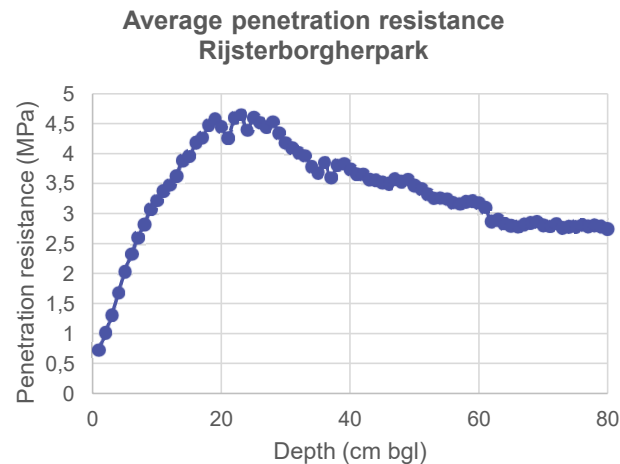
- Main objective: determine extent of soil compaction
 - Resistance to penetration was measured at 60 locations (32 in Rijsterborgerpark and 28 in Worpplantsoen)
 - Resistance was measured in N/m² per 1 cm until 80 cm bgl
 - Categorization: <1.5 MPa, 1.5-3.0 MPa, >3MPa
- Additional parameters were included to obtain a more complete picture of the soil health
 - Soil biota (earthworm counting), visual classification of the soil, soil environment (pH and oxygen), amount and stability of organic matter, soil fertility and soil depletion



City Parks Deventer

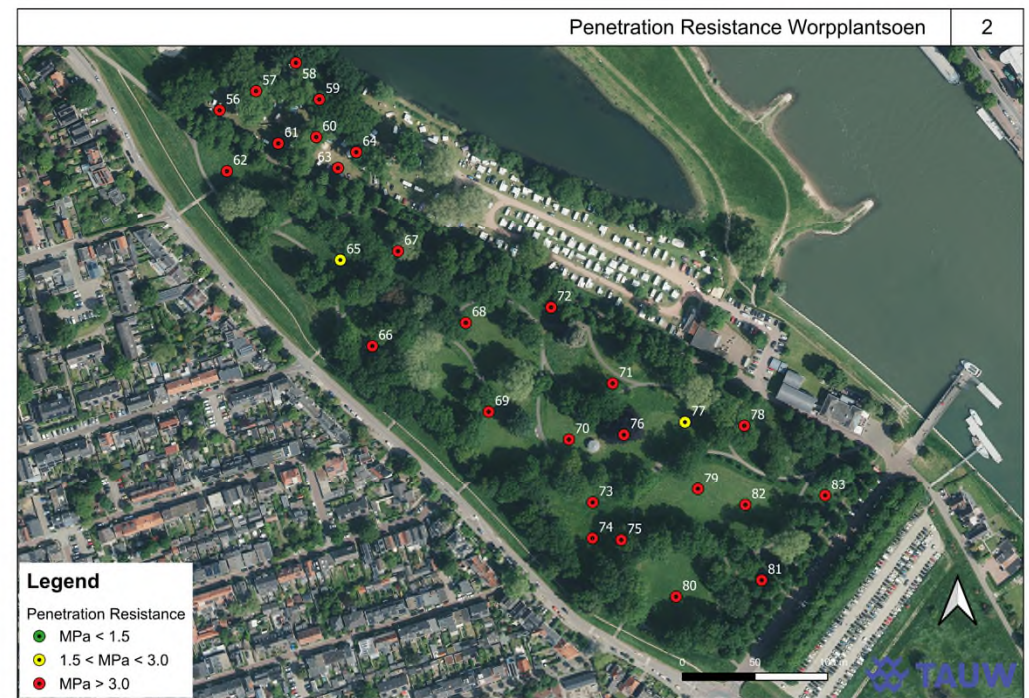
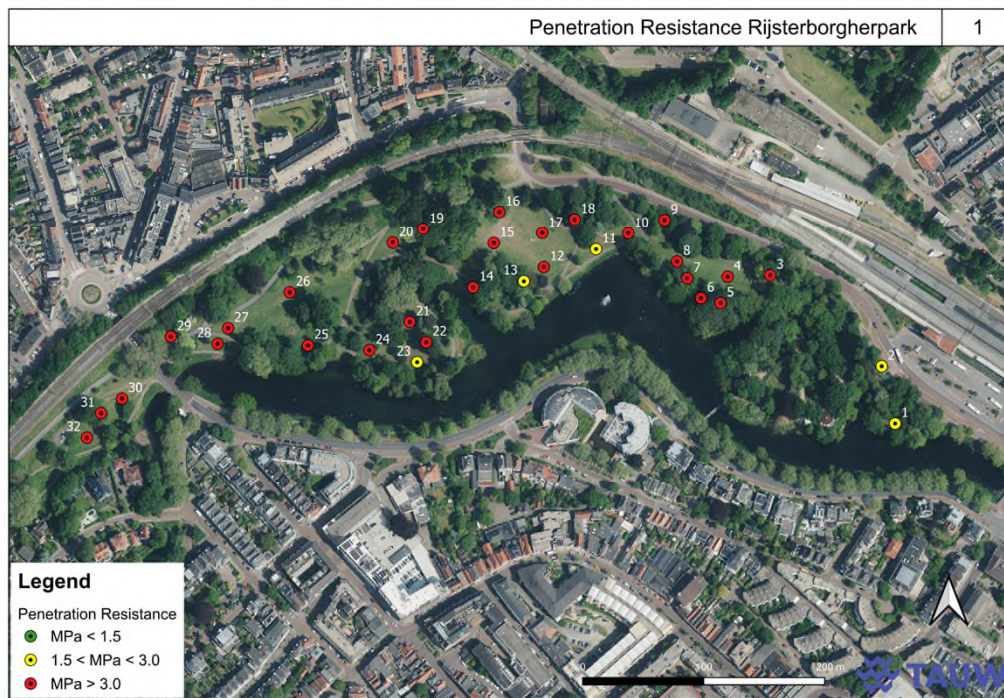
Results: Soil Compaction

