LATVIJAS UNIVERSITĀTE
ANNO 1919

NACIONĀLAIS ATTĪSTĪBAS PLĀNS 2020

EIROPAS SAVIENĪBA
Eiropas Reģionālās attīstības fonds

IEGULDĪJUMS TAVĀ NĀKOTNĒ

MATERIAL RECOVERY AND REVITALISATION OF LANDFILLS: MULTITASKING APPROACH STRIVING TO 'BEYOND THE ZERO WASTE'

Inovatīva atkritumu stabilizācija - vides ietekmju mazināšana un resursu potenciāls aprites ekonomikā
Projekta numurs 1.1.1.2/16/I/001
Pētniecības pieteikuma numurs 1.1.1.2/VIAA/3/19/531

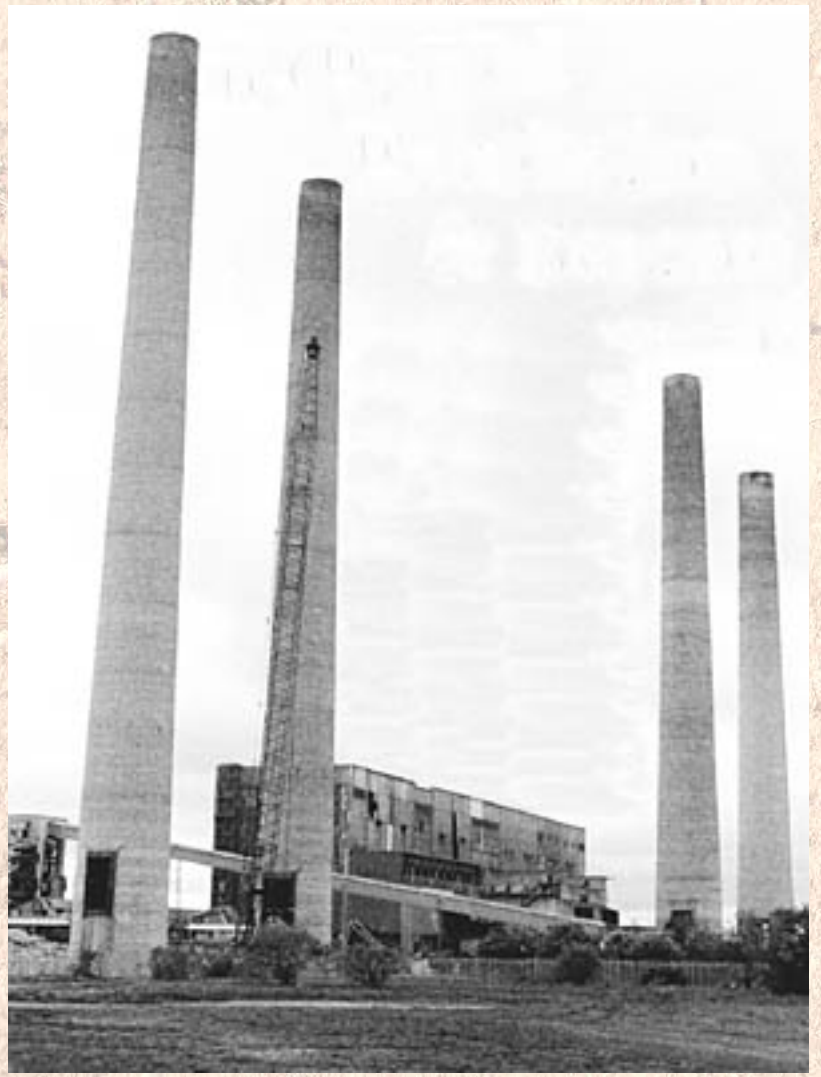
Dr. Juris Burlakovs

XXIth International Multidisciplinary Scientific GeoConference Surveying, Geology and Mining, Ecology and Management – SGEM 2021
14 - 22 August, 2021

STABILIZATION OR TREATMENT ?!?

What about recovery options?

What…is the Problem with the Pollution / Contamination



- Brownfields, landfills and former military areas are contaminated with different kind of pollution
- **What to Do?**

What to Do?

1) *In situ* – we can solve the problem on the place – to fulfill remediation works without moving the contaminated soil and / or groundwater anywhere

2) *Ex situ* – we can transport the contamination away and treat somewhere else

Specifications? Factors?

