



Phytomanagement of Contaminated Sites

Young Soil Researcher's Forum

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Background



Swedish context:

- 84,000 potentially contaminated sites
- Reliance on conventional remediation options
 - Slow progress and lack of innovation
 - ‘Over-remediation’ in many cases
 - Excavation (‘dig-and-dump’) is still most common method
 - Bioavailability usually not considered
- **Soil is viewed as a disposable waste**



*Non-toxic
environment*

Overarching research objective:

To develop further gentle remediation options (GRO) as viable remediation techniques for managing risks and improving ecosystem services at contaminated sites – particularly in the Swedish context

Gentle remediation options (GRO)

= risk management strategies / technologies that result in a net gain in soil function as well as achieving effective risk management

[Cundy et al. (2016), J. Environ. Manage. (184), 67–77.]

GRO Strategies:

- Phytoremediation →
- Bioremediation:
 - Bioaugmentation – inoculate with specific microbes (bacteria)
 - Biostimulation – improve existing microbes in-situ
 - Monitored natural attenuation / natural source zone depletion
 - Fungi (mycoremediation)
 - Earthworms (vermiremediation)
- Enhancements
 - Soil amendments – compost, biochar, etc. (stimulation)
 - PGPR, Endophytic bacteria, mycorrhizal fungi, etc.