- A strong increase in penetration resistance in the first 20 cm to 4 – 4.5 MPa.
- A slow decrease in penetration resistance until stabilization at 2.5 – 3 MPa at approximately 55 cm bgl



City Parks Deventer

Results: Soil Compaction



Penetration Resistance at 20-30 cm bgl, the depth where values were on average the highest

City Parks Deventer

Results: Other Parameters

Parameter	Rijsterborgerpark	Worpplantsoen
Soil classification	Sand with low clay, humus and lime content	Loam with low humus and high lime content
Earthworms	Average of 242 earthworms/m ²	Average of 408 earthworms/m ²
pH and oxygen	pH 6.8-7.2, periodic anaerobic conditions	pH 7.4-8.1, periodic anaerobic conditions
Organic matter	3.7-5.3%, stable fraction: 16%	5.9-6.8%, stable fraction: 16%
Fertility and depletion	Immediate nutrient availability is good Low long-term availability of phosphorus, potassium, sulphur and sodium	Immediate nutrient availability is good Low long-term availability of phosphorus, potassium, sulphur and sodium



City Parks Deventer

Soil Management Practices

- Additional measurements during a different season (soils were very dry)
- Preventive measures: avoid soil compacting activities in the wet season, using set driving routes, applying a mulch layer (woodchips) during festivals
- Improving soil structure: (vertical) mulching or releasing earthworms
- Extreme measures: Mechanically decompact soil through subsoilers, diggers and supersonic air tools
- Improve long-term nutrient availability: apply slow-release nutrient sources such as (stable) compost, anhydrite, gypsum or rock flour





Brownfield, former industrial site

Brownfield, former industrial site

Introduction (1/2)

- **Objective of assignment: undertake environmental impact assessment of revitalization project**
 - Degraded site location North-east of France, industrial region
 - Area 6,8 ha – woods, basins, grassland
 - Former textile factory used the site for the management of its liquid effluents and industrial wastes : presence of 3 basins and a landfill
 - Metallic contamination (chromium, arsenic), cyanides, C10-C40 hydrocarbons, naphthalene and BTEX in the sediments of the basins ; metallic contamination, PCBs and cyanides in the soil of the landfill ; arsenic and cyanides in groundwater



