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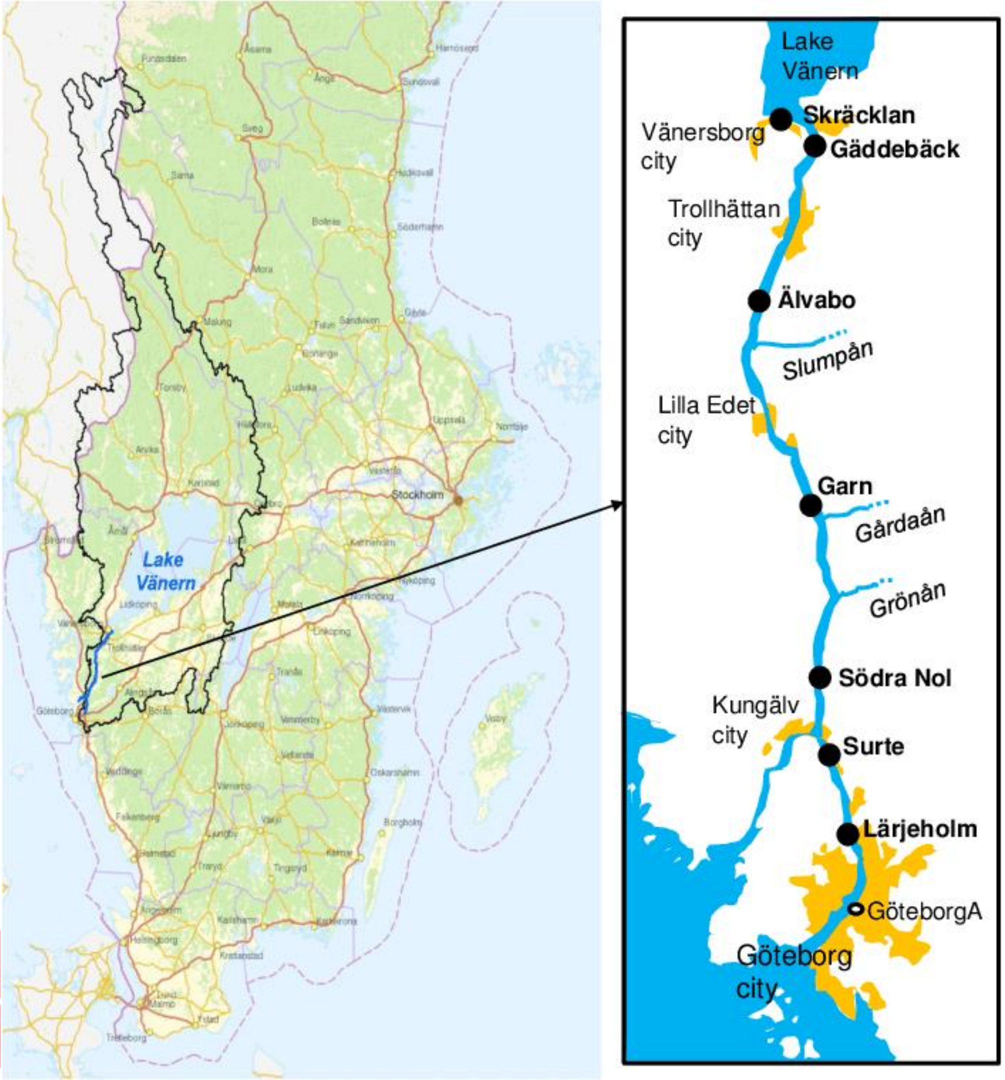
Round 2: Session 6 – Sediment Quality

Chalmers University of Technology
Anna Norén

Göta älv



Göransson et al, 2013

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Dredging needed…

Photo: Anna Norén, 2017

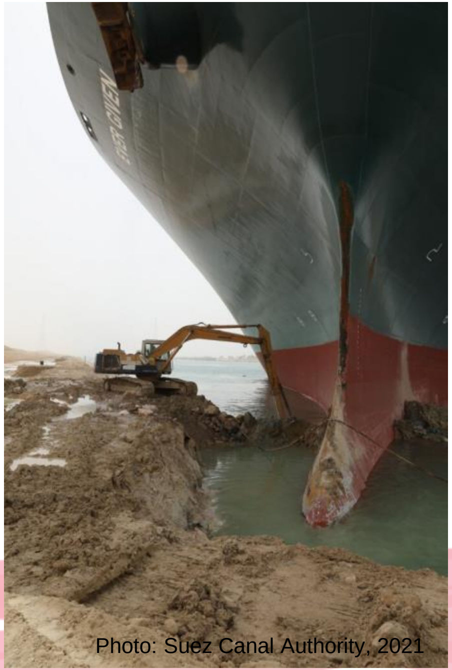
Photo: Suez Canal Authority, 2021


Norén, 2021


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Main problems: TBT, Cu and Zn marine silt & clay


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How can we manage contaminated sediment?

