NBS to Mine Tailings

Results of a field research

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Who are we?

Presenters

Tobias Praamstra

- Senior consultant soil, groundwater & sustainability at TAUW bv
- BSc in Environmental Sciences from Van Hall Institute and MSc in Environmental Hygiene – Soil Quality from Wageningen University and Research
- 27 years experience as an environmental consultant, expert in NBS

Ellen Verboom

- Project engineer of international environmental projects at TAUW bv
- BSc in Natural Environmental Sciences from Utrecht University and MSc in Biology and Chemistry of Soil and Water from Wageningen University and Research
- Experience with site investigation, remediation design for contaminated sites and NBS

Project Description

Project Description

Current NBS remediation and TAUW Foundation project: Nature Sustains

- Current project of TAUW and Narxoz University
- **Prevention / Remediation / Restoration** of mine tailings environmental impacts through NBS
- Potential pollution by **leachate** from mine tailings and by process water basins
- Potential pollutants:
  - Acid Mine Drainage (oxidation of pyrite → sulphuric acid)
  - Heavy metals
  - Anions (nitrate, sulphate, phosphate)
  - Additives (e.g. cyanide)

Project Description

Project phases

1. Literature review of best global practices of NBS to tailings contamination
2. Development of a publication of mine tailings that are suitable for NBS in Central Asia
3. Site visit for data collection to two selected sites where identified NBS are deemed most suitable
4. Pre-design of NBS to the selected sites
5. International stakeholder consultation on results/fundraiser for their application

Project Description

Pilot site setup

- Two pilot sites:
  - Gold mine in Kazakhstan (operating)
  - Uranium and metal mine in Kyrgyzstan (closed)
- Focus on: **source – pathway – receptor**
- Fieldwork mission 24 – 27 April 2023
- Collection of surface water and soil / sediment samples

Project Description

Interpretation of results

- Comparison of analytical results with Dutch legislation
- Internationally most widely accepted legislation
- More elaborate than local legislation

NBS for Mine Tailings

NBS for Mine Tailings

Impacts: Acid Mine Drainage (AMD)