Source: IGN - Auteur: TAUW France 2023 - n°1621827

Brownfield, former industrial site

Introduction (2/2)

- **Revitalization project : a solar plant**
 - Suitable size 5,5 ha for a power of 5,5 MWc
 - Connection to electrical network
- **The project owner wants to design the best project regarding People / Planet / Profit**

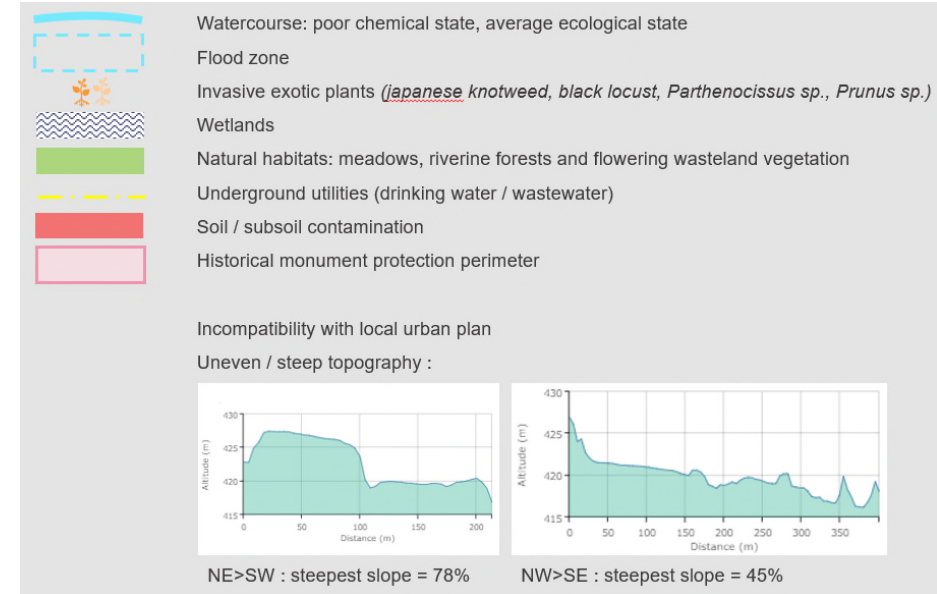
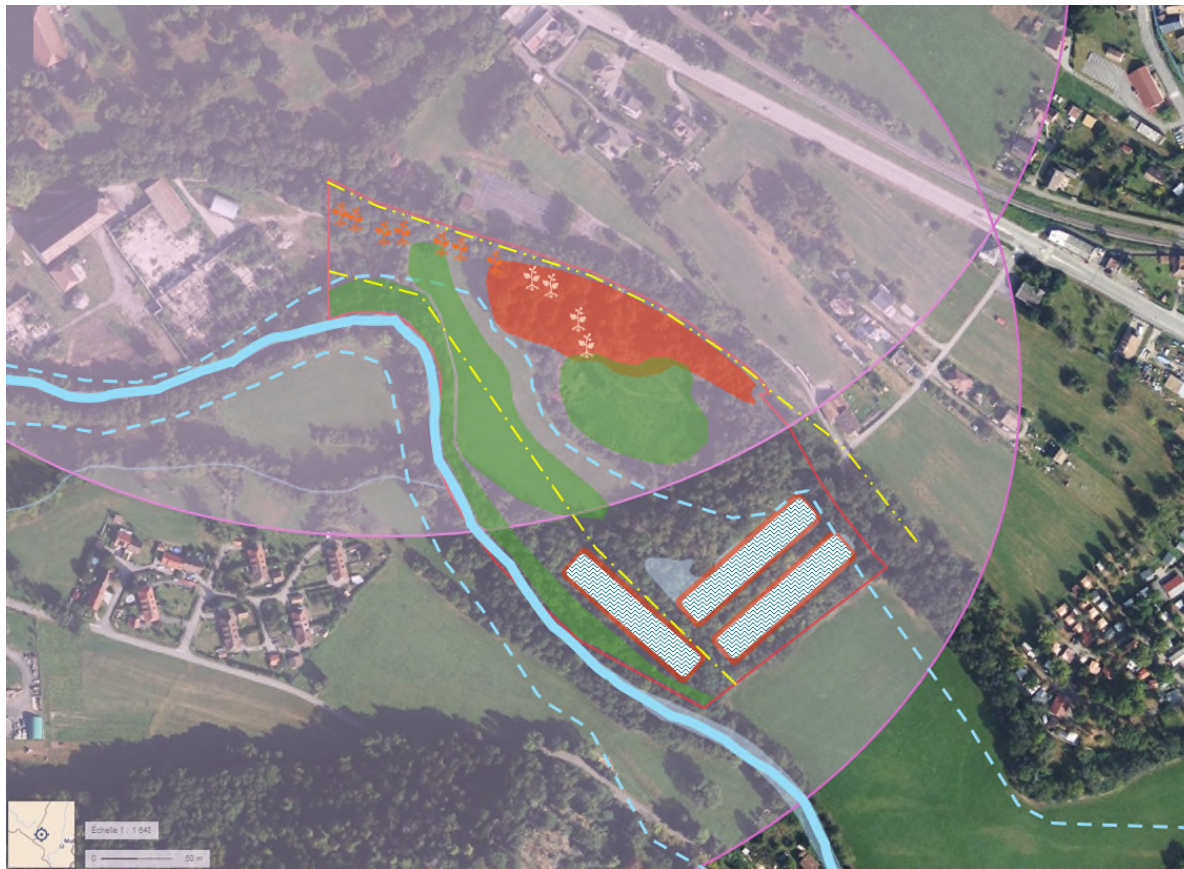
Research approach