- In the vadose zone
- Aeration zone technologies
- Costs
- Speed of the process
- Flexibility of method

Criteria

1) Impact to the environment and health
2) Must consider legislation criteria
3) Speed of the effect
4) Sustainability
5) Reduction of toxicity and mobility of contamination
6) Feasibility and applicability
7) Costs
8) Governal acceptance
9) Society attitude

How to Do that???
Soil Remediation Methods

- Barriers and Treatment Walls
- Chemical Treatment
- Soil Amendments
- Separation / Concentration Process
- Soil Washing
- Soil Flushing
- Stabilization / Solidification (S/S technologies)
- Vitrification
- Electrokinetic Methods
- Phytoremediation
- Bioremediation
- Soil Vapor Extraction & Air Sparging (for VOC’s most)
- Landfill Capping/Isolation and Mining

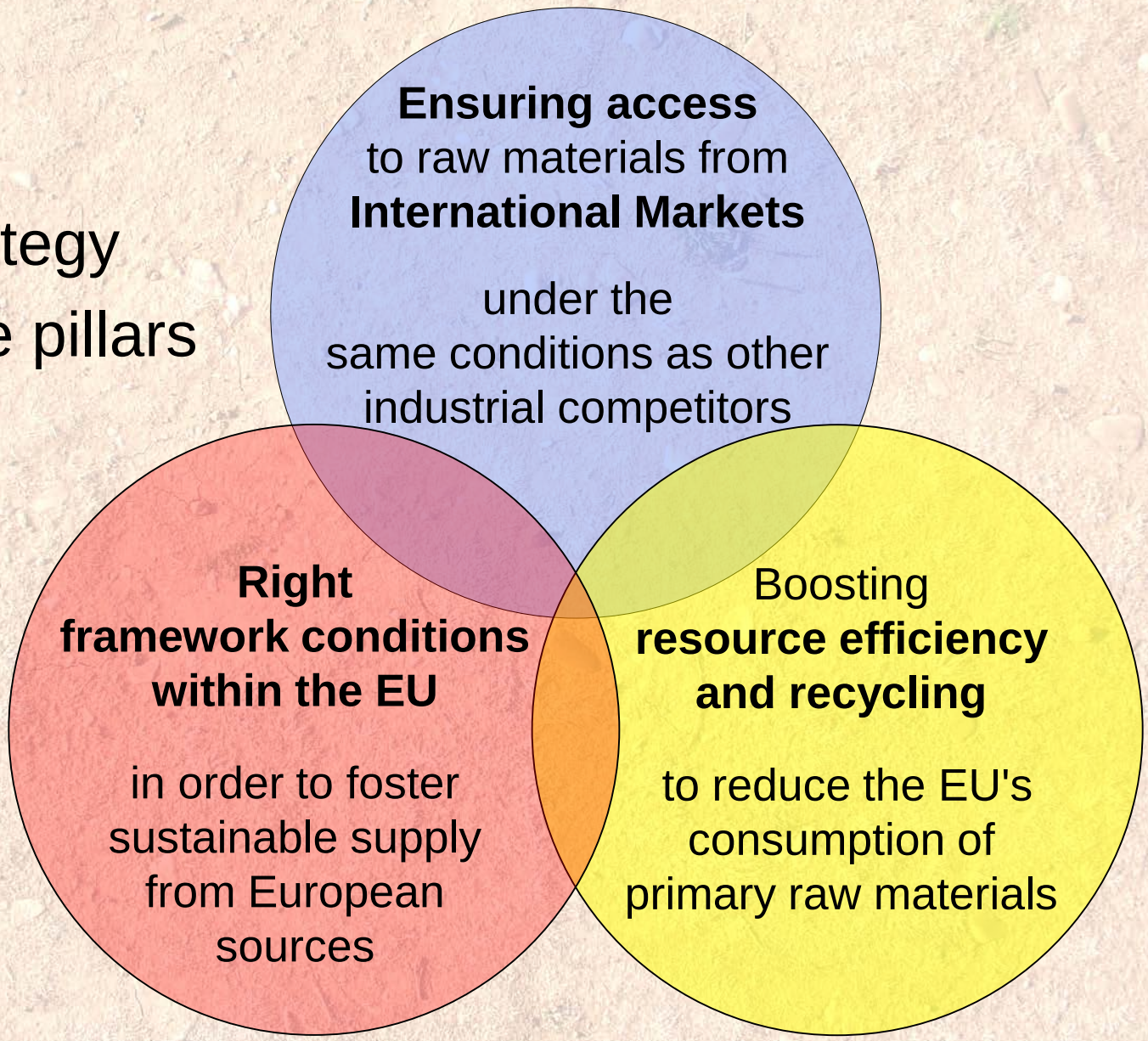
The EU Raw Materials Initiative

- Critical Raw Materials for the EU -

European Commission
Enterprise and Industry

The Raw Materials Initiative

Integrated strategy
based on three pillars



Efficiency & recycling

3rd pillar

- Huge potential of EU's Urban Mines
- Tackle illegal shipment of waste to third countries through a more harmonised enforcement of Waste Shipment Regulation
- Develop best practices in the area of collection and treatment of key waste streams
- Develop eco-design measures aimed at fostering more efficient use of raw materials in products

