Interreg North-West Europe
EUROPEAN UNION
RAWFILL
European Regional Development Fund

Dynamic landfill management:
an introduction to anthropogenic resource management

Eddy Wille,
Senior advisor-geologist, OVAM

Geological Research Seminar UG
November 6th 2020

Overview

- Rawfill-project
- Dynamic Landfill Management
- Conceptual site model versus Complex adaptive systems
- Experiences ?
- The myth of Orion & Cedalion
- DST 1 : Cedalion
- DST 2 : Orion

https://www.nweurope.eu/projects/project-search/supporting-a-new-circular-economy-for-raw-materials-recovered-from-landfills/

Raw materials recovered from landfills

The Interreg North-West Europe Project is coordinated by SPAQuE and unites 8 partners from 4 EU regions.

100.000 landfills in North-West Europe

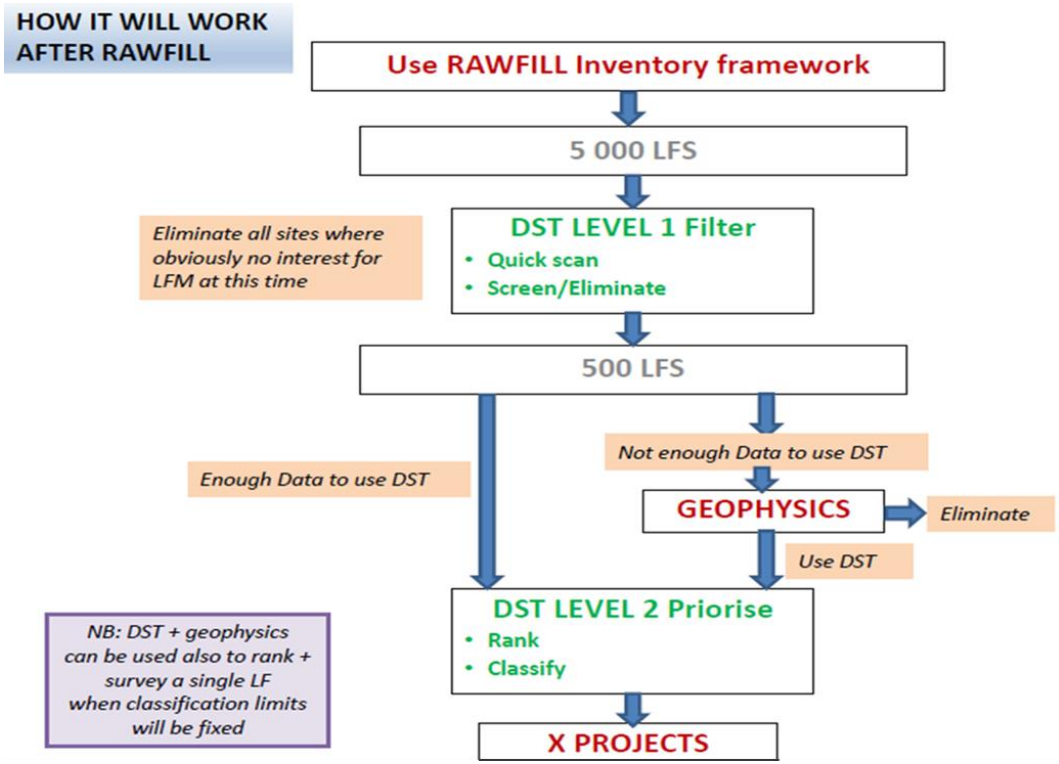
Most of these sites lack state-of-the-art environmental protection systems, leading to local pollution, land-use restrictions and global impacts.

Fortunately, the large volumes of resources can be recovered through Landfill Mining.

The main challenge for stakeholders is the profitability risk due to the lack of reliable data on the recovery potential of landfills.

Outcomes of RAWFILL

- enhanced framework for private/regional/ transregional landfill inventories
- landfill geophysics
- decision support tool



Waste management in Flanders

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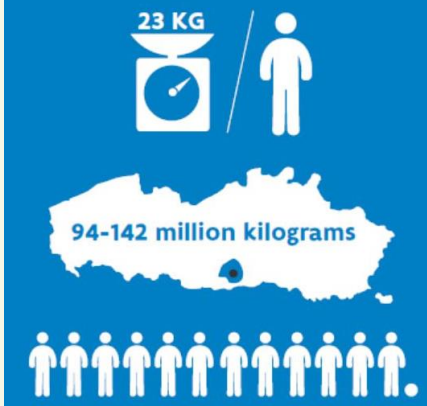
Household waste per inhabitant of Flanders

The amount of residual waste we produce is decreasing much more slowly than the waste that is collected separately. Therefore, OVAM wants to improve separate collection even more.

2007	2017
555 KG	490 KG
400 KG	338 KG (- 62 KG)
Collected separately	Collected separately
155 KG	152 KG (-3 KG)
Residual waste	Residual waste

How much food are we wasting?



Flemish consumers waste up to 23 kg of food per person each year.

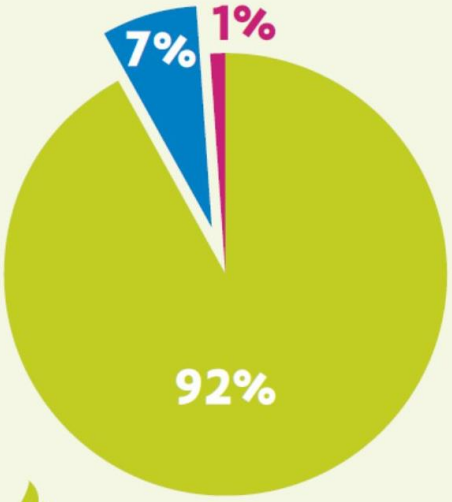
For Flanders as a whole the amount is between 94 and 142 million kilograms.

With this amount of food 30,000 football teams can be fed for one year.

How is residual household waste processed?

950,000 TONNES

This is the amount of non-separated residual waste collected in Flanders each year.



OVAM

WTF Landfills ?!

What's the future of landfills ?

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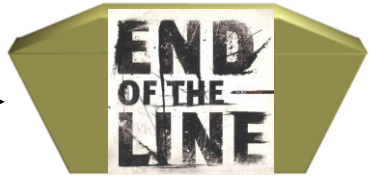
Final waste disposal ?

Start of a bright future ?

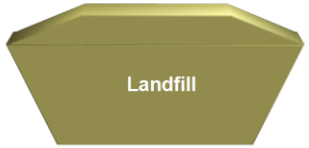
COCOON objective : develop, integrate and improve relevant cross-cutting policy instruments on landfill management in the EU

Landfilling : final waste disposal sites as the end of the line in a linear economy



Is this the end of story ?

Risk based approach (source – pathway – target) : install a safe infinite containment



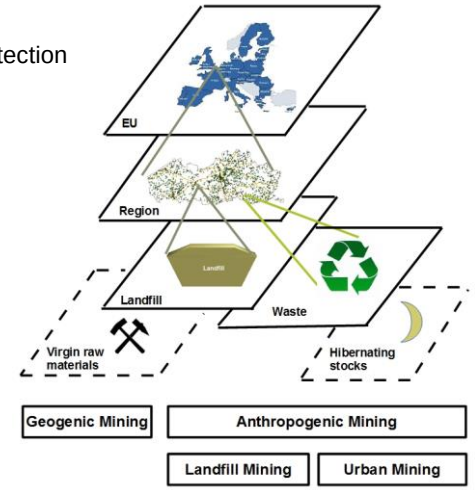
guarding the status quo :
Is this static concept robust to environmental changes ?