- Main objective: determine the environmental constraints and opportunities for the project design
 - Sampling and lab analysis on soil: contaminants, organic matter content, ...
 - Sampling and lab analysis on groundwater: contaminants, ...
 - Soil study (visual classification of the soil, hydromorphy, biological activity)
 - Flora and fauna inventories
- Additional objective: focus on 4 soil ecosystem services that are important for site functioning



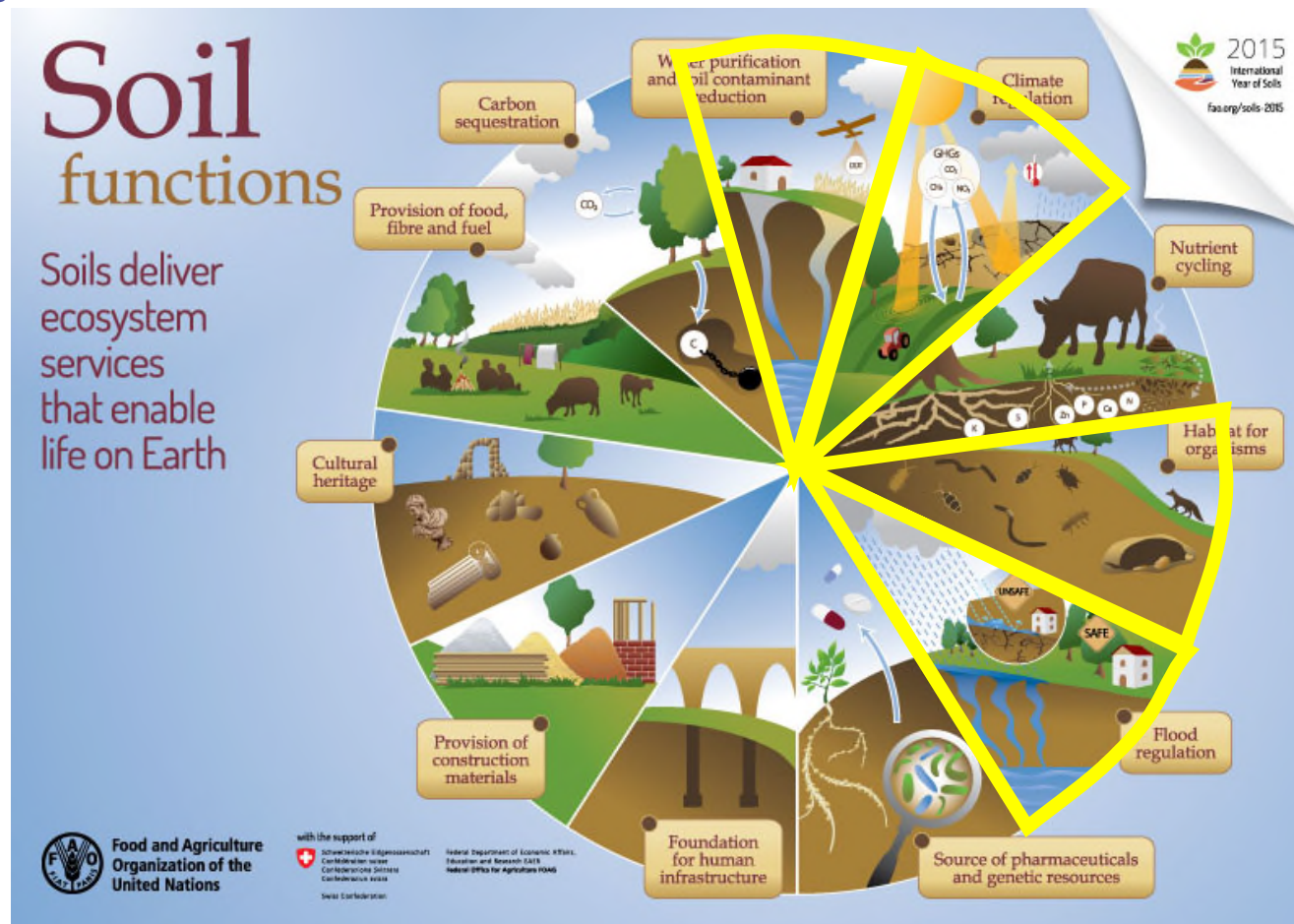
Brownfield, former industrial site

Results of environmental diagnosis



Brownfield, former industrial site

Soil ecosystem services selection



Brownfield, former industrial site

Indicators selection*

Soil ecosystem services	Indicator	Result	Goal after revitalization
Soil and groundwater purification	Soil quality	<u>Basins' sediments</u> Contaminated volume = 5 663 m ³ Copper, chromium, hydrocarbons, PCB (method: statistical analysis on lab results)	Depending on remediation technique: <ul style="list-style-type: none">- Excavation- On site remediation- Confinement
	Groundwater quality	Contaminant: upstream value BOU5 ; downstream value BOU2 Copper: <2 µg/L ; 2 350 µg/L Cyanide: 3,7 µg/L ; 96 µg/L (BOU5 and BOU2: average over 2 campaigns)	No more impact on groundwater BOU2 comparable to BOU5

*based on RECORD methodology (list of indicators related to soil functions) and available data (no extra investigations specifically on that topic)



Brownfield, former industrial site

Indicators selection*

Soil ecosystem services	Indicator	Result	Goal after revitalization