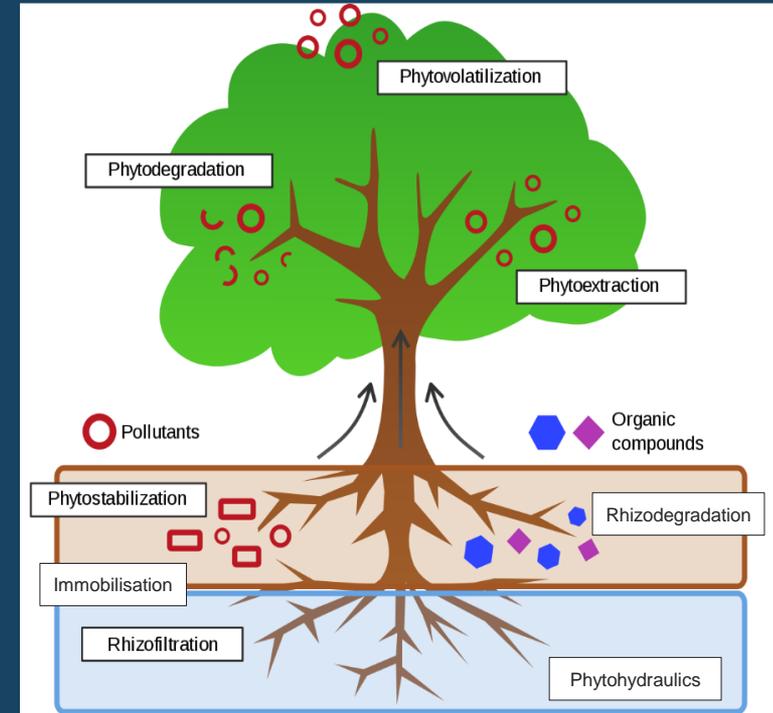


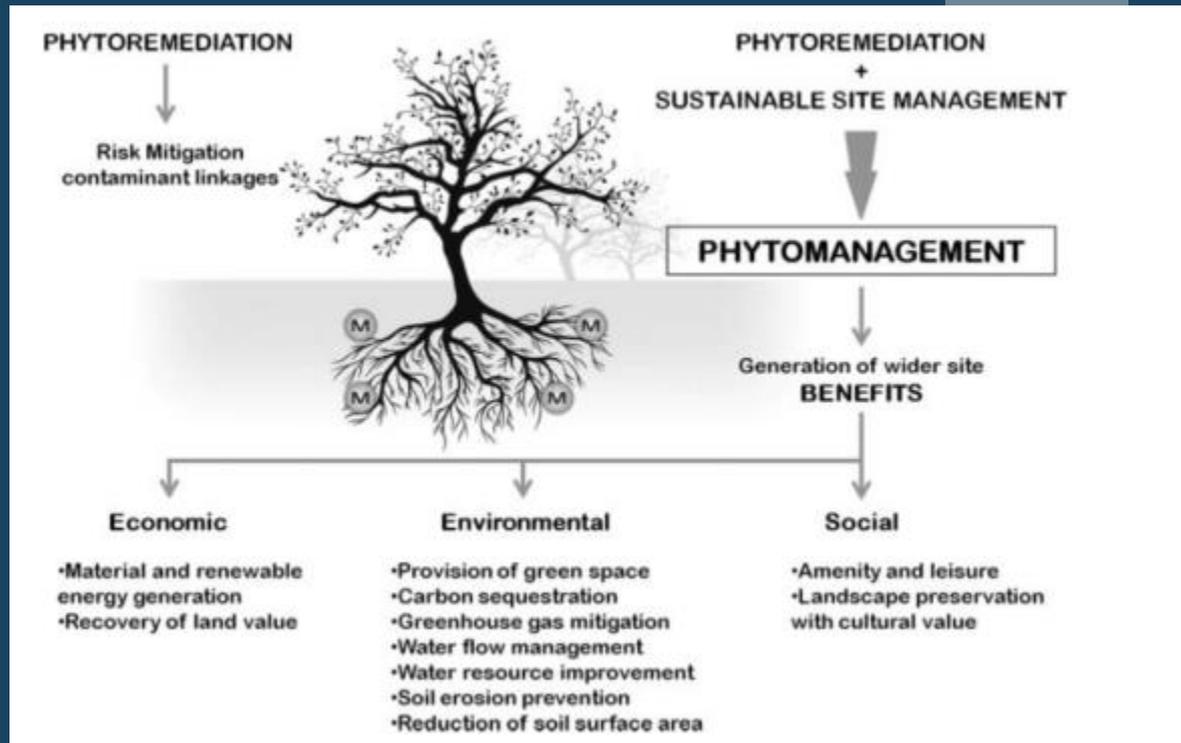
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Phytomanagement

= the long-term combination of gentle remediation options (GRO) with beneficial land use (e.g. profitable crop production) to gradually reduce risks posed by contaminants and restore ecosystem services

→ 'phytomanagement' encompasses a range of land management activities:

- Nature-based solutions (NBS)
- Green infrastructure



Methodology

Risk management framework for GRO

Aim: develop a framework that can be used as a communication tool in the early stages of a brownfield redevelopment project to:

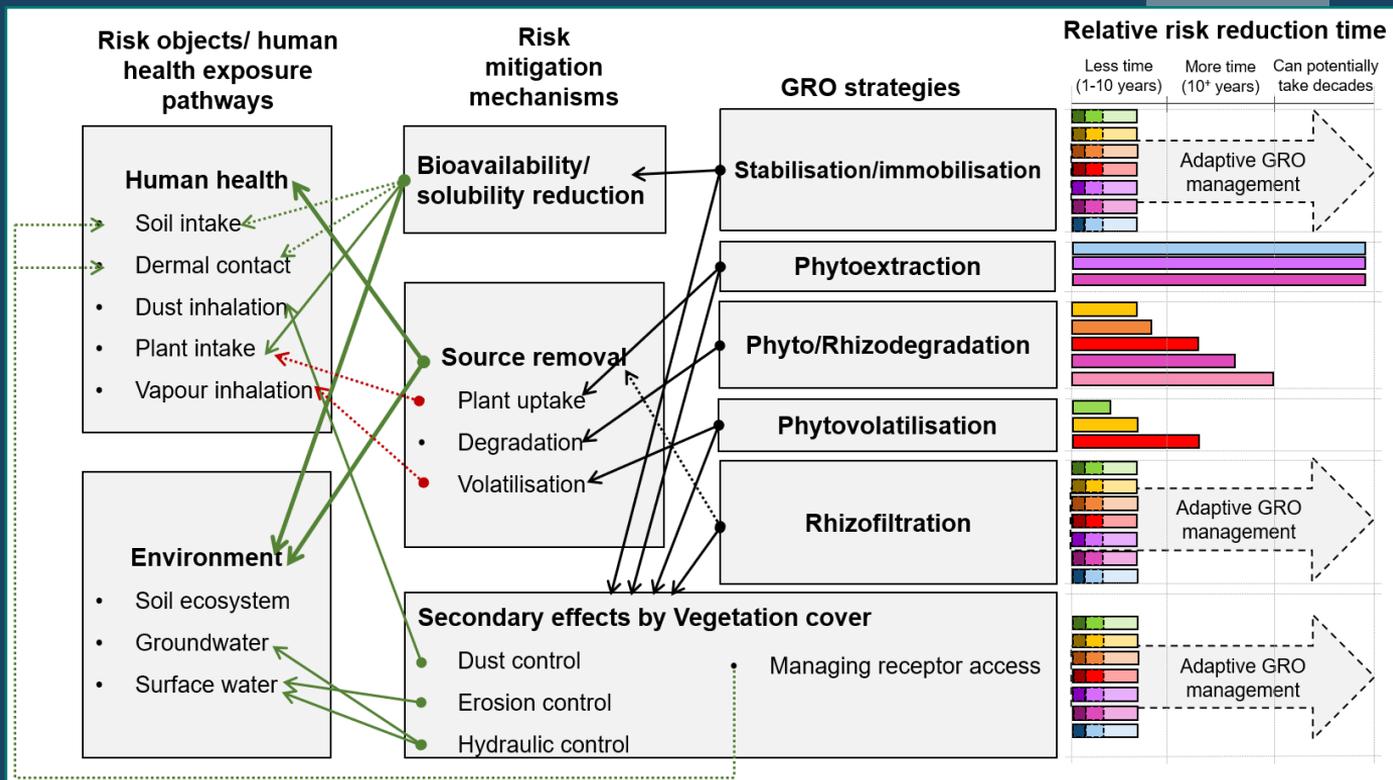
1. Educate remediation contractors, decision-makers, regulatory bodies and other stakeholders & address stakeholder concerns
2. Identify relevant GRO strategies for phytomanagement of contaminated sites and achieving an envisioned land use

Working process:

- Conceptualize connections between GRO, attributable risk mitigation mechanisms and their expected effect for managing ecological and human health risks
 1. Literature review to identify and find support for risk mitigation mechanisms
 2. Create conceptual diagram (generic)
 3. Mapping expected timeframes of GRO strategies for groups of contaminants

Results

GRO Risk Management Framework



LEGEND

- ← Green arrow: Decreased risk - acts on all exposure pathways/all environmental risk objects
- ← Green arrow: Decreased risk – specific exposure pathways/ environmental risk objects
- ← Dotted green arrow: Potentially mitigated risk

- ← Dotted red arrow: Potentially increased risk
- ← Black arrow: GRO strategy influence on risk mitigation mechanisms
- ← Dotted black arrow: Continuous removal of solutes from water

- Nutrients** (Green)
- Chlorinated solvents** (Yellow)
- Pesticides** (Orange)
- Petroleum products** (Red)
- Explosives** (Pink)
- POPs** (Purple)
- Radioactives** (Light Purple)
- Metal and metalloids** (Blue)
- Dark - Grasses/amendments: 6 - 8 weeks** (Dark Grey)
- Medium - Shrubs: 1 - 2 years** (Medium Grey)
- Light - Trees: 2 - 4/5 years** (Light Grey)

* Different shades represent time required for different types of vegetation cover *



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