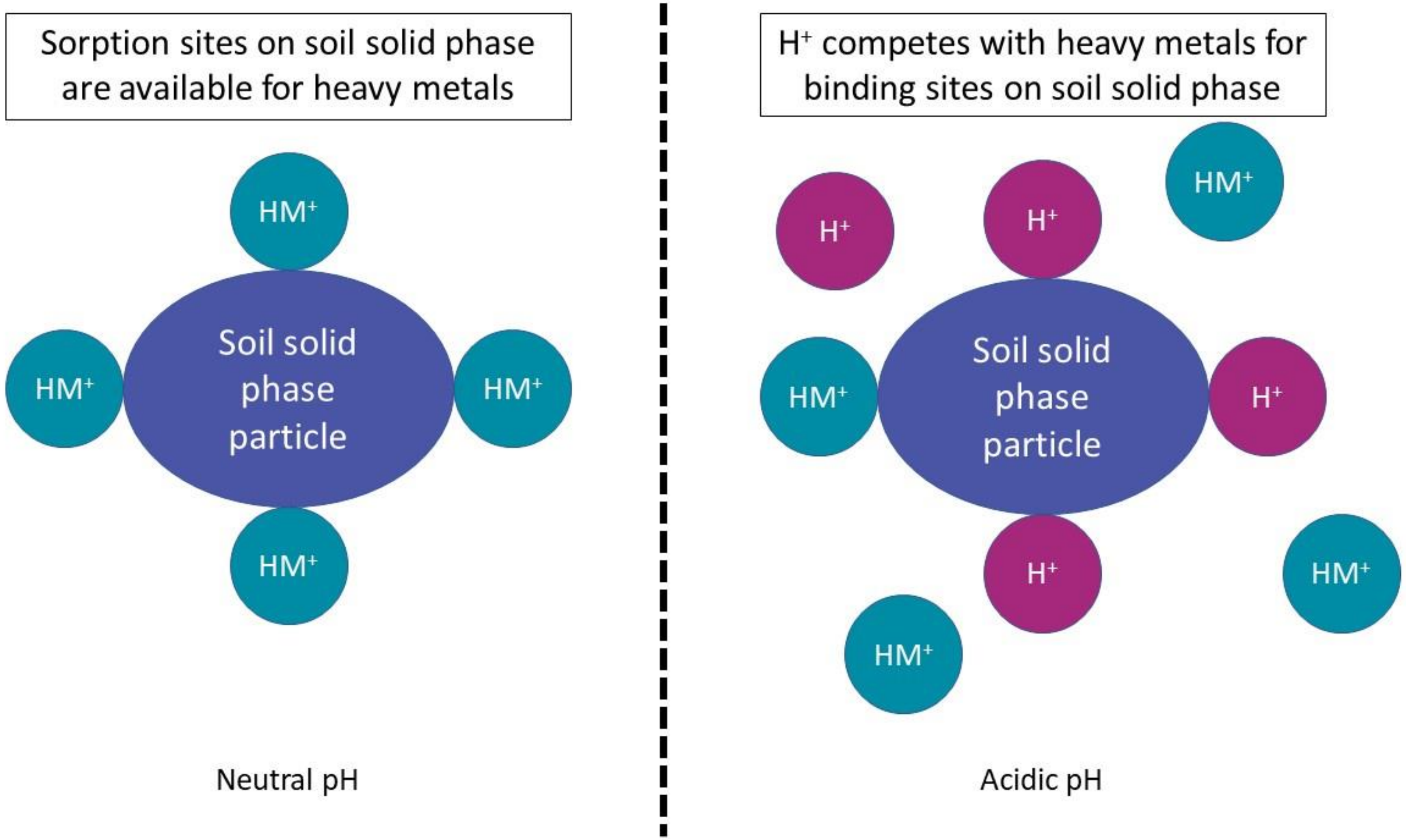
Sulphide minerals → Oxidation → Sulphate → Dissolution → Sulphuric acid

- Natural process
- Mine tailings: Increased exposure to oxygen, water and microorganisms

NBS for Mine Tailings

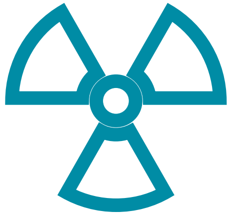
Impacts: Heavy metals

- AMD causes mobilization of heavy metals
- Higher bioavailability
- Higher mobility



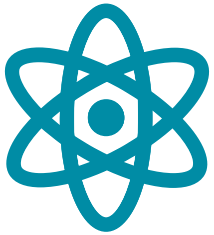
NBS for Mine Tailings

Impacts: Site specific impacts



Radionuclides

Chemical additives (e.g. cyanide)