Flood regulation	Hydromorphic level	<u>Basins:</u> Hydromorphic score = 1 <u>Rest of the site:</u> Hydromorphic score = 0 Weighted average = 0,18 (method: RhoMéO)	Increase site score
	Flood water storage capacity	73 275 m ³	Preserve capacity

**based on RECORD methodology (list of indicators related to soil functions) and available data (no extra investigations specifically on that topic)*



Brownfield, former industrial site

Indicators selection*

Soil ecosystem services	Indicator	Result	Goal after revitalization
Habitat for organisms	Vegetation structure	Coverage > 75% 3 habitats: <ul style="list-style-type: none">- meadows: good condition- riverine forests: correct spontaneous ecological course- lowering wasteland vegetation: pioneer status- wetlands: degraded condition (method: MNHN)	Coverage >75% Preserve habitats in good condition Rectify ecological course of lowering wasteland vegetation
	Presence of invasive species	Presence <30% (method: MNHN)	Absence

**based on RECORD methodology (list of indicators related to soil functions) and available data (no extra investigations specifically on that topic)*



Brownfield, former industrial site

Indicators selection*

Soil ecosystem services	Indicator	Result	Goal after revitalization
Carbon sequestration	Organic matter content in soils	<ul style="list-style-type: none">- meadows: 3,6% (not significant due to contamination :- lowering wasteland vegetation: 17,4%- basins: 36,9%)	Normalize OM content at the landfill and the basins Increase OM content at the meadows
	Carbon storage capacity	Carbon sequestration = 4,4 ktCO ₂ e / year (estimated stock 8,7 MtC) (method: ALDO, ADEME, based on soil use)	Increase carbon sequestration at the meadows ?