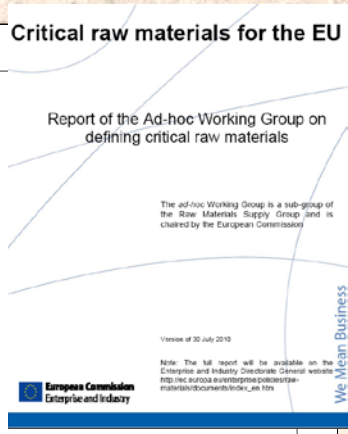
Define critical raw materials

Critical raw materials

High supply risks

- High share of the worldwide production
  - China (antimony, fluorspar, gallium, germanium, graphite, indium, magnesium, REE, tungsten)
  - Russia (PGM)
  - Congo (cobalt, tantalum)
  - Brazil (niobium, tantalum)
- Low substitutability
  - REE, PGM
- Low recycling rates
  - When used in very low concentrations

Critical raw materials



Hydrometallurgy

Pre-treatment

Leaching

Recovery

From lab-scale to full-scale applications

Conclusions and research needs

Leaching

- Acidolysis
- Redoxolysis
- Complexolysis
- Bioleaching

Recovery

- Adsorption
- Complexation
- Precipitation
- Electrowinning
- Selective recovery strategies (SX/IX)
- Reduction/cementation

Microorganisms involved

- Bioleaching microbes (Autotrophic and heterotrophic)
  - Autotrophs (iron-and sulfur-oxidisers)
  - Heterotrophs (acid and complexant producers)
- Biorecovery microbes
  - Reductive bioprecipitation microbes
  - Biomineralization microbes
  - Sulfate oxidisers (sulfidic precipitation)
  - Biosorption microbes

Biochemical mechanisms

- Bioleaching
  - Acidolysis
  - Redoxolysis
  - Complexolysis
- Hybrid approaches
  - Chemical and biological combined approaches
- Biorecovery
  - Bioprecipitation
  - Biomineralization
  - Biosorption

From lab-scale to full-scale applications

- **Pilot & commercial applications HYDROWEEE – RELIGHT plant in Milano and one is on-going in Belgium or UMICORE – it is a combination process as hydro+pyro or similar**

- **COST ES 1405 ReCrew on Recovery of Waste Electronics**

At 3rd Int. Symposium on Enhanced Landfill Mining,
Lisboa, 8-10.2.2016

Metals and rare Earth's elements in landfills: case studies

Juris Burlakovs[1], Mait Kriipsalu[2], Dace Arina[3], Fabio Kaczala[4], Ruta Ozola[1], Gintaras Denafas[5], Marika Hogland[4], Valeriy Mykhaylenko[6], Yahya Jani[4], Kaja Orupold[2], Tsitsino Turkadze[7], Valdone Daugelaite[5], Algimantas Bucinskas[5], Vita Rudovica[1], Mika Horttanainen[8], Maris Klavins[1], William Hogland [4]

[1] University of Latvia; [2] Estonian University of Life Sciences; [3] Institute of Physical Energetics, Latvia; [4] Linnaeus University, Sweden; [5] Kaunas University of Technology, Lithuania; [6] Taras Shevchenko National University of Kyiv, Ukraine; [7] A. Tsereteli State University, Georgia; [8] Lappeenranta University of Technology, Finland

Background

Characterisation of sites: BLB, Riga, Latvia

Characterisation of sites: BLB

- The mobility of contamination **must be reduced**
- Result **must be quick**
- Choosing the Technology:
  - Some remediation technologies are not appropriate because of high groundwater level, concentration of contaminants, or ongoing industrial activities
  - To stabilize or to excavate???
  - Is Urban Mining a tool for remediation?