How can we treat contaminated sediment?

Can we use treated sediment?

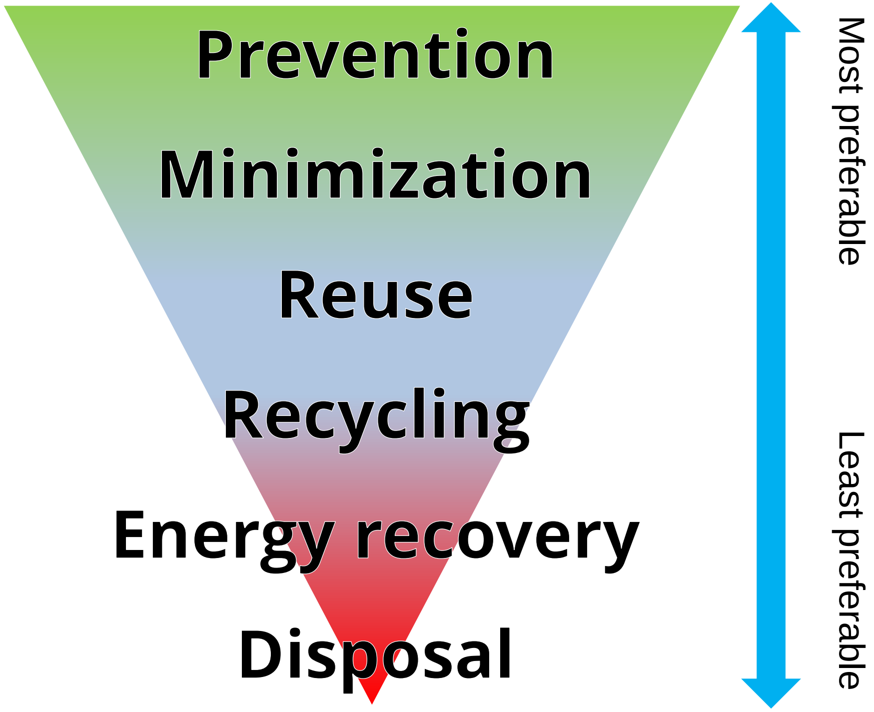
Conventional sediment management

Disposal out at sea
Landfilling

Photo: Royal IHC, n.d.

Sediment management

- Disposal in landfills
- Disposal at sea
- Stabilization and solidification



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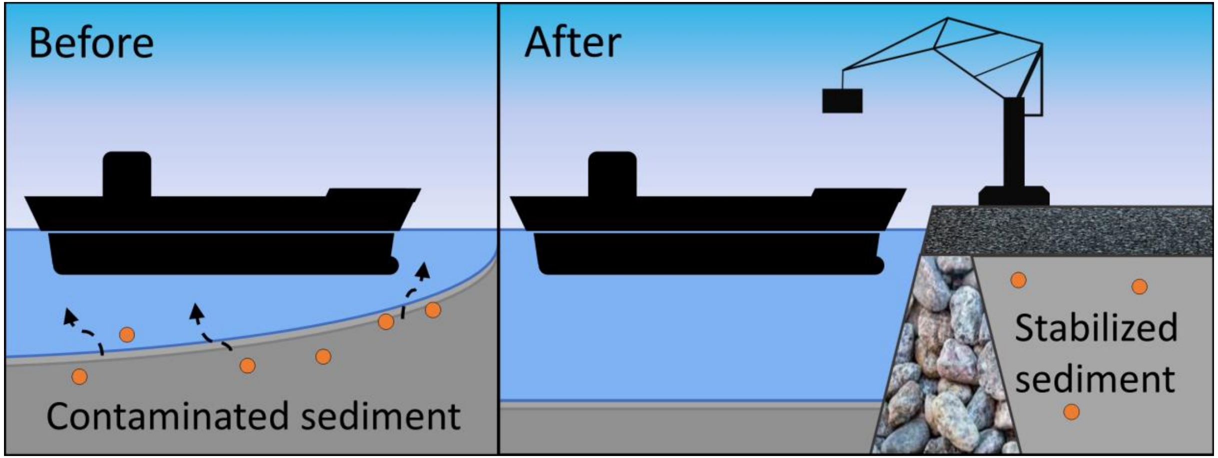
Stabilization and solidification (S/S)