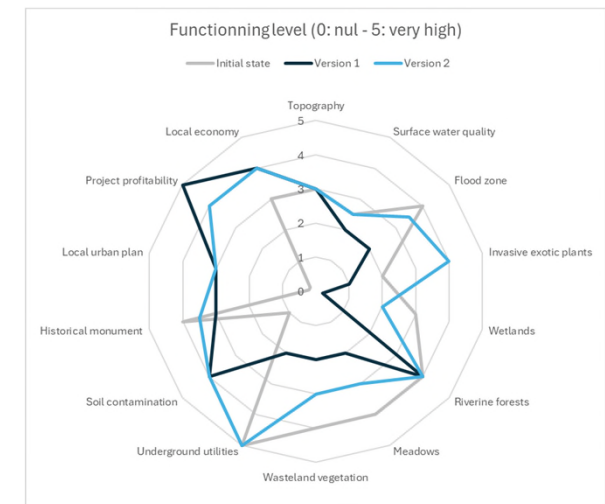
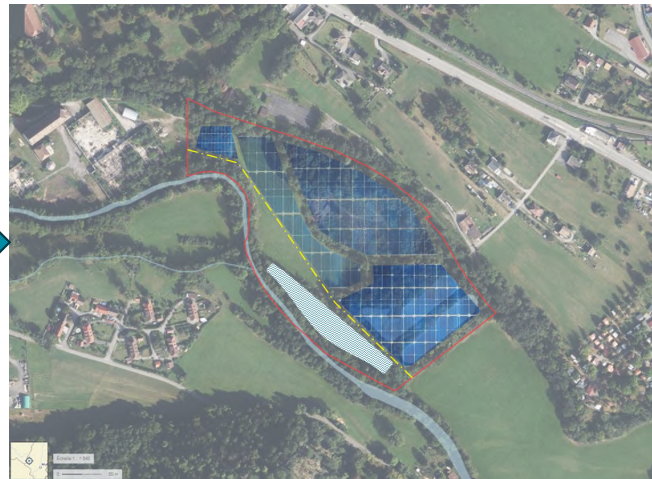
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Brownfield, former industrial site

Soil Management Practices

- On site remediation on the most impacted areas, confinement of the landfill
- Project design minimizing the degradation of wetlands and preserving the hydraulic functions of the flood zone (testing several layouts)
- Careful removal of invasive species
- Monitoring biodiversity during and after the construction phase
- Promoting plant species and green area management that are interesting both for ecological habitats and flood zone functioning





Conclusion

Conclusion

- Different approaches to define a “healthy soil” leading to different recommendations regarding soil management practises

Subjectivity ?

Variability, how to compare ?

Multiple recommendations :
difficult for project / site owners to embrace ?

- Appreciate the benefits of soils in a positive way for better consideration

Learn to love our soils !

« We love what we marvel at,
and we protect what we love »

(Jacques-Yves Cousteau)



Conclusion

- So why the Soil Monitoring Law focuses on threats ?

Raise awareness ?

More consensual ?

1st step to inflect
a negative trend

- Complementary scale of use : SML to identify regions where soils are particularly threatened and nature of the threat(s)
- SES to work at site level

Act now !

Article 7: When monitoring and assessing soil health, Member States shall apply the soil descriptors and soil health criteria listed in Annex I.


Soil descriptor	aspect of soil degradation
Electrical Conductivity	salinization
Soil erosion rate	loss of soil by erosion
SOC concentration	loss of organic matter
Bulk density in subsoil	compaction
Bulk density in topsoil	
Extractable phosphorus	excess nutrients
Nitrogen in soil	
Concentration of heavy metals	contamination
Concentration of other contaminants	
Soil water holding capacity	loss of capacity for water retention
Soil acidity (pH)	acidification
Soil basal respiration	loss of soil biodiversity

land take/soil sealing area/%	land take and soil sealing
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