COCOON-analysis :

- Poor exchange of data of (former) landfills
- Majority of old landfills (<1999) seldom state of the art; often lacking LT-monitoring & aftercare
- LT-effects not limited to landfill scale: local level to global level
- External impact underestimated: climate change, spatial pressure, flooding, soil sealing, drinking water protection
- Rarely landfilling with regard to re-mining (monofills)

COCOON-conclusion :

- Dynamic landfill management approach required in view of demand and supply
- Integration in broader frameworks : circular economy, resource efficiency, sustainable development



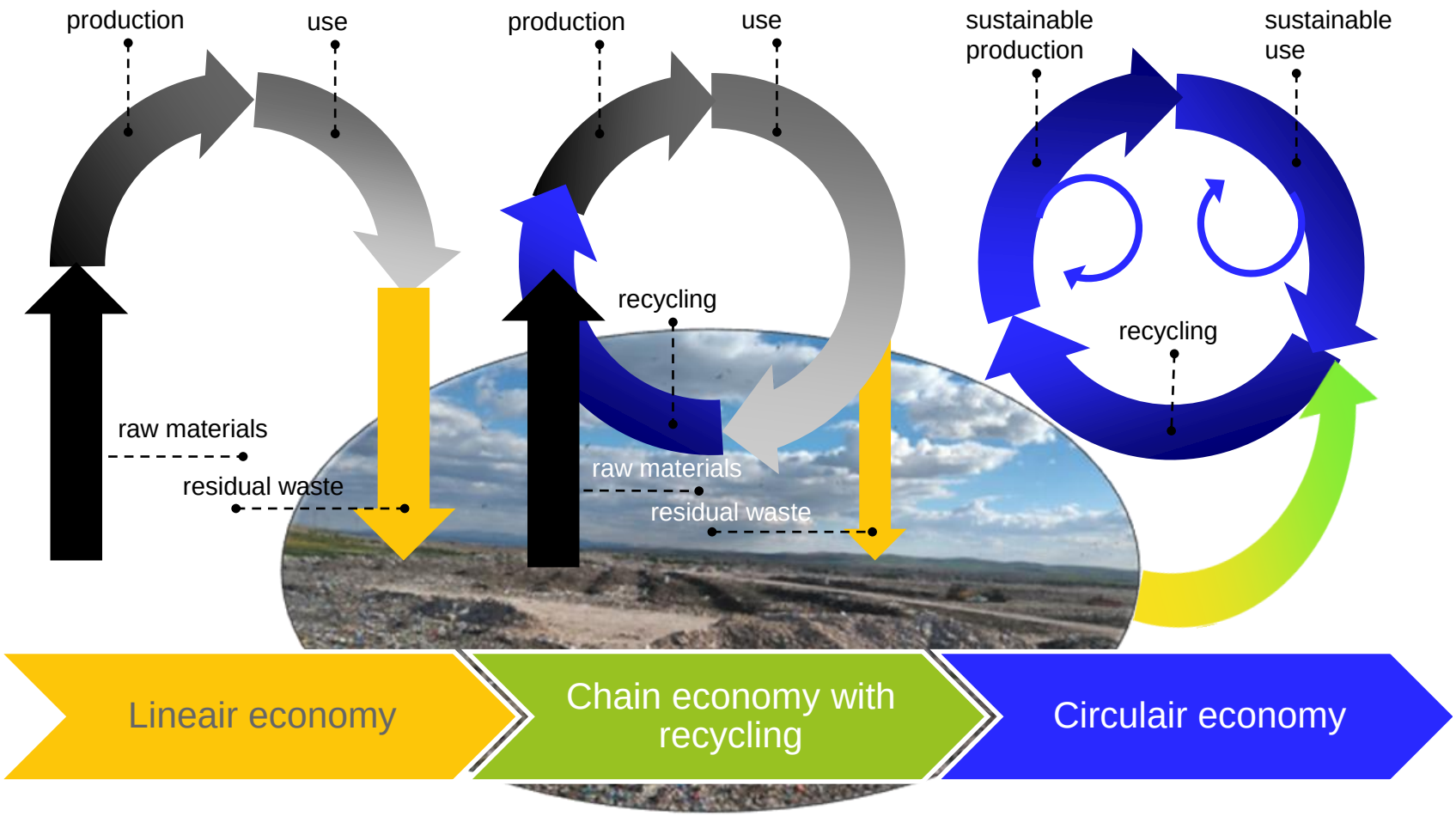
Transiti ON

to a dynamic landfill management focusing on Resources and Reserves in order to provide Waste to Materials/Energy/Land & Protection of Resources.

https://www.interregeurope.eu/cocoon/

Dynamic Landfill Management

Transition of Landfills : Dynamic Landfill Management
from waste to resources



Landfills & Circular economy

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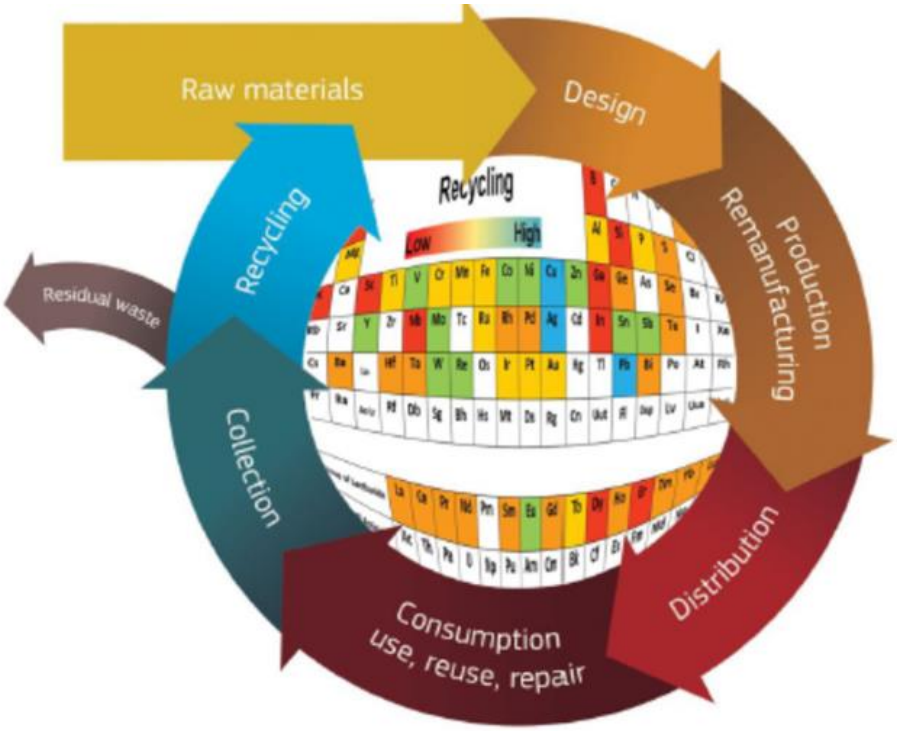
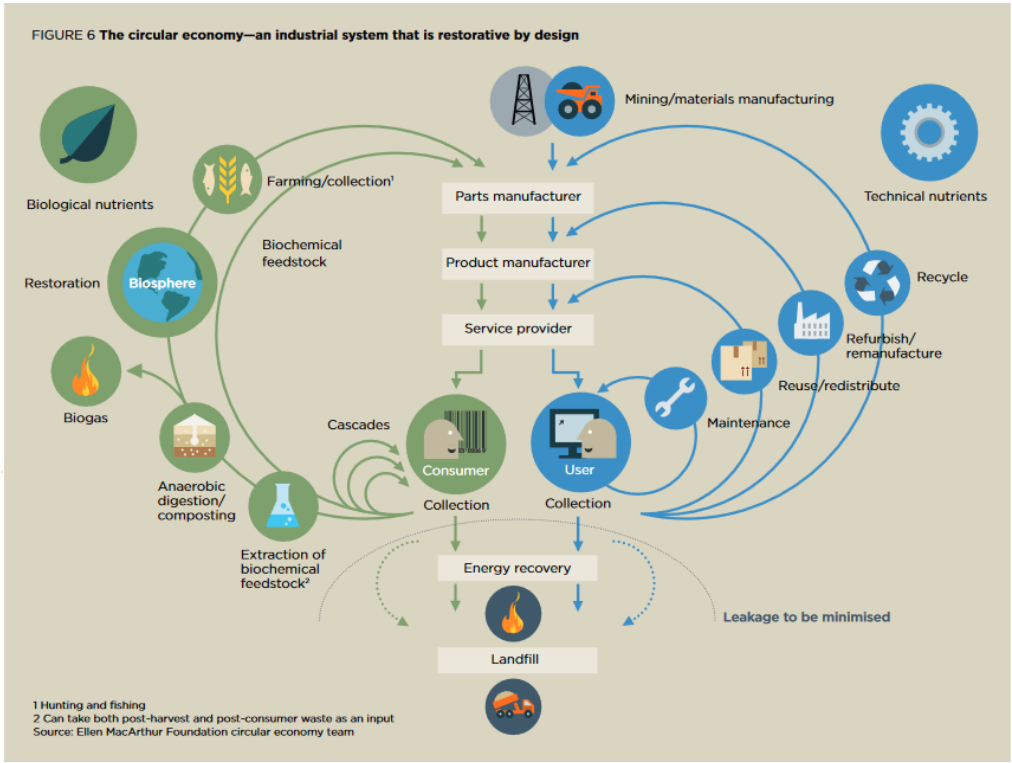
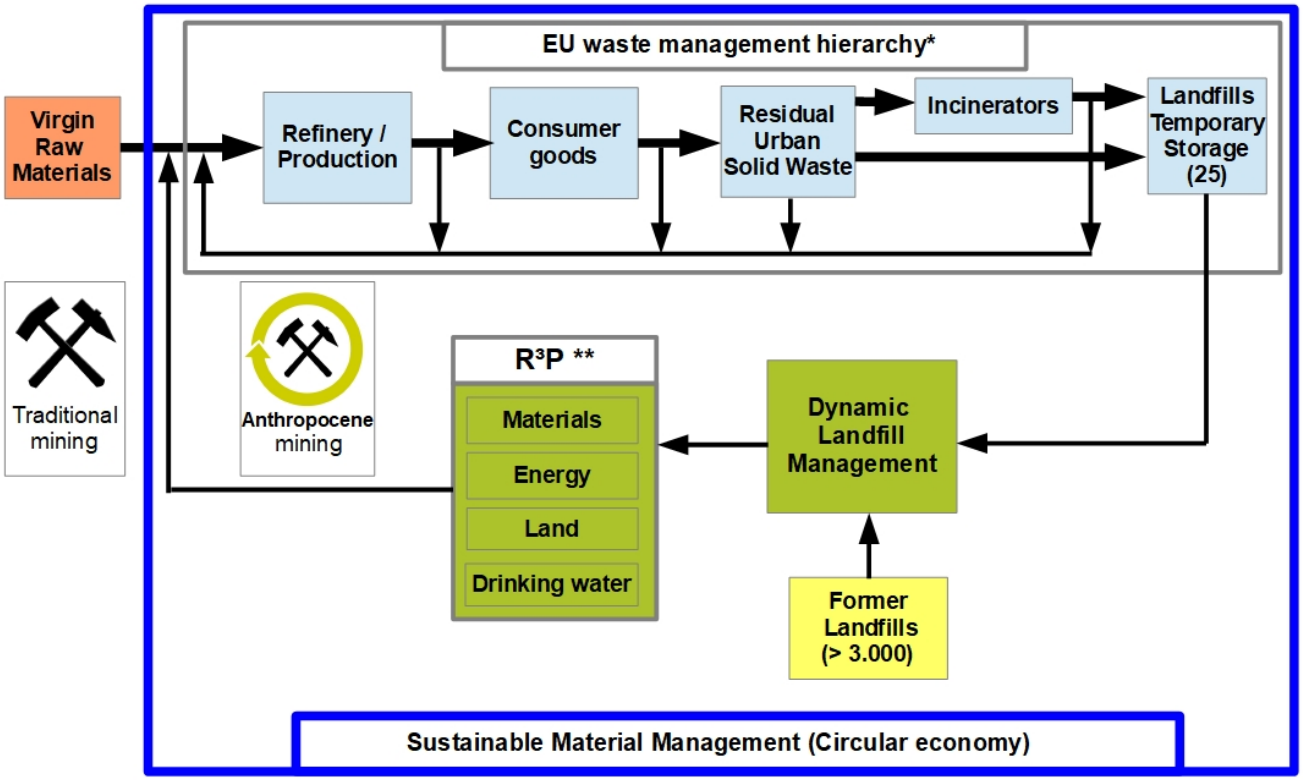