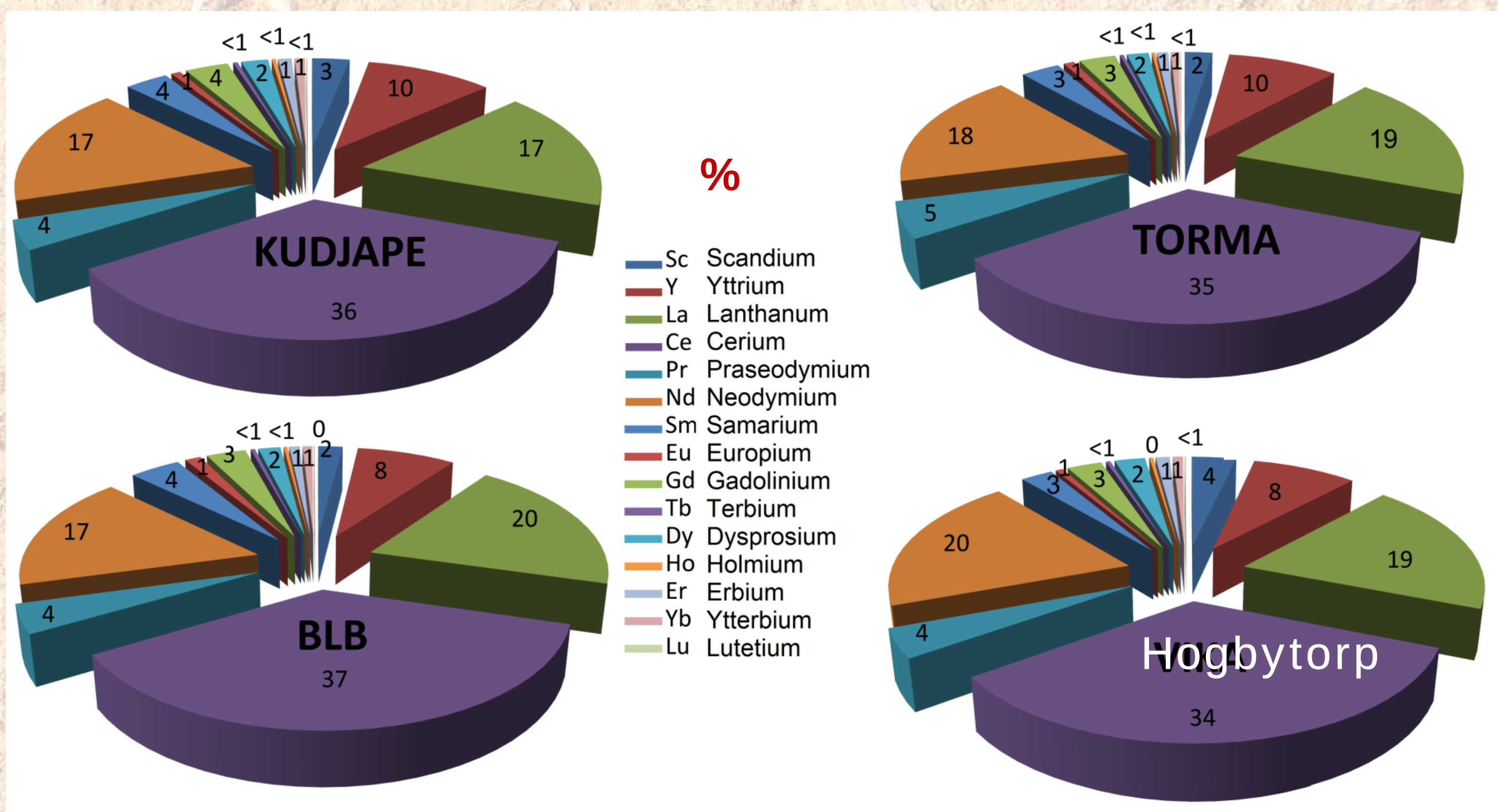
Objectives

- The aim of this study was to determine elemental content of colloidal, clayey and silty aggregates (very fine fraction) from excavated soil-like material in order to assess recovery potential of metals and REEs.
- **Why REEs**, they were not the primary objective in any of the projects?
- REEs strategic and expensive (up to 3-5 housand $/kg).
- It is useful to know what do we have in ‘stock’.
- If we go for extracting major metals, perhaps we can get REEs too?
  - Advanced leaching and bioextraction (approved technologies).

- There is competence → Molycorp (Sillamäe, Estonia), is producing tantalum and niobium (loparite ore imported from the Kola Peninsula)

Ditribution of REEs in fine fraction

Municipal, old **Municipal, fresh**



Contaminated soil **Commercial**

References

Report on critical raw materials:
http://ec.europa.eu/enterprise/policies/raw-materials/critical/index_en.htm

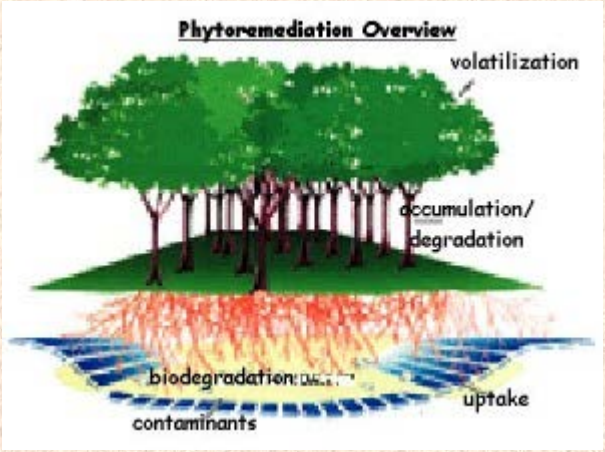
Report on best practices in area of land use planning, permitting and geological knowledge:
http://ec.europa.eu/enterprise/policies/raw-materials/sustainable-supply/index_en.htm

Natura 2000 guidelines:
http://ec.europa.eu/environment/nature/natura2000/management/guidance_en.htm

Trade raw materials activity report 2009:
http://trade.ec.europa.eu/doclib/docs/2010/june/tradoc_146207.pdf