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- Sediment
- Binders
  - Cement
  - Ground granulated blast furnace slag (GGBS)
  - Fly ash

Figure: Göteborgs hamn, 2016

How should we manage contaminated sediment?

How should we manage contaminated sediment?

An integrated assessment method was developed, using life cycle assessment (LCA) and multicriteria analysis (MCA)

- Costs
- Metal quantity and value
- Climate impact (CO_2)
- Other environmental impacts short- and long-term

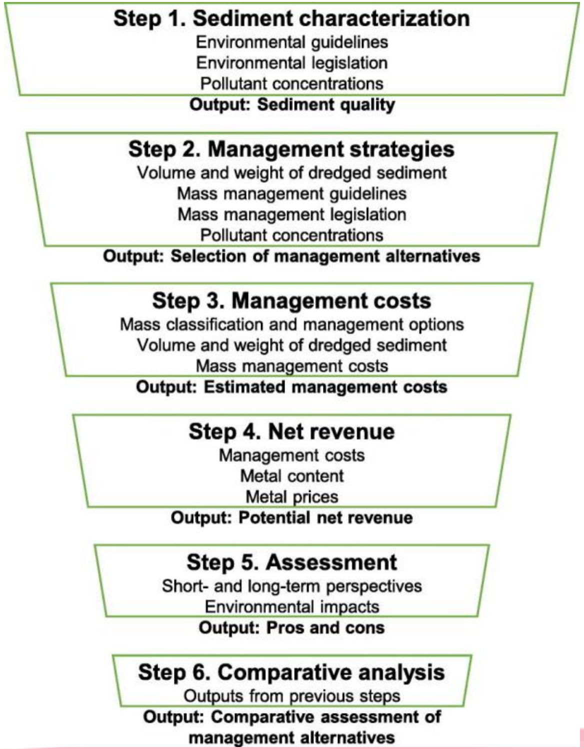

Image from Norén, 2020

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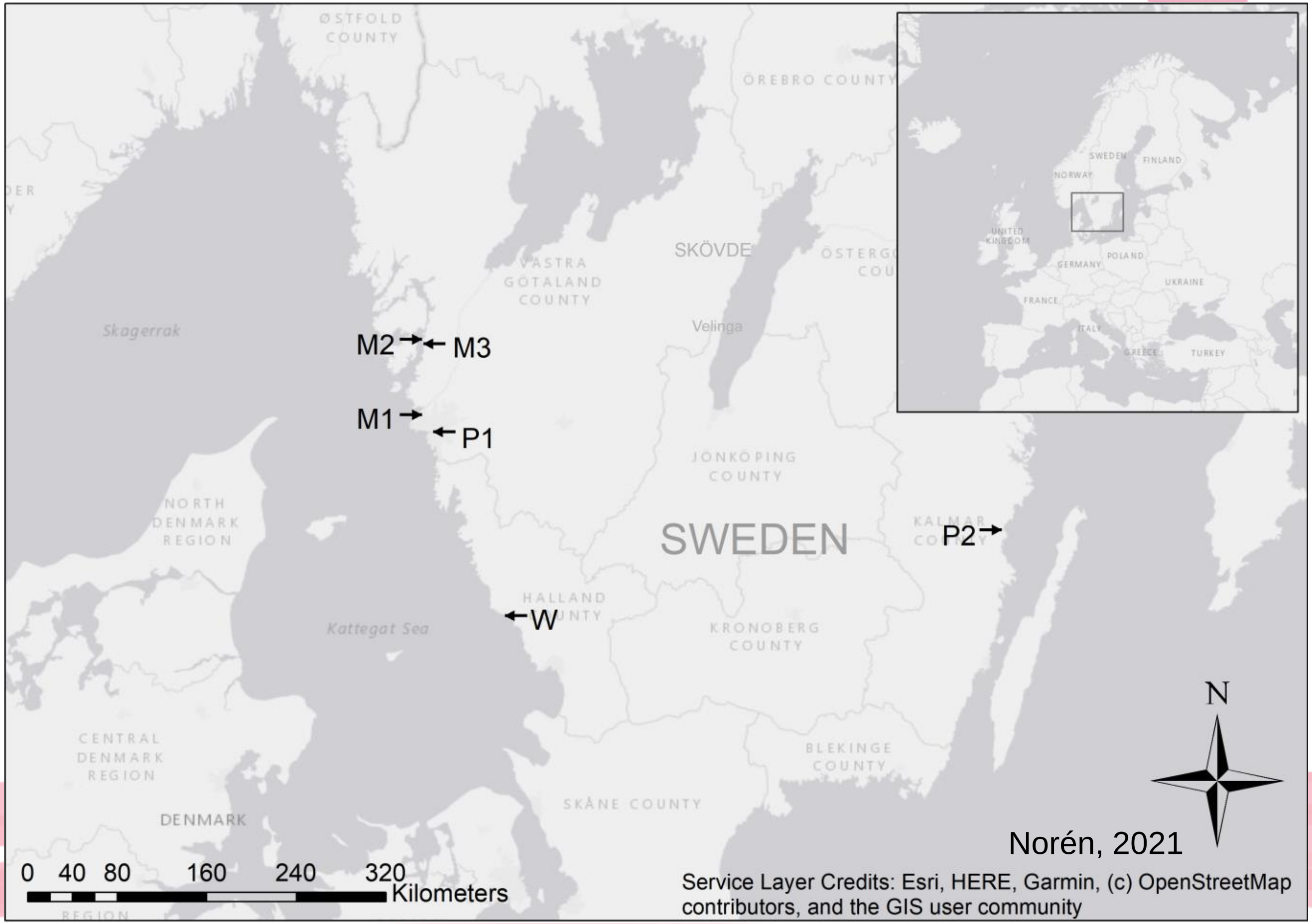
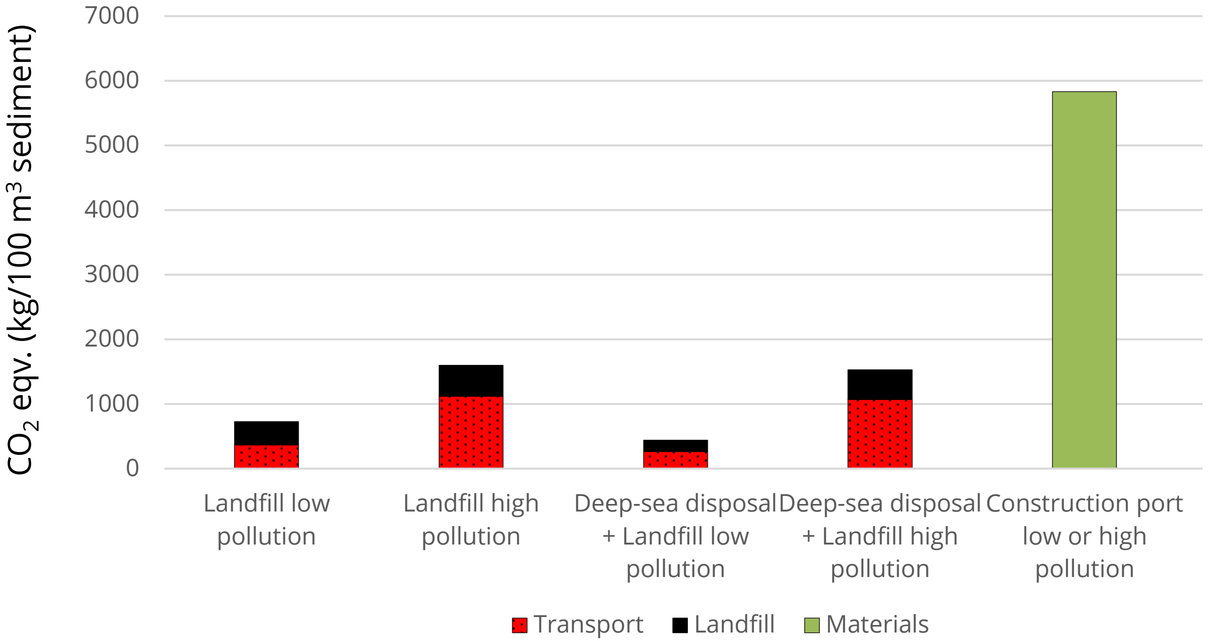
Studied sites