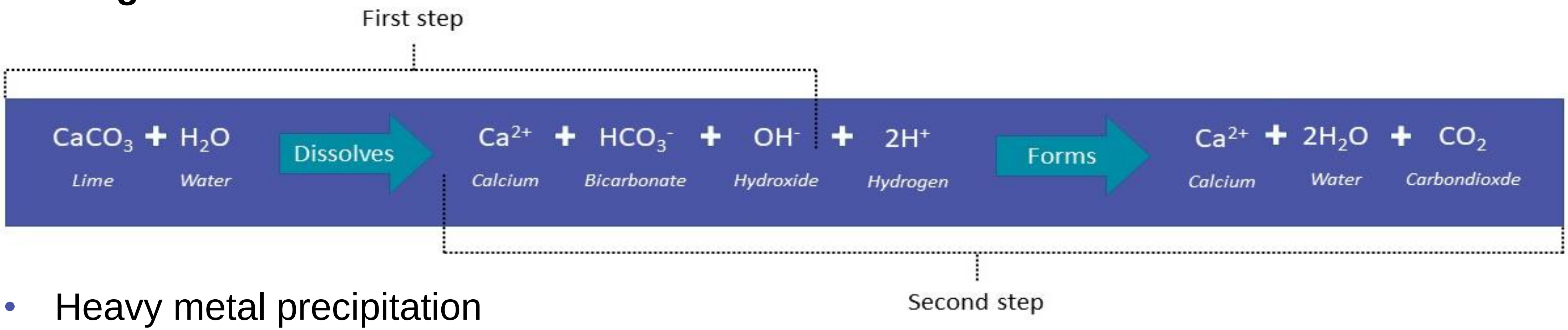


Anions (e.g. sulphates, nitrates phosphates

NBS for Mine Tailings

Solutions: pH increase

Liming



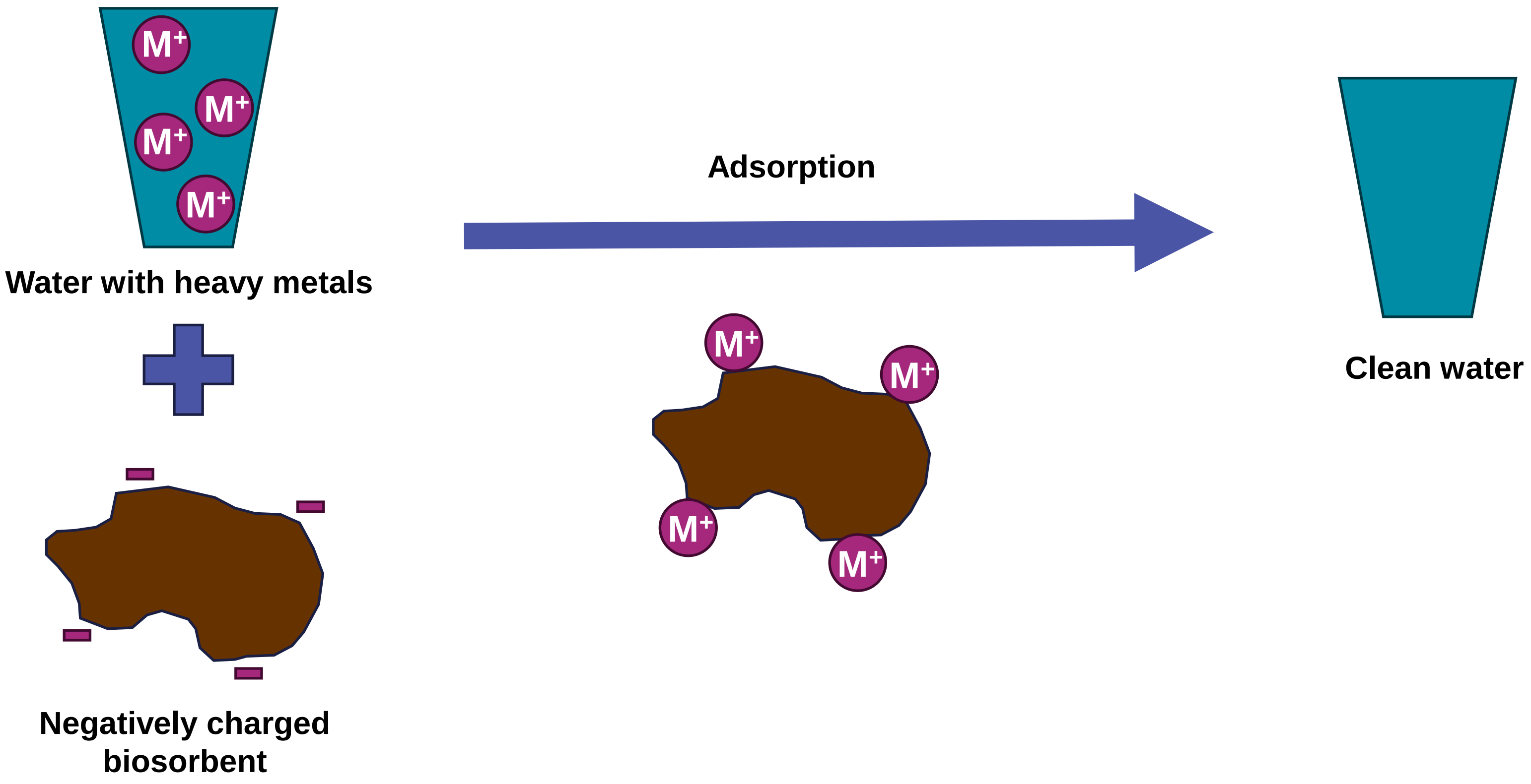
- Heavy metal precipitation

- Inorganic: most efficient
- Organic: improves other soil qualities
- Combination of compounds
- Waste products