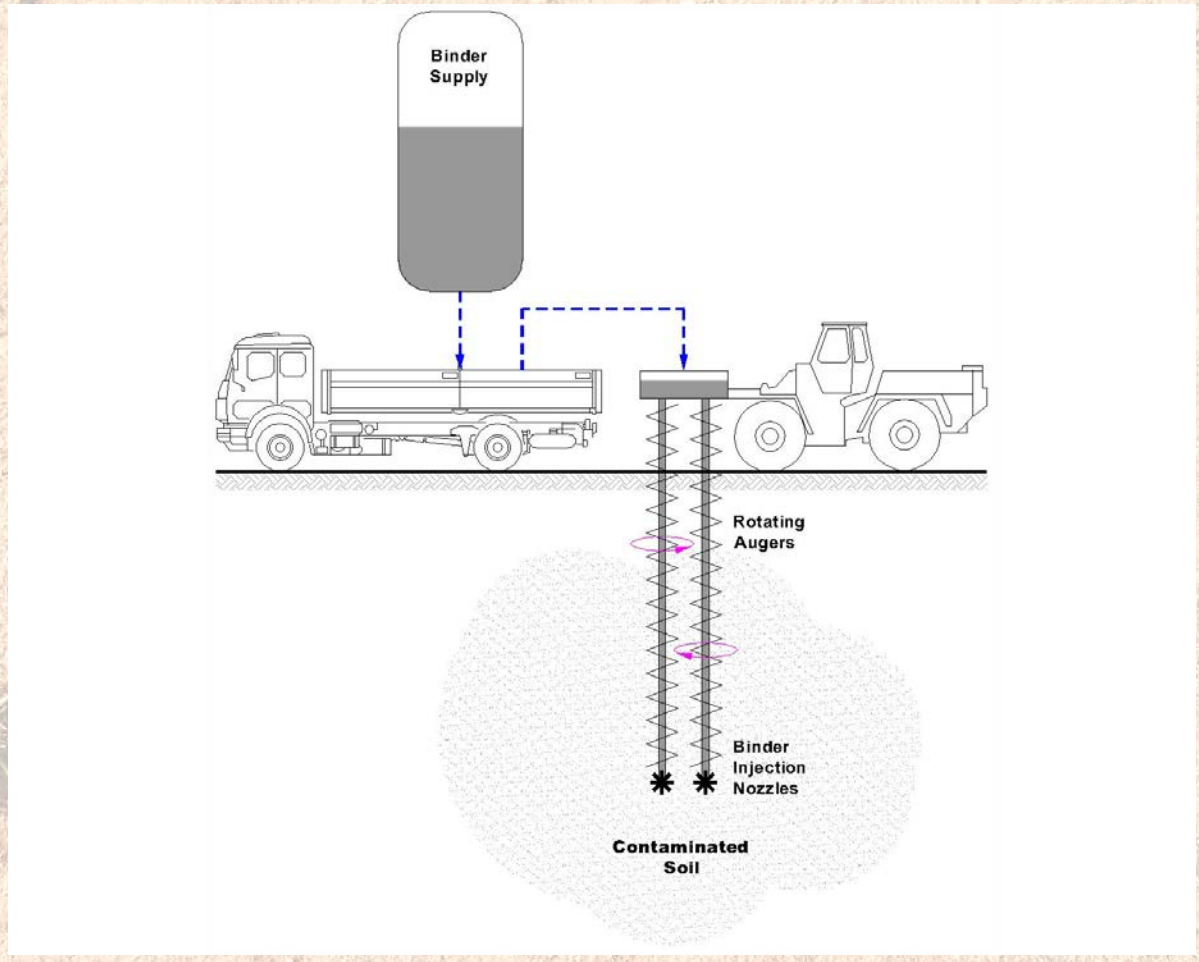
Communication on the EU 2020 Flagship Initiative Innovation Union:
http://ec.europa.eu/research/innovation-union/pdf/innovation-union-communication_en.pdf

Phytoremediation



- Plants are “uptaking” the contamination
- Low costs
- Friendly for environment
- BUT: Takes a long time and highly contaminated areas are problematic for treatment with this method

Stabilization / Solidification (S/S)