- 3 Marinas (M)
- 2 Ports (P)
- 1 Waterway (W)



Climate impact



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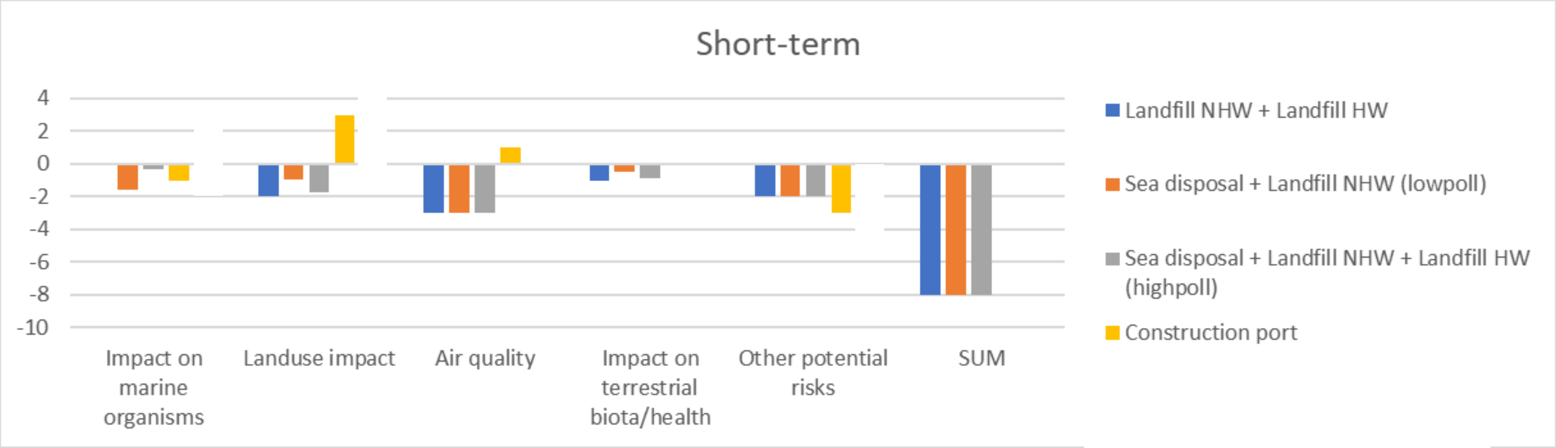
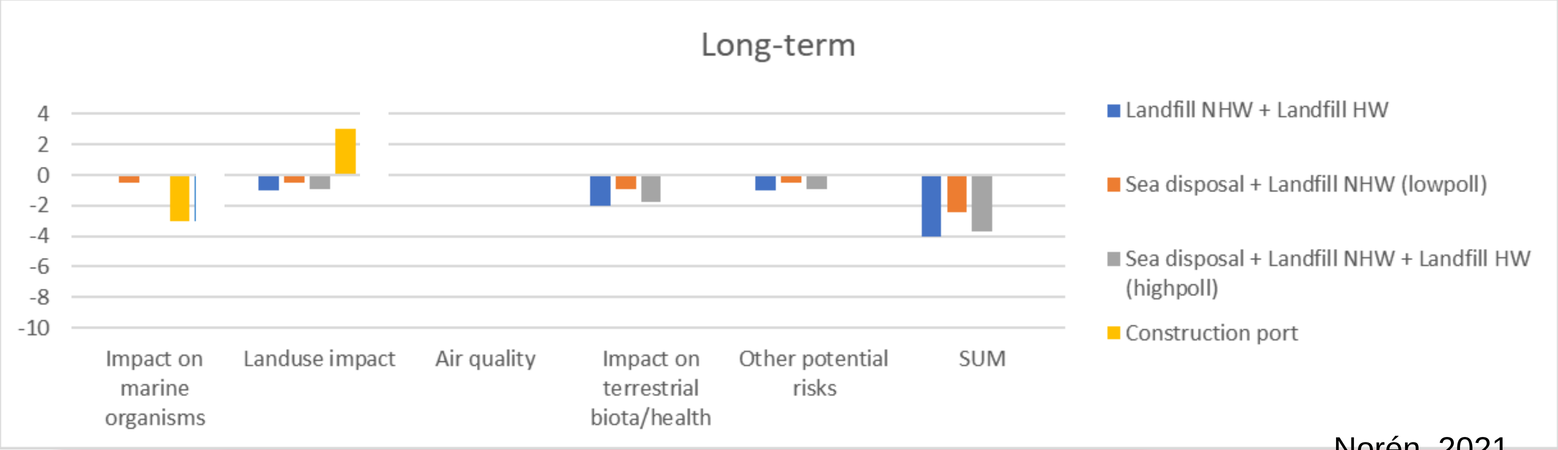