NBS for Mine Tailings

Solutions: Heavy metal filters

- Offer binding sites for adsorption
  - pH increase



NBS for Mine Tailings

Solutions: Phytoremediation

Remediation of pollutants with the use of plants

- **Phytostabilization:** Immobilization of pollutants in the soil
  1) Precipitation of pollutants
  2) Adsorption of pollutants to root system
- **Phytoextraction:** Uptake of pollutants from soil into plant tissue
  → Permanent removal of pollutants with harvest
  3) Uptake of pollutants by roots
  4) Translocation to aboveground biomass

Site I: Kazakhstan

Active gold mine

Site I: Kazakhstan

Fieldwork

Site I: Kazakhstan

Analytical results

Soil:

- No evidence for soil contamination → all tested heavy metals were below Dutch intervention values

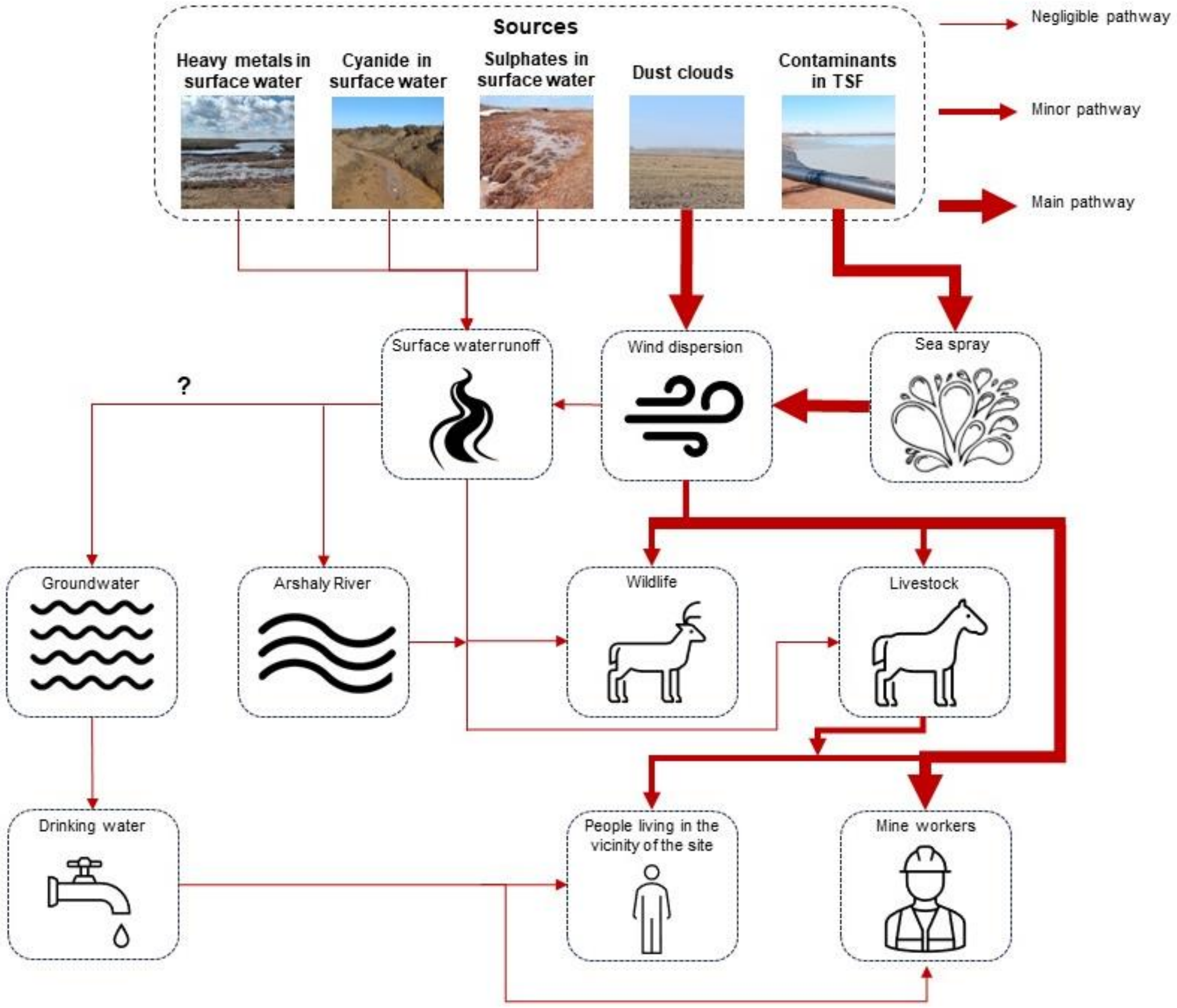
Surface water:

- Increased above Dutch legislative values for surface water:
  - Chromium, copper and zinc (copper 20 – 240 x legislative value)
  - Sulphate (8.5 x legislative value)
  - Cyanide (6 x legislative value)

Site I: Kazakhstan

Identified issues and Conceptual Site Model

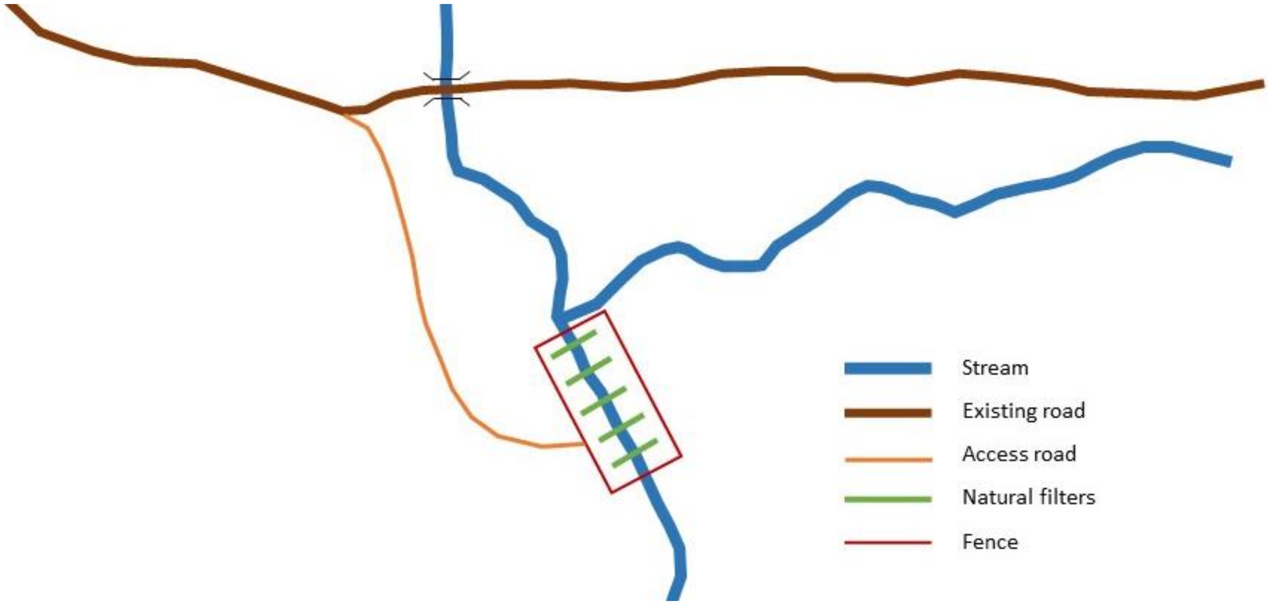
- Contaminated surface water
- Sea spray from tailing facilities (process water basin)
- Dust clouds (Included in previous project NBS Narxoz University)