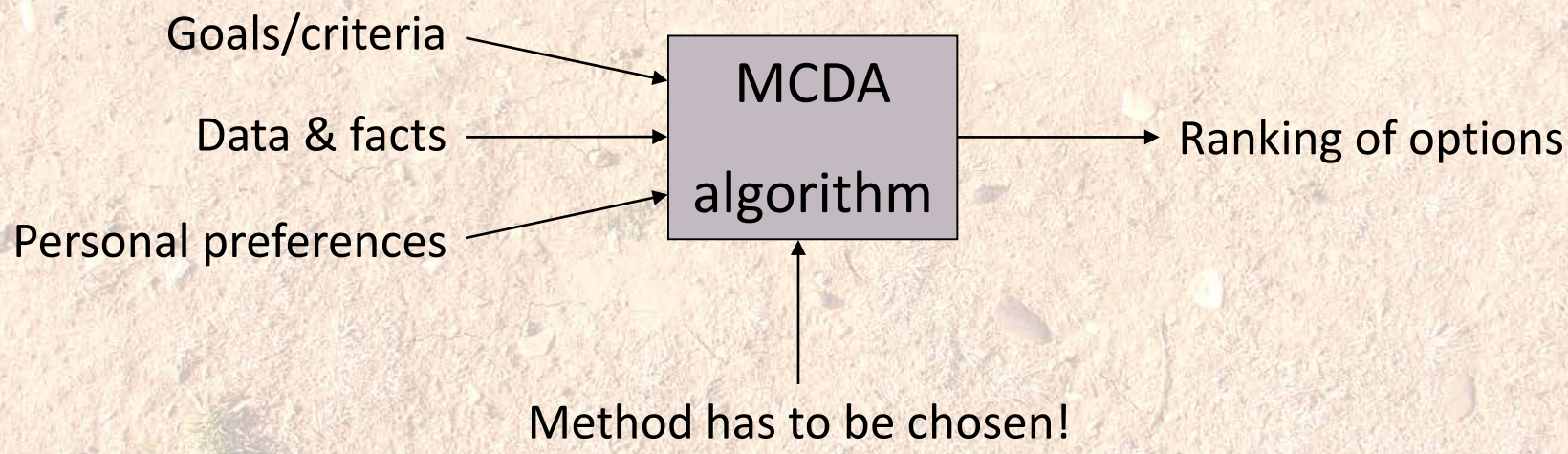
Stabilisation / solidification:

- S/S method is often used for treatment in port areas

- Aurajoki – Turku, Finland

- Trondheim Port, Norway

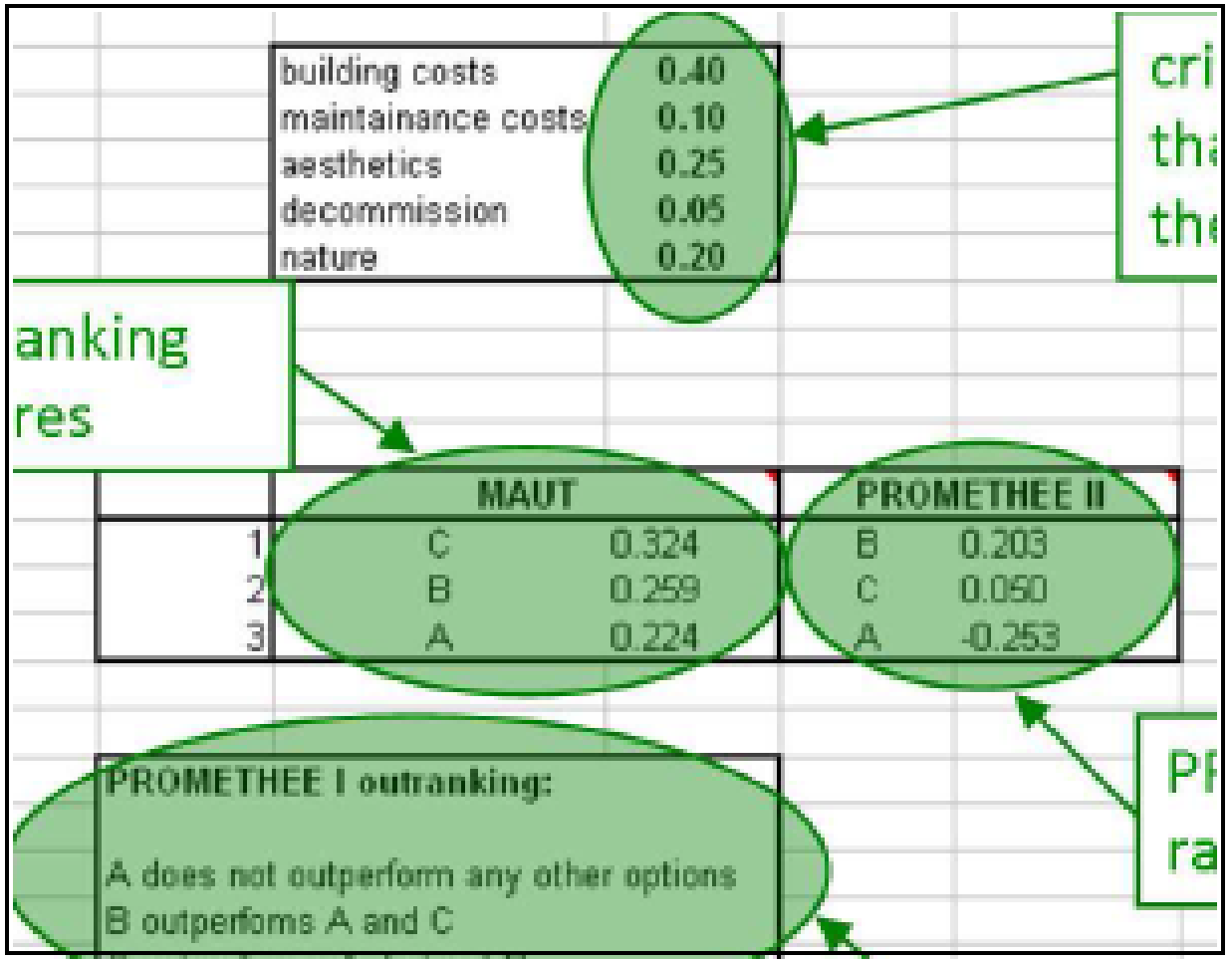
MCDA analyses decision problems and tries to identify the best option from the decision-maker's point of view