https://publications.jrc.ec.europa.eu/repository/bitstream/JRC116131/aaa_20190506-d3-jrc-science-for-policy-recovery_of_rm_from_mining_waste_and_landfills_4_07_19_online_final.pdf
https://ec.europa.eu/jrc/en/publication/eur-scientific-and-technical-research-reports/critical-raw-materials-and-circular-economy-background-report
https://www.ellenmacarthurfoundation.org/assets/downloads/publications/Ellen-MacArthur-Foundation-Towards-the-Circular-Economy-vol.1.pdf

Landfills & Circular economy



*Prevention (Ecodesign, dematerialisation,...), Reuse/ Recycling, Incineration, Landfilling (EU Waste Framework Directive)
** R³P = Recycling of Materials, Recovery of Energy, Reclaiming of Land, Preserving Drinking water supplies

Landfills & Circular economy

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Geofysische prospectie
t.b.v. enhanced landfill mining
–
stortplaats Sint-Truiden
(Melveren)

Opdrachtgever
OVAM

Leiding: Prof. Dr. K. Walraevens
Studie en verslag:
Dr. Kristine Martens

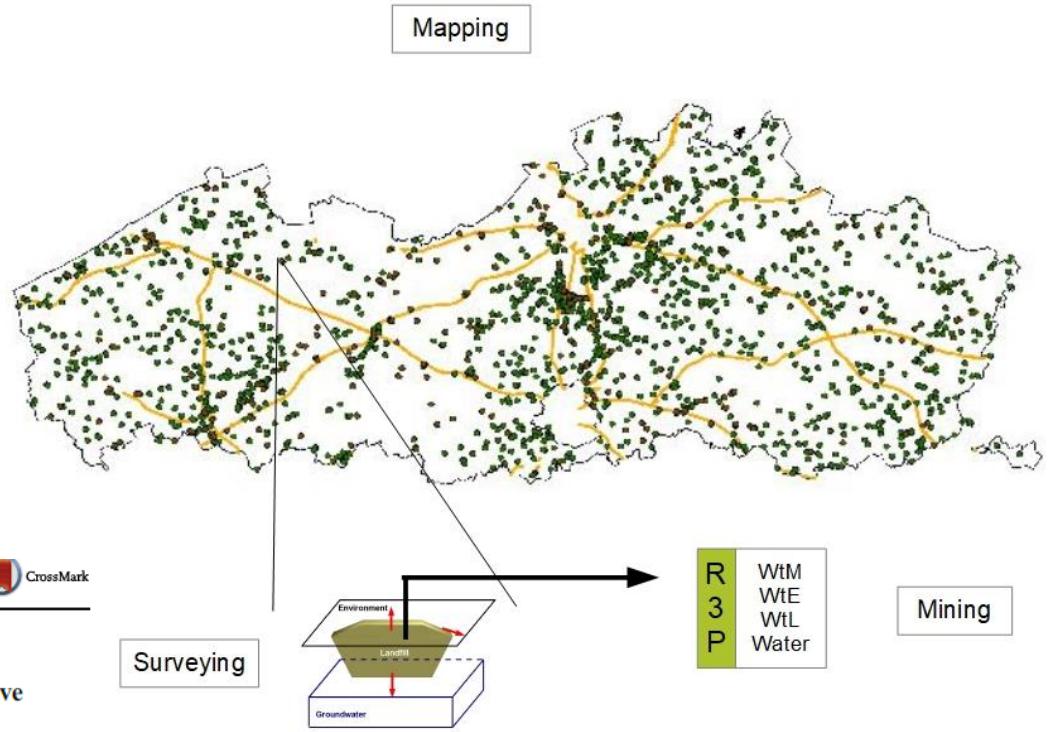
Dossiernummer: TGO 13/01
Datum: november 2013

Bull Eng Geol Environ
https://doi.org/10.1007/s10064-017-1169-2

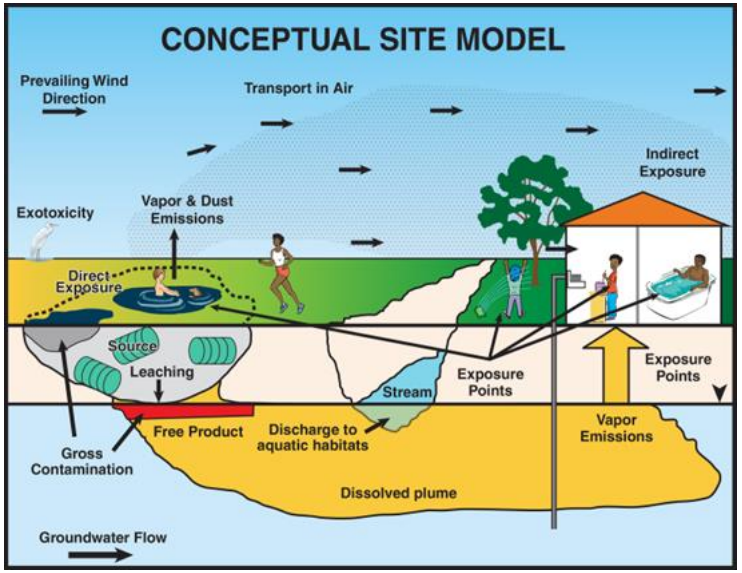
ORIGINAL PAPER

Geophysical exploration of an old dumpsite in the perspective of enhanced landfill mining in Kermt area, Belgium

Mero Yannah[1] · Kristine Martens[2] · Marc Van Camp[2] · Kristine Walraevens[2]



Conceptual Site Model



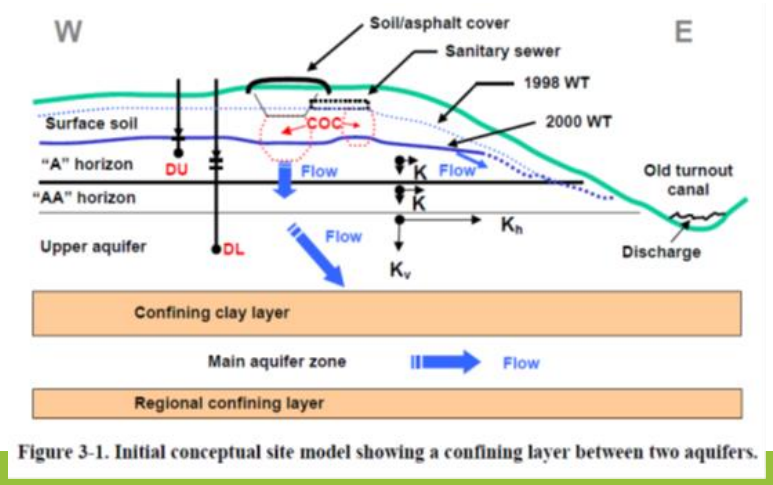


Figure 3-1. Initial conceptual site model showing a confining layer between two aquifers.

Traditional Conceptual Site Model sets focus mainly on impacts and risks.

Seldom detailed data on waste (quality and quantity), infrastructure, geotechnical characteristics,...

Often limited scales (spatial, timing,...)

Conceptual Site Model

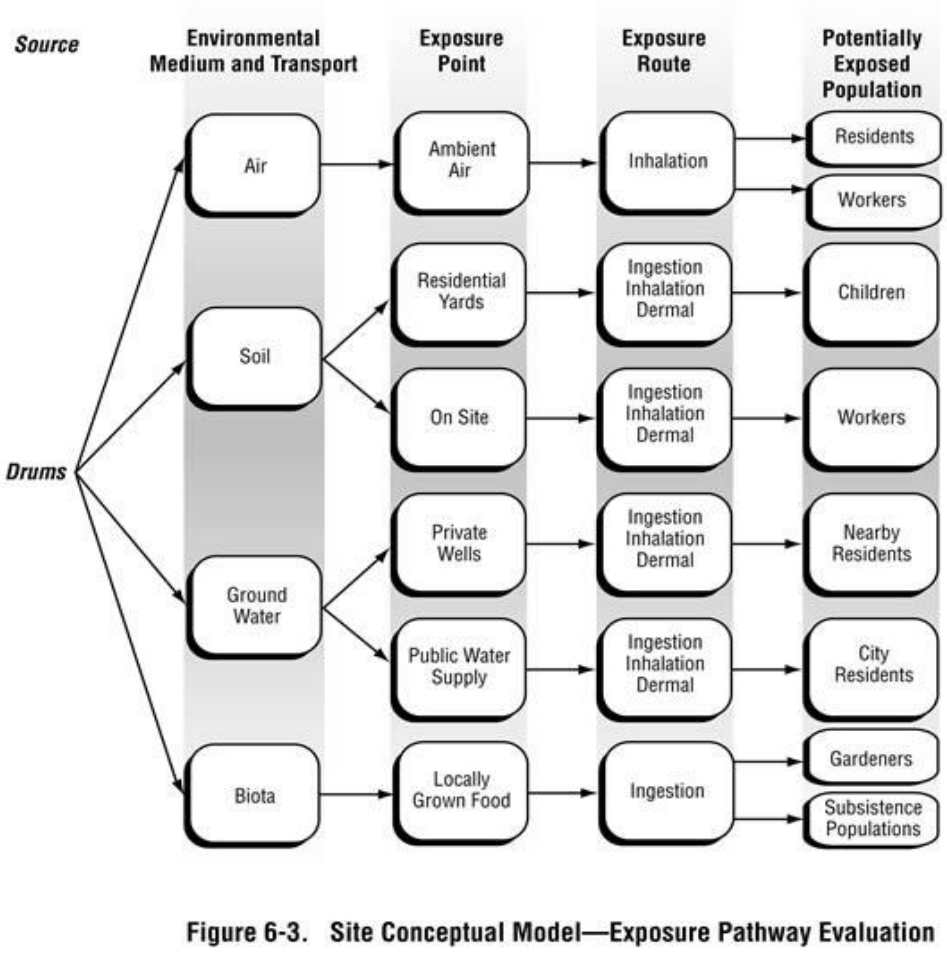
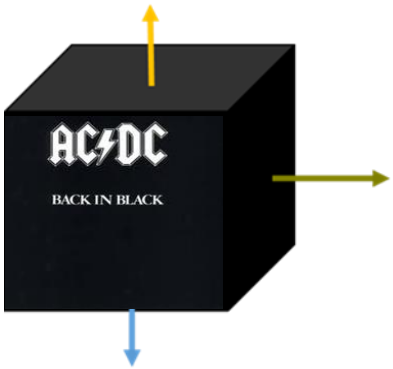


Figure 6-3. Site Conceptual Model—Exposure Pathway Evaluation

Conceptual Site Model identifying :
Source – Pathway – Target

Black box : what's leaving the box ?



Conceptual Site Model

Main objective : preventing/remediating soil & groundwater contamination

Latest news : roadmap New Soil Strategy EU

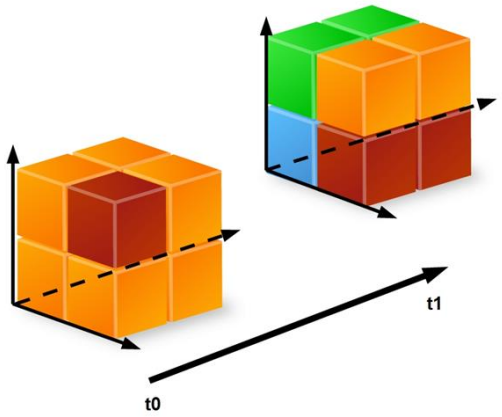
https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12634-New-EU-Soil-Strategy-healthy-soil-for-a-healthy-life

European Commission

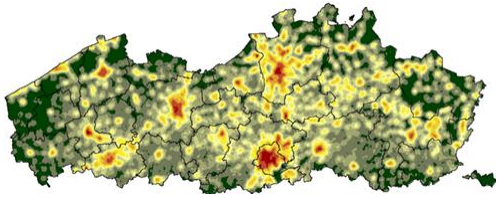
Ref. Ares(2020)6391319 - 05/11/2020

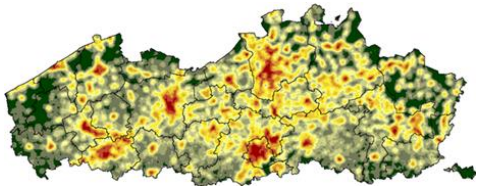
ROADMAP	
Roadmaps aim to inform citizens and stakeholders about the Commission's work in order to allow them to provide feedback and to participate effectively in future consultation activities. Citizens and stakeholders are in particular invited to provide views on the Commission's understanding of the problem and possible solutions and to make available any relevant information that they may have.	
TITLE OF THE INITIATIVE	New Soil Strategy - healthy soil for a healthy life
LEAD DG – RESPONSIBLE UNIT	DG ENV D1 Land use and management
LIKELY TYPE OF INITIATIVE	Communication
INDICATIVE PLANNING	Q2 2021
ADDITIONAL INFORMATION	The update of the Soil Thematic Strategy was announced in the EU Biodiversity Strategy for 2030.[1]

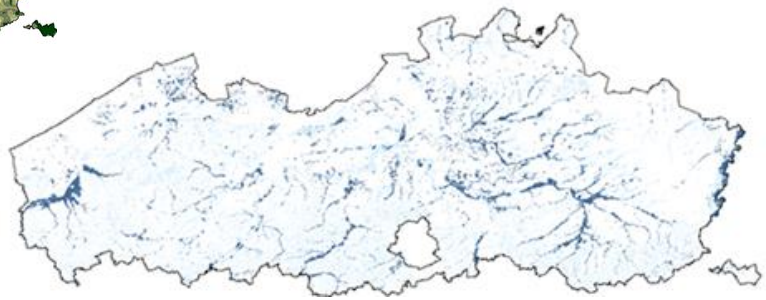
Dynamics of the system



In situ & ex situ landfill dynamics







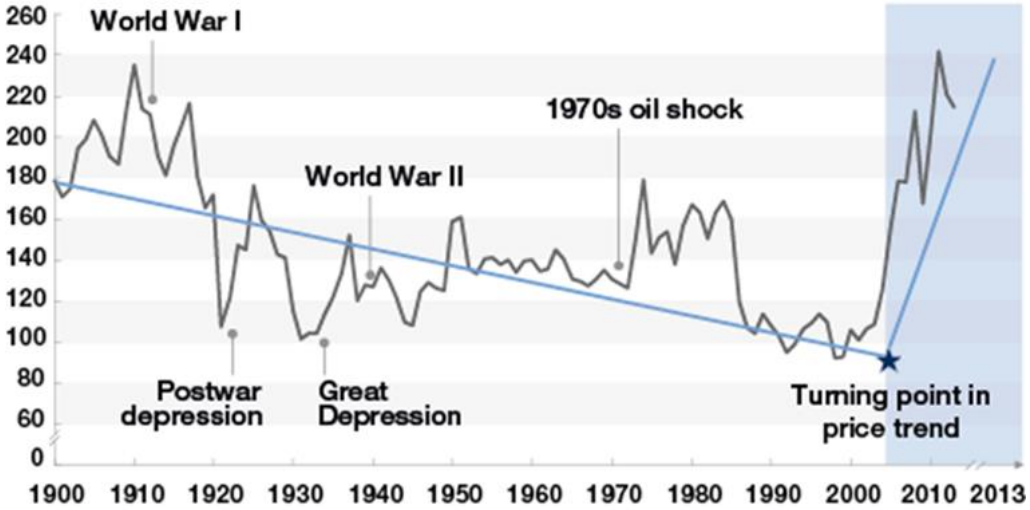
Internal dynamics: degradation

External dynamics: anthropogenic

External dynamics: Natural / climate

Dynamics of the system

Keep in touch with the dynamics of the system. Predictions and modelling are part of it and might change.

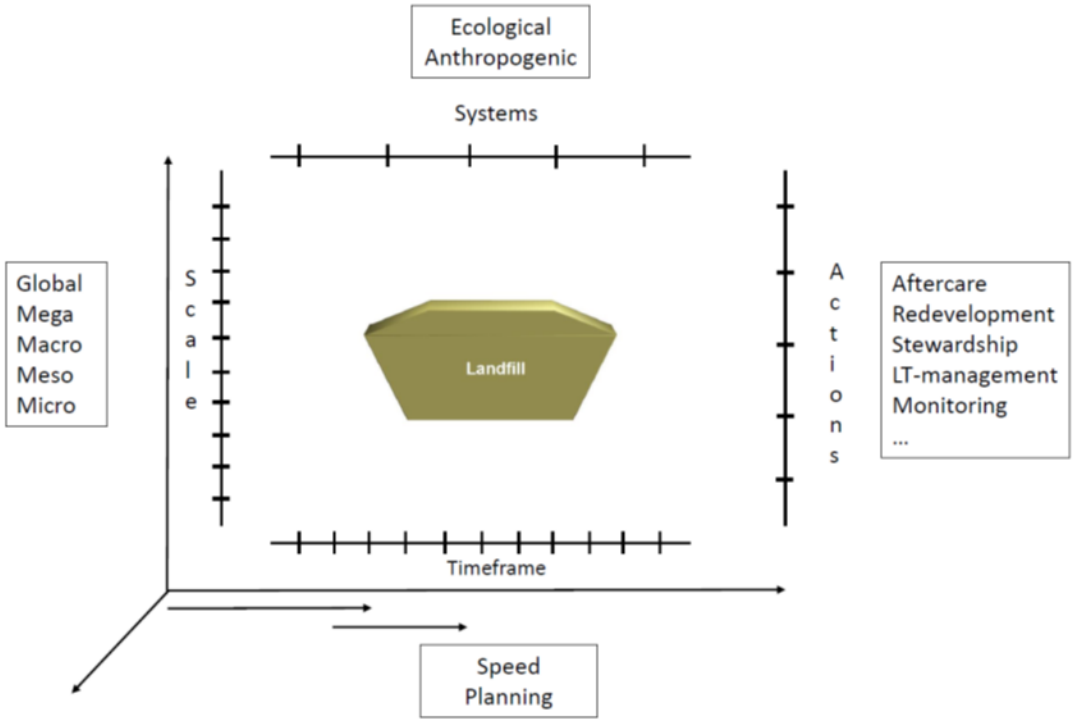


Evolution of Commodity prices (2011)

https://www.mckinsey.com/~/media/McKinsey/Business%20Functions/Sustainability/Our%20Insights/Resource%20revolution/MGI_Resource_revolution_full_report.ashx

Complex Adaptive Systems

The art of sustainable management



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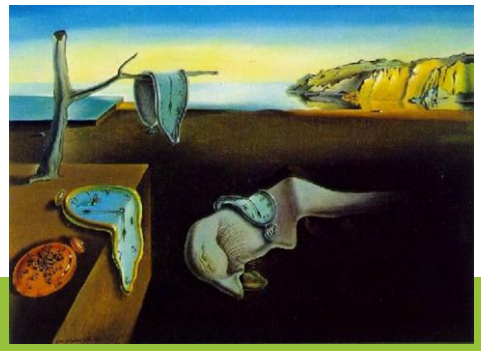
Complexity :

- Diversity of stakeholders;
- Uncertainties about causes, consequences & remedies;
- Different formal & informal laws and levels of government;
- Difficulty to rapid change of configurations;
- Complex dependencies which constantly change.



Salvador Dali

Flexibility in timeframes (4D) & (re)thinking the inside

(an unknown and unexpected embrace)

Geert De Geyter

Reclaiming Land(fills)
1 MSW LF - Turnhout

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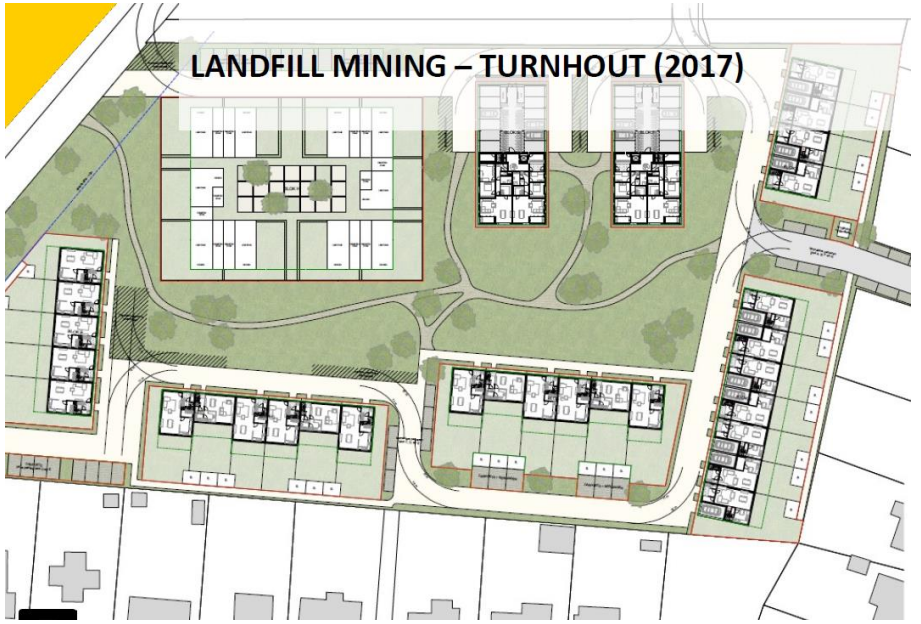

Residential land use project

Reclaiming Land(fills)
De Lediaan - Diegem

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Residential land use project
Incl. park

Reclaiming Land(fills)
3 Industrial LF - Gent

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Industrial land use project

Reclaiming Land(fills)
21 Eiland - Zwijnaarde

Mixed land use project
Incl. logistics, research park, nature preservation

Reclaiming Land(fills)
12 Schuddebeurze - Lombardsijde

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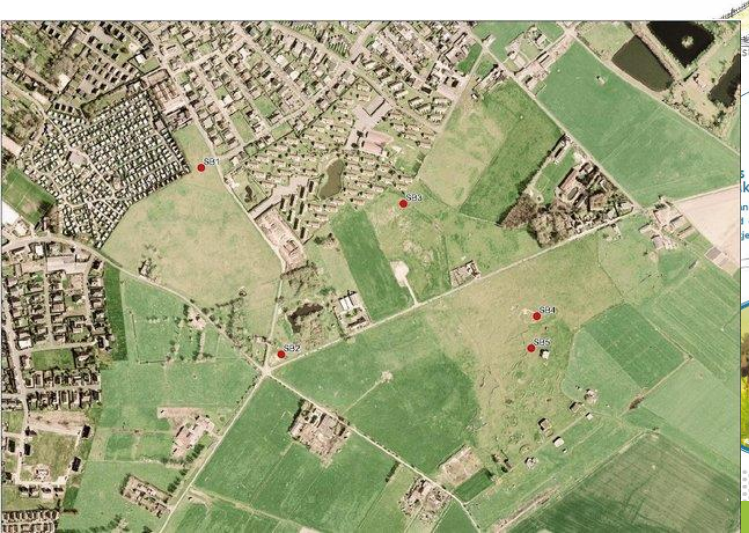
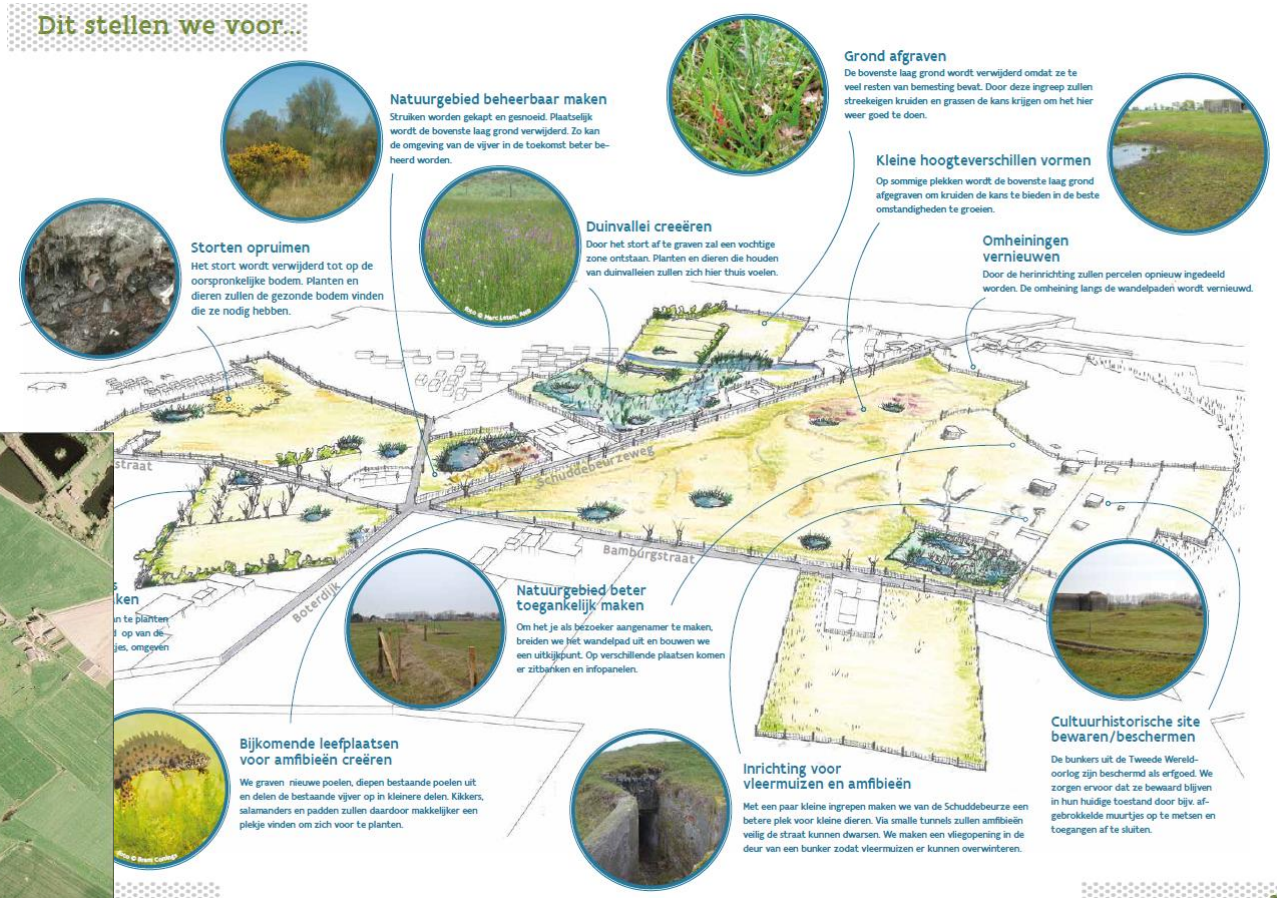
Nature preservation project





Reclaiming Land(fills)
10 Gipsberg - Zelzate

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Mixed land use project
Incl. interim use, nature preservation

Reclaiming Land(fills)
22 Coal tip - Beringen

Interreg
North-West Europe
RAWFILL

Mixed land use project
Offices, recreation, housing, nature preservation

Reclaiming Land(fills)
Lingreville - Normandie

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Coastal erosion restoration project

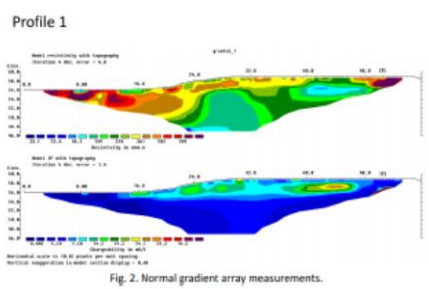
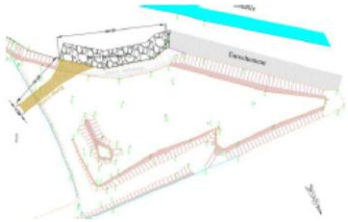
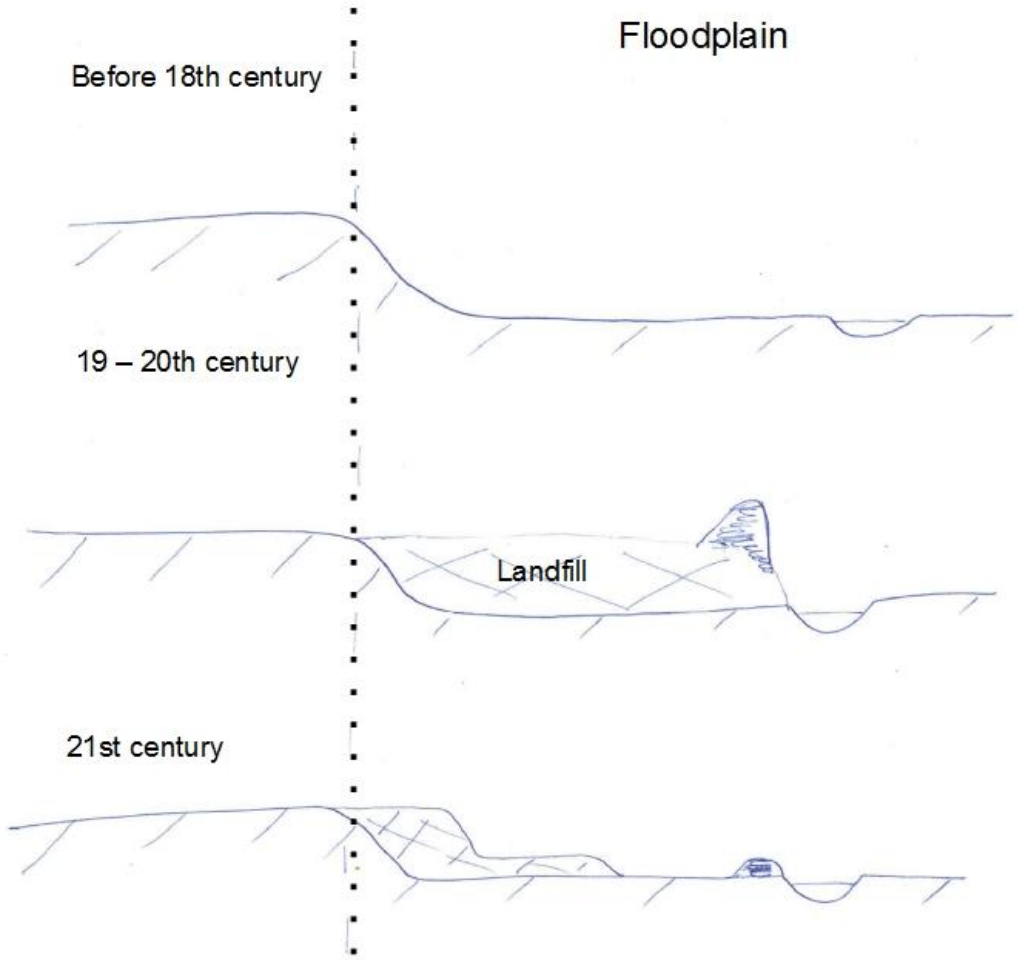


Fig. 2. Normal gradient array measurements.



Crédit photo : Ouest-Fran

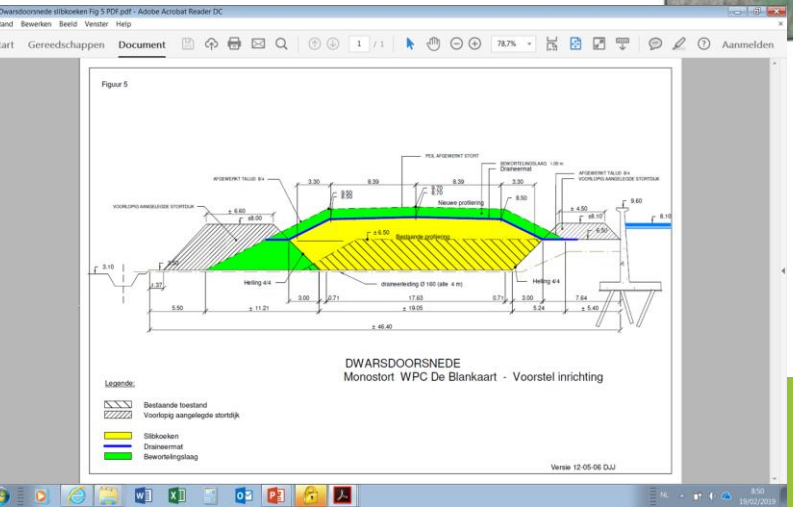
Integrating Land(fills) and flooding protection

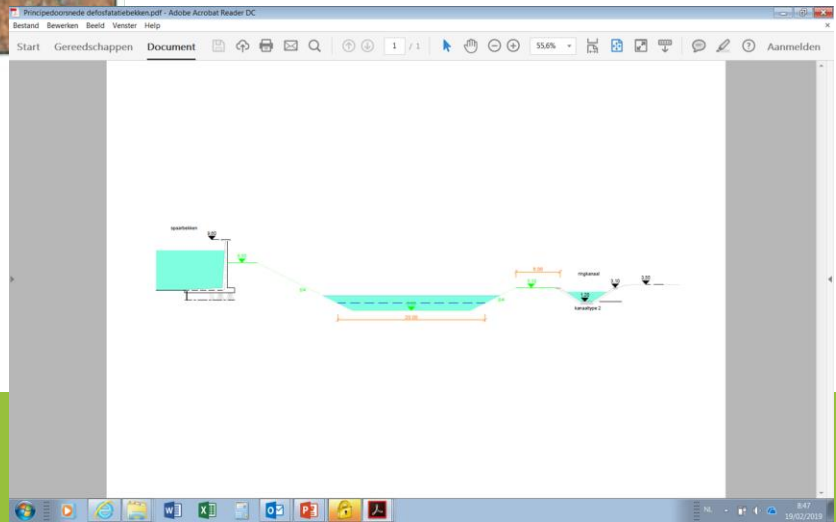


Reclaiming Land(fills)
15 Mono LF - Diksmuide

ELFM-project :

- 100% valorization of landfilled waste;
- 100% land reclamation;
- Future use: phosphate recovery unit;
- Drinking water production.





Sharing experiences

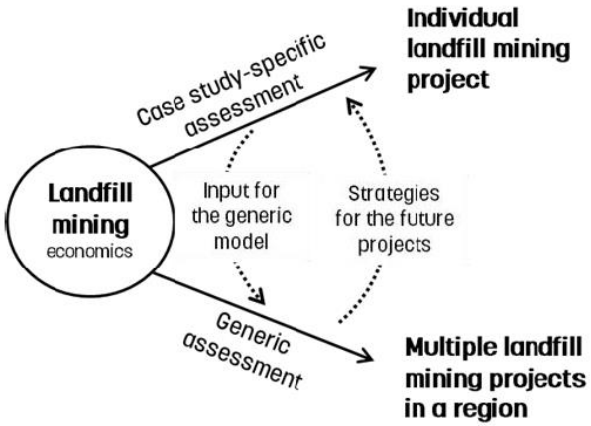


Figure 12. Illustration of the recommendations for the future use of economic assessments and their interactions towards a strategic development of cost-efficient LFM projects and directing future research.

Uit: Economics of landfill mining. John Laurence Esguerra, April 2020. (New-Mine)
http://new-mine.eu/

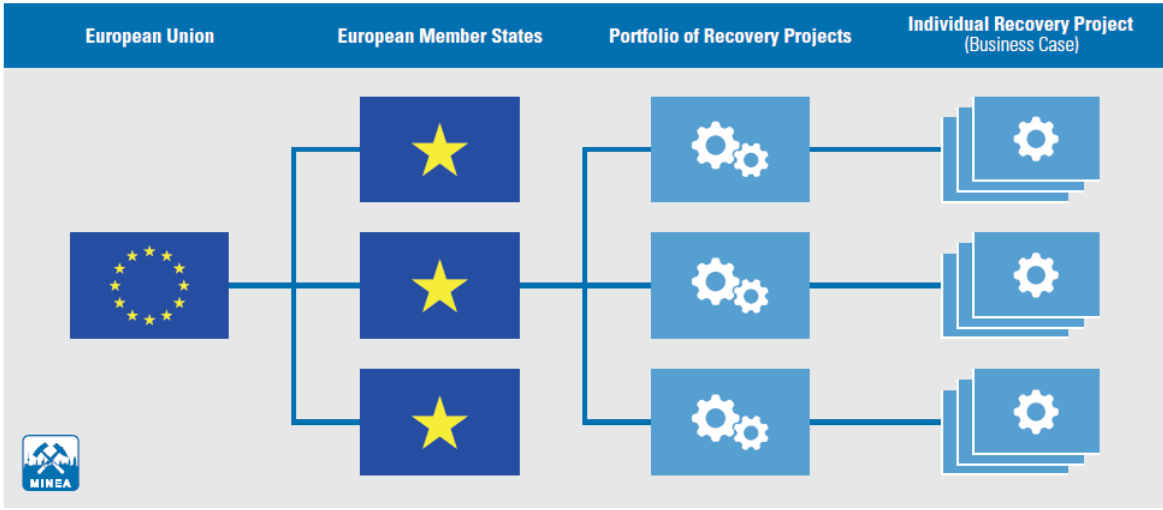


FIGURE 4
Perspectives on different levels of anthropogenic resource management (courtesy of Eddy Wille, PublicWaste Agency of Flanders (OVAM)).

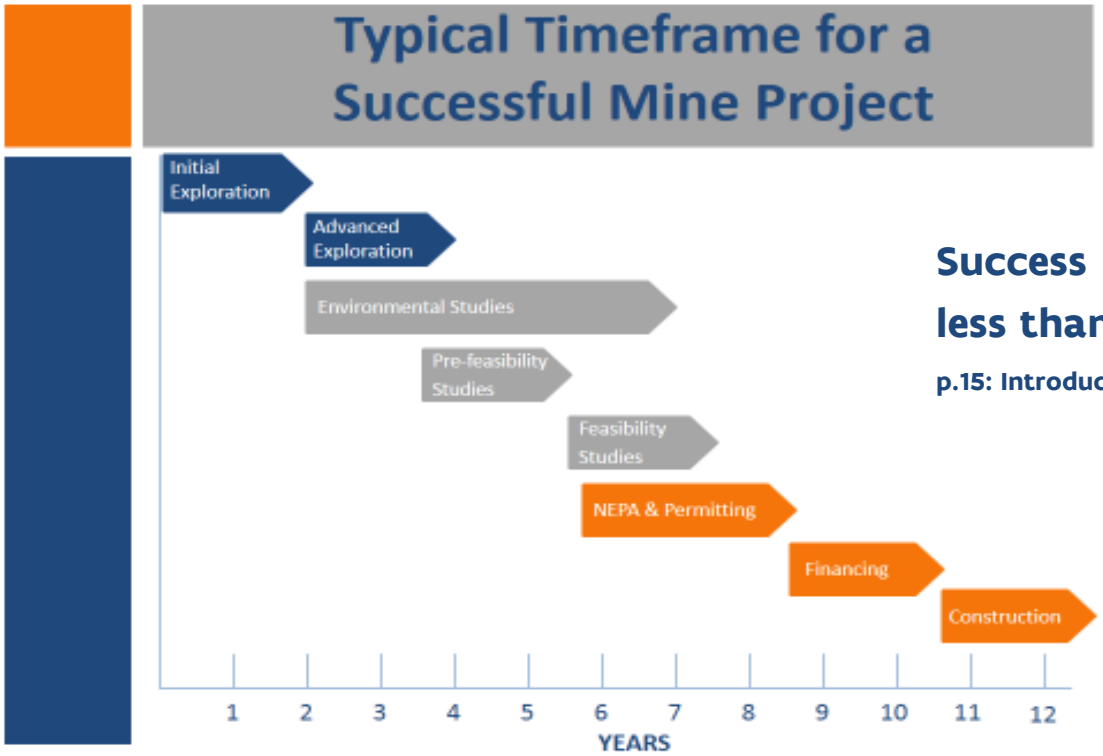
Uit: Strategic roadmap on sustainable management of anthropogenic resources. April 2020 (Minea)

https://zenodo.org/record/3739164#.X3SNAO1cKUk
https://zenodo.org/record/3739269#.X3SOJ-1cKUk

Vlaanderen is materiaalbewust

SAMEN MAKEN WE MORGEN MOOIER
OVAM

Timeframes & expectations



Success rate of exploration :

less than a tenth of a percent is the norm.

p.15: Introduction to mineral exploration. Ed. Moon, Whateley, Evans.

https://clu-in.org/conf/tio/NEPAandMining101-1_051216/
https://clu-in.org/conf/tio/NEPAandMining101-2_052416/
https://slideplayer.com/slide/10266650/

The myth of Orion, Cedalion

Servant Cedalion is leading the temporary blinded giant Orion to the light Eos.

The metaphor of dwarfs standing on the shoulders of giants (Latin: nanos gigantum humeris insidentes) expresses the meaning of "discovering truth by building on previous discoveries".

Isaac Newton in 1675: "If I have seen further it is by standing on the shoulders of Giants."

The myth of Orion, Cedalion

Decision Support Tool 1 : **Cedalion**

Easy to use application (no specific expertise required).

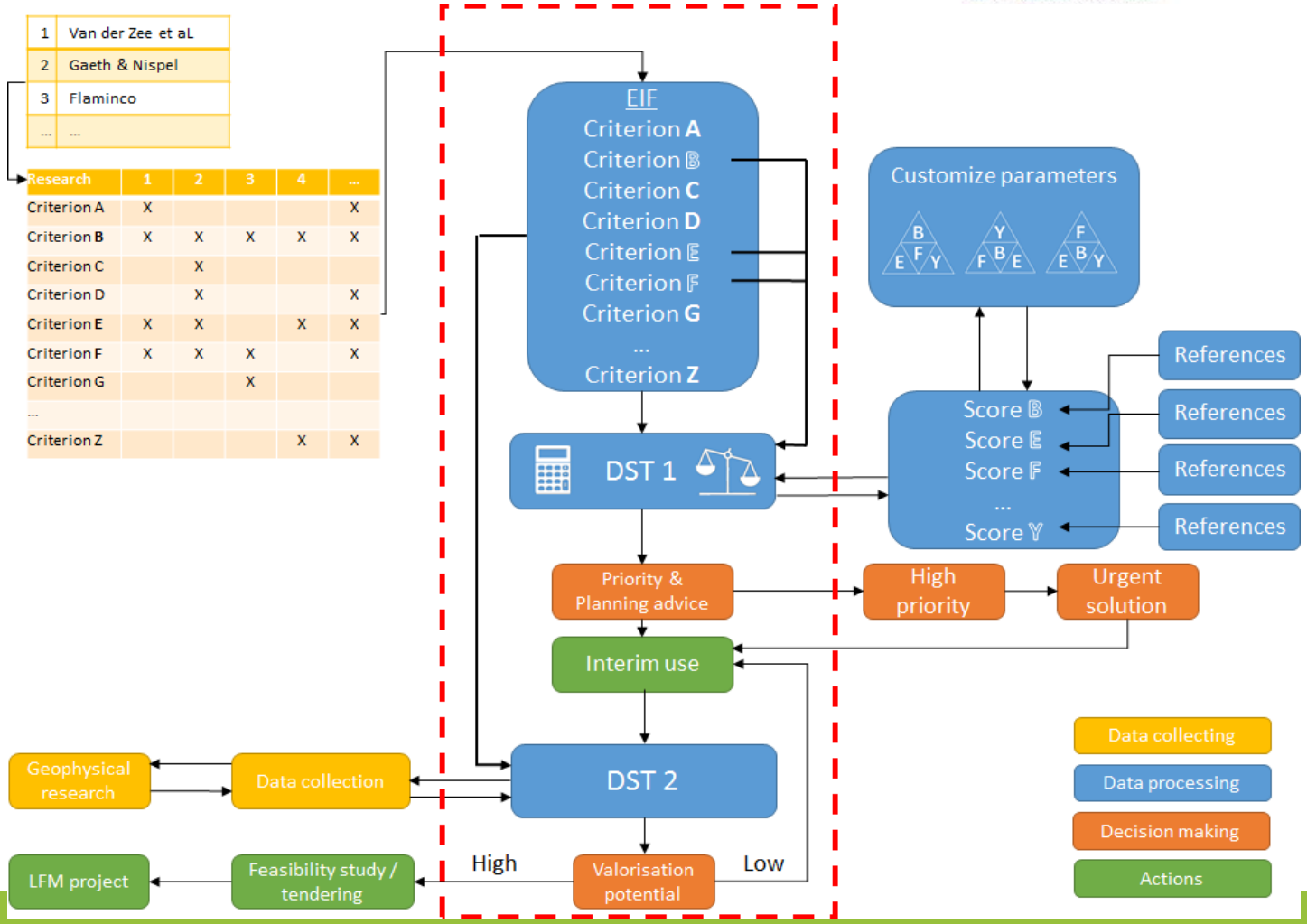
- ➢ Quick scan & overview

Decision Support Tool 2 : **Orion**

Roadmap and dashboard to facilitate detailed analysis by using specific tools (expert level required). Complex, only for most promising landfills.

- ➢ Ranking & preparation business cases