Proposed NBS

Heavy metals in surface water

- Natural adsorption filter from organic material (EU RESANAT Ghent; Scheppelijke Nete)
- Heavy metals are positively charged, organic matter is negatively charged
- Heavy metals adsorption to binding sites on organic matter
- Additional fieldwork to demonstrate the structural presence of contaminants and to be able to design the final filter system

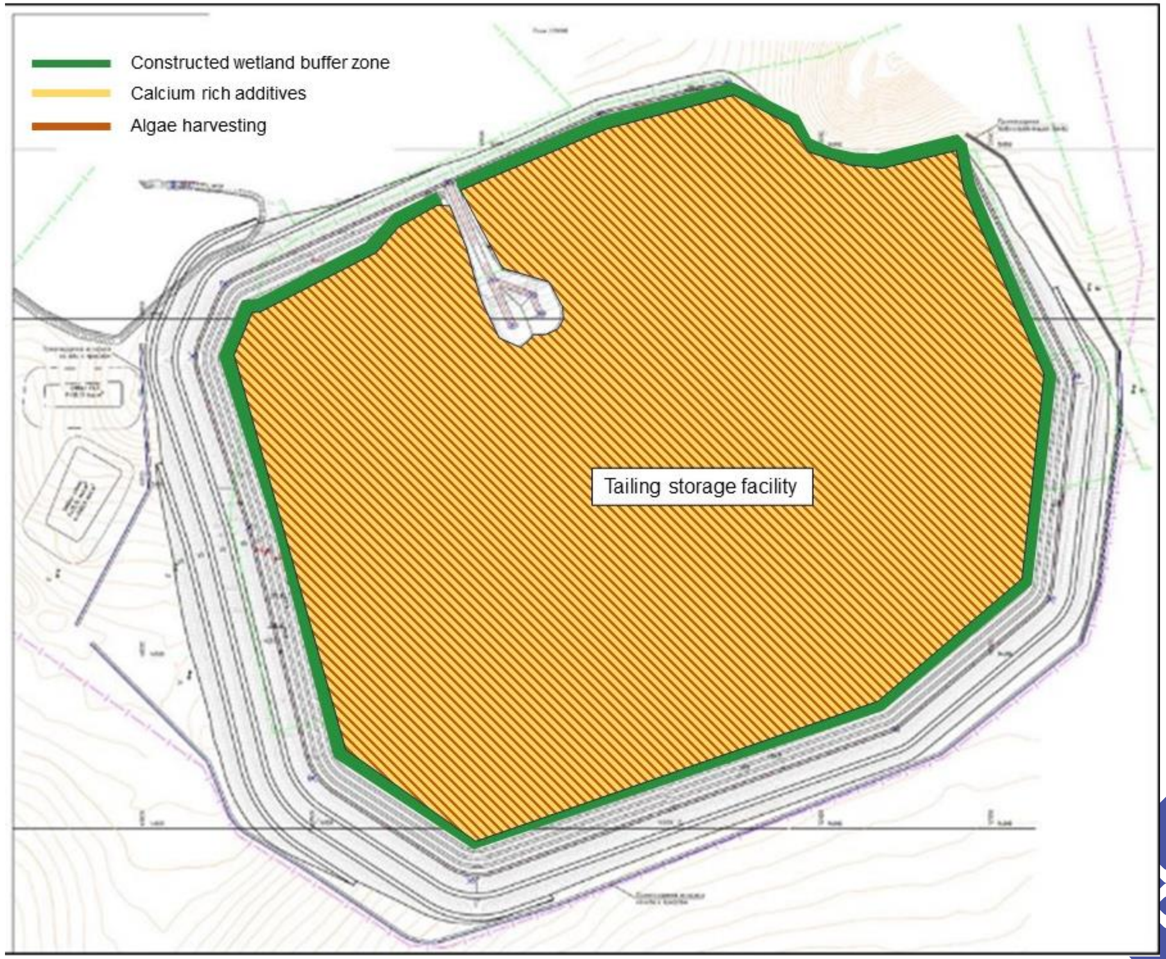


Proposed NBS

Sea spray from tailing facility

Complete capture of sea spray is not realistic

- Addition of calcium rich materials → precipitate pollution
- Growing and harvesting resistant algae → remove pollution
- Constructed wetland at edges of TSF → capture larger sea spray droplets