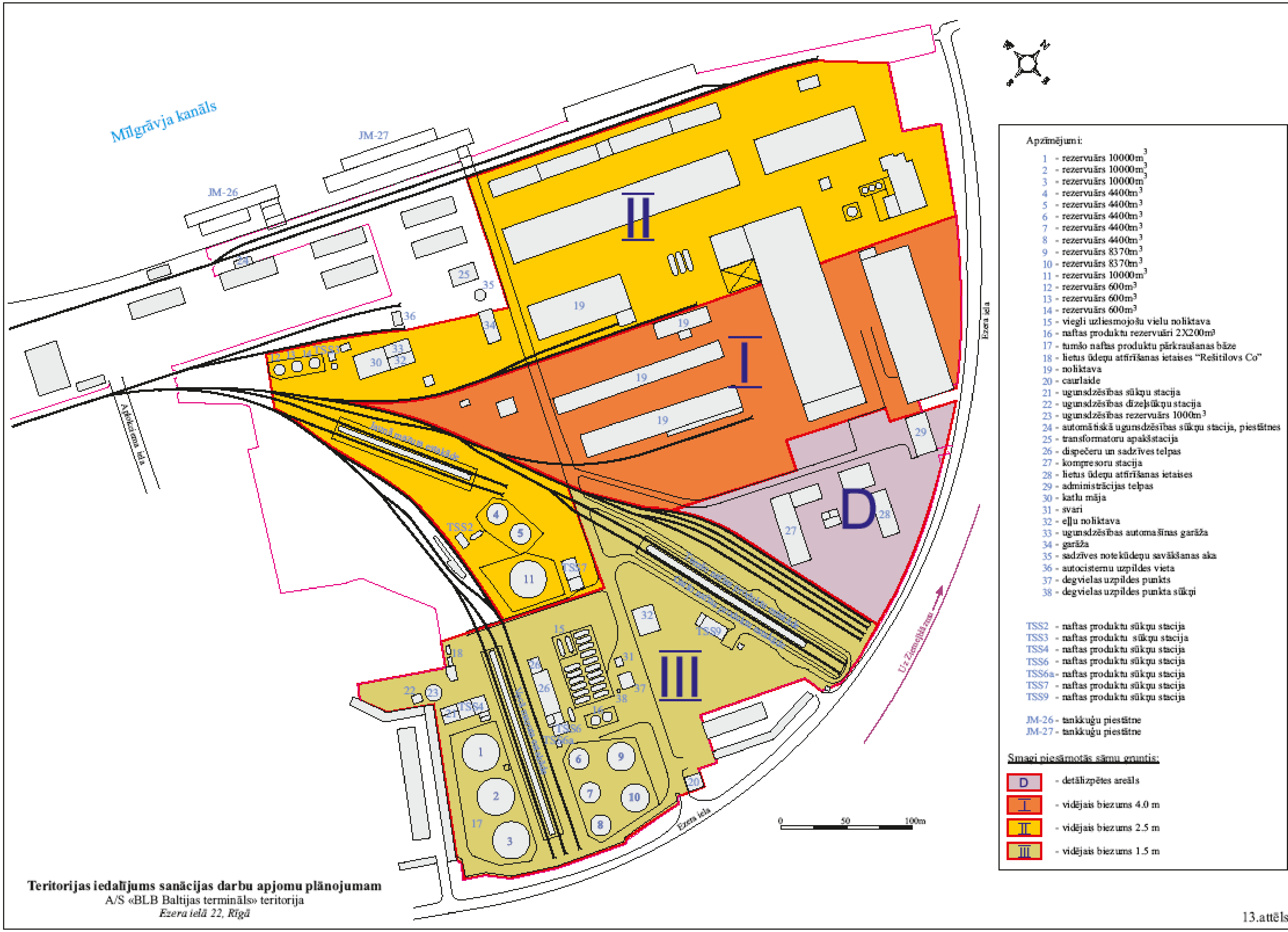


MCDA helps choice

- MCDA helps to evaluate criteria
- Developed„decision matrix” –every criteria has its own „weight”
- Algorithms and calculations