Short-term
4
2
0
-2
-4
-6
-8
-10
Impact on marine organisms
Landuse impact
Air quality
Impact on terrestrial biota/health
Other potential risks
SUM
Landfill NHW + Landfill HW
Sea disposal + Landfill NHW (lowpoll)
Sea disposal + Landfill NHW + Landfill HW (highpoll)
Construction port


Long-term
4
2
0
-2
-4
-6
-8
-10
Impact on marine organisms
Landuse impact
Air quality
Impact on terrestrial biota/health
Other potential risks
SUM
Landfill NHW + Landfill HW
Sea disposal + Landfill NHW (lowpoll)
Sea disposal + Landfill NHW + Landfill HW (highpoll)
Construction port

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Metal recovery

- Break-even treatment cost ~120-390 USD/tonne
- Metal recovery might be more attractive in the future

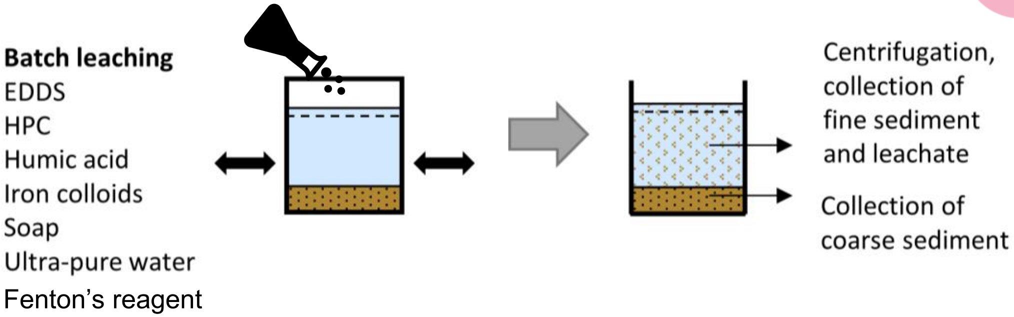
How can we treat contaminated sediment?

Gothenburg

Maps: Eniro/ Lantmäteriet, Göteborg

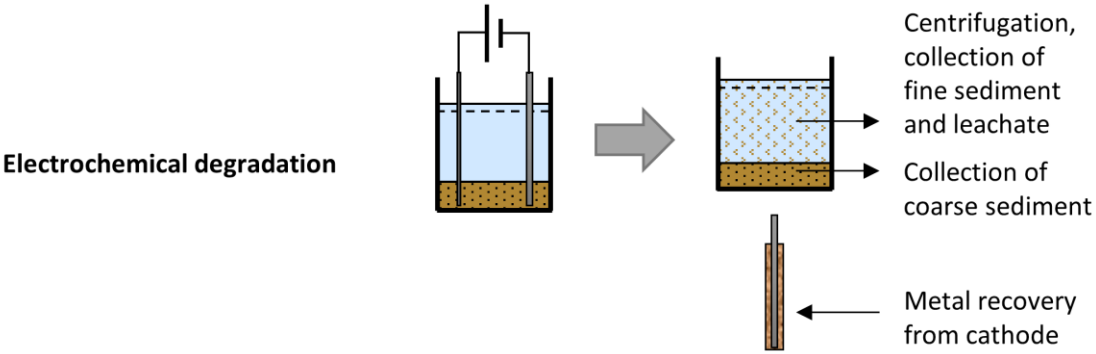
Leaching

- Low environmental impact leaching agents
- Tougher leaching agents



Oxidation

- Electrochemical treatment
- Fenton's reagent (Fe^{2+} + H_2O_2)



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Results

	Electrochemical oxidation	Fenton reagent oxidation	Ultra-pure water
Removal [%]			
TBT	58	**64**	46
Cu	13	**45**	15
Zn	13	**40**	12
+	Relatively unchanged sediment residue, which enables potential use in construction.	The highest reduction of TBT and high reduction of metals.	Unchanged sediment residue, which enables potential use in construction. Low working environment risks.
-	High environmental impact by the production of electrodes. Working environment risks (gas production during electrolysis). Management of leachate.	Low pH, changed sediment residue (smaller particles). Working environment risks (handling of chemicals, gas production during treatment). Management of leachate.	Expensive equipment for the production of the leaching agent. Management of leachate.