Site II: Kyrgyzstan

Closed uranium and (rare) metal mine

Site II: Kyrgyzstan

Fieldwork

Site II: Kyrgyzstan

Analytical results

Soil:

- Increased levels above Dutch intervention values for:
  - Arsenic, lead and zinc (lead 7x intervention value)
- Locally increased levels in comparison to other sediment samples:
  - Yttrium and zirconium

Surface water:

- One sampling location with slightly increased concentrations of arsenic, sulphate and ammonium

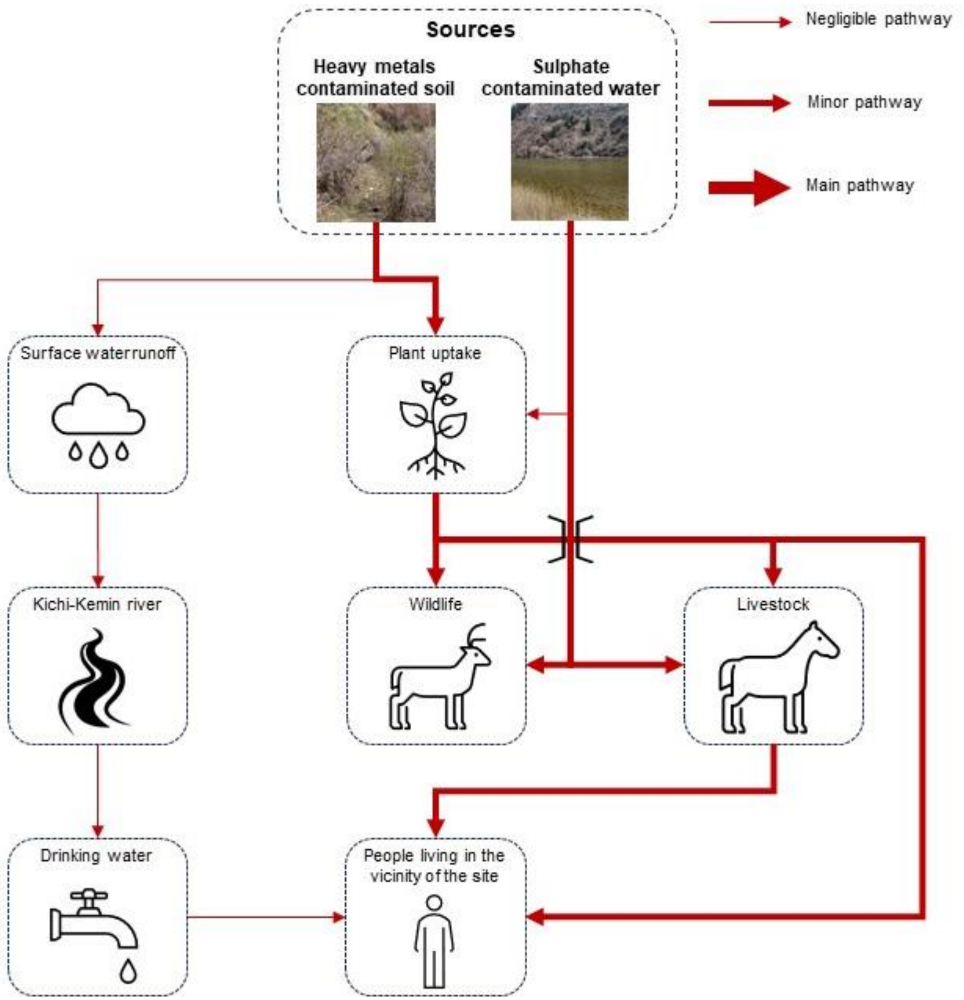
Field measurement:

- No increased radioactive radiation of samples

Site II: Kyrgyzstan

Identified issues and Conceptual Site Model

- Heavy metals contaminated soil
- Sulphate contaminated water
- Lifespan of isolation constructions



Proposed NBS

Phytoremediation

- Combination of phytoextraction and phytostabilization
- Additional research needed for selection of plant species
- Preferably native plant species

Figure: Phytoremediation of contaminated soil through
1) precipitation
2) root adsorption
3) root uptake
4) translocation

Follow up and conclusions

Conclusions

Contaminants found in pathway from source to receptor

NBS can provide a solution to issues that were identified at two pilot sites

Additional actions needed for a final design

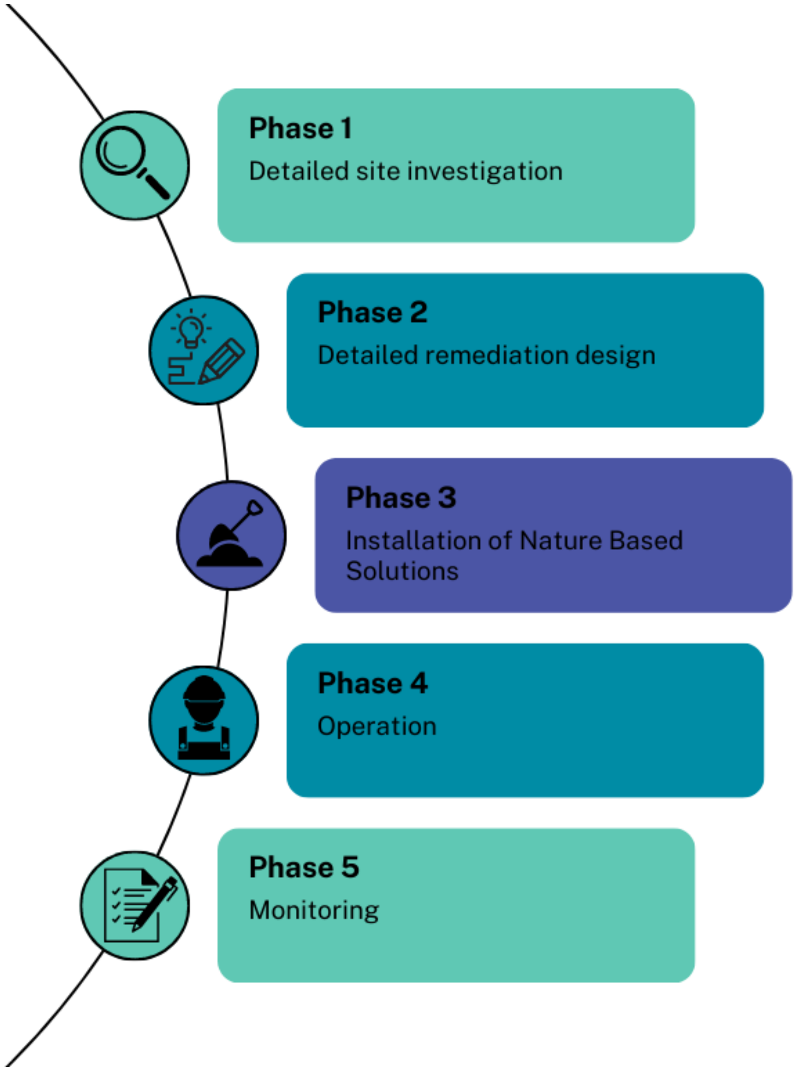
A follow up project for the Kazakh site has been initiated

Follow up

Next steps

To demonstrate the structural presence of contaminants and to finalize the designs, the following phases are necessary →

Higher goal: to assess and demonstrate NBS for application at other mine tailing sites with pollutant migration risks



Questions?

Questions

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