Remediation choices are input, criteria chosen and weighed




Mīlgrāvja kanāls
JM-27
JM-26
Apdzīvēma iela
Ezera iela
Uz Ziemeļblāzmu
II
I
III
D
Apzīmējumi:
1 - rezervuārs 10000m3
2 - rezervuārs 10000m3
3 - rezervuārs 10000m3
4 - rezervuārs 4400m3
5 - rezervuārs 4400m3
6 - rezervuārs 4400m3
7 - rezervuārs 4400m3
8 - rezervuārs 4400m3
9 - rezervuārs 8370m3
10 - rezervuārs 8370m3
11 - rezervuārs 10000m3
12 - rezervuārs 600m3
13 - rezervuārs 600m3
14 - rezervuārs 600m3
15 - viegli uzliesmojošu vielu noliktava
16 - naftas produktu rezervuāri 2X200m3
17 - tumšo naftas produktu pārkraušanas bāze
18 - lietus ūdeņu attīrīšanas ietaises "Rešitilovs Co"
19 - noliktava
20 - caurlaide
21 - ugunsdzēsības sūkņu stacija
22 - ugunsdzēsības dīzeļsūkņu stacija
23 - ugunsdzēsības rezervuārs 1000m3
24 - automātiskā ugunsdzēsības sūkņu stacija, piestātnes
25 - transformatoru apakšstacija
26 - dispečeru un sadzīves telpas
27 - kompresoru stacija
28 - lietus ūdeņu attīrīšanas ietaises
29 - administrācijas telpas
30 - katlu māja
31 - svari
32 - eļļu noliktava
33 - ugunsdzēsības automašīnas garāža
34 - garāža
35 - sadzīves notekūdeņu savākšanas aka
36 - autocisternu uzpildes vieta
37 - degvielas uzpildes punkts
38 - degvielas uzpildes punkta sūkņi
TSS2 - naftas produktu sūkņu stacija
TSS3 - naftas produktu sūkņu stacija
TSS4 - naftas produktu sūkņu stacija
TSS6 - naftas produktu sūkņu stacija
TSS6a - naftas produktu sūkņu stacija
TSS7 - naftas produktu sūkņu stacija
TSS9 - naftas produktu sūkņu stacija
JM-26 - tankkuģu piestātne
JM-27 - tankkuģu piestātne
Smagi piesārņotās sāmu gruntis:
D - detālizpētes areāls
I - vidējais biezums 4.0 m
II - vidējais biezums 2.5 m
III - vidējais biezums 1.5 m
0 50 100m

Teritorijas iedalījums sanācijas darbu apjomu plānojumam
A/S «BLB Baltijas termināls» teritorija
Ezera ielā 22, Rīgā

13.attēls

The Process

- Each zone evaluated separately
- Excavation and landfilling of soil ex situ was excluded as too expensive approach, hydrogeological aspects as the proof – “excluding approach”

Landfill mining market

Necessity → Supply → Decisions

Highly specific market
from the ecosystem and
economic services approach

Resource recovery strategy

Landfill Mining

Perspectives in Baltic countries in general:

- 1700 closed landfills and technogenic dump sites
- 2 milj t refuse derived fuel
- 0.33 milj t metals
- 140 000 kg rare earths metals

Problems and benefits

- ✓Sales – the hazardous waste problem
- ✓Unstable market
- ✓Multiple revenue streams
- ✓Problem – risks, permits, EIAs

Practical gains

- Stabilisation can be done as option where contamination level very high
- Resource recovery possible
- Complex approaches and technologies possible for remediation
- Important aspects for land use recovery

Theme 1: Conceptual understanding of the landfill and its potential for development of functional construction material for sustainable closure from its own material

Theme 2: Leaching from waste and Phytoremediation. Parks?

Theme 3: Potential recovery of critical elements, including REEs from fine fraction if concentration is unacceptable for the use as construction material without additional treatment

Conclusions

- Fine fraction contains potentially recoverable scarce metals.
- The concentration of REEs is lower than in conventional REE-mining sites.
- Future extraction of REEs can be interesting in combination with elements like Fe, Al, Cu, Pb, Ni and other (which appear in high concentrations).
- Phyto- and bio-extraction technologies? Geochemical perspectives in Geomicrobiology is the newest trend for Victor Goldschmidt followers ☺.

- Co-operation with people who extract metals from WEEE!
- Transportation of soil over long distances is unrelistic. REEs must be pre-processed (concentrated) on-site ☹. Volume reduction by incineration???
- Studies on speciation and potential hydrometallurgical approaches for extraction of individual metals, metalloids and REEs have to be continued.

Благодаря ти много!
Thanks for attention!

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- August 2021
- University of Latvia