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How can we use treated sediment?

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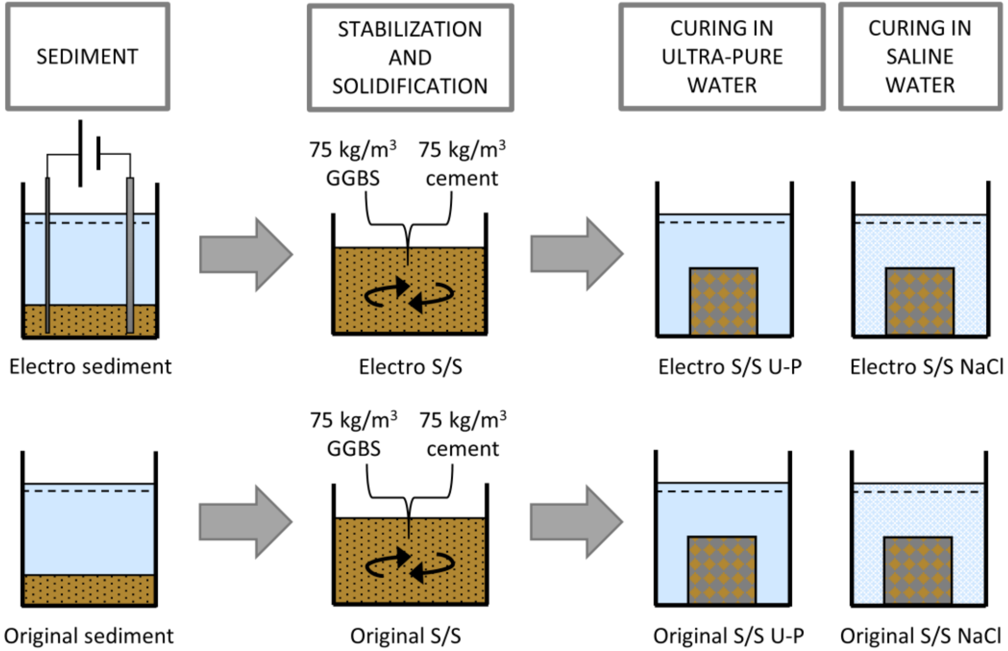
Stabilization and solidification

- Compression strength
- Leaching



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TBT reduction after S/S

	Electrochemical oxidation	Fenton reagent oxidation	Stabilization and solidification	Ultra-pure water
Removal [%]				
TBT	58	64	46[a]	46
Cu	13	45	61[a]	15
Zn	13	40	-13[a]	12

[a] ***Reduction with S/S alone from initial original content (dilution effect excluded).***

Electrolysis pretreatment – effect on S/S

+ DECREASED THE LEACHING OF METALS

- DECREASED THE COMPRESSION STRENGTH

(STILL PASSED THE SET REQUIREMENTS)

Curing in saline water – effect on S/S

- INCREASE THE LEACHING OF METALS

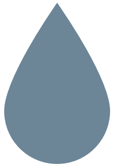
+ DECREASE THE LEACHING OF TBT

+ INCREASE THE COMPRESSION STRENGTH

How can we manage contaminated sediment?

Integrated assessment with MCA and LCA

→ Include social aspects



How can we treat contaminated sediment?

Both leaching and degradation could be effective (e.g., ultra-pure water, electrolysis)

→ Toxicity + sequential leaching tests

→ Technique development

→ Scale up treatment

Can we use treated sediment?

Stabilization and solidification

→ Other uses?

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References

Published work behind this presentation within the IMMERSE project

- https://doi.org/10.1016/j.scitotenv.2019.135510
- https://doi.org/10.1016/j.jenvman.2020.111906
- https://doi.org/10.1007/s11356-021-17554-8
- https://doi.org/10.1016/j.wasman.2021.11.031
- https://research.chalmers.se/publication/525021/file/525021_Fulltext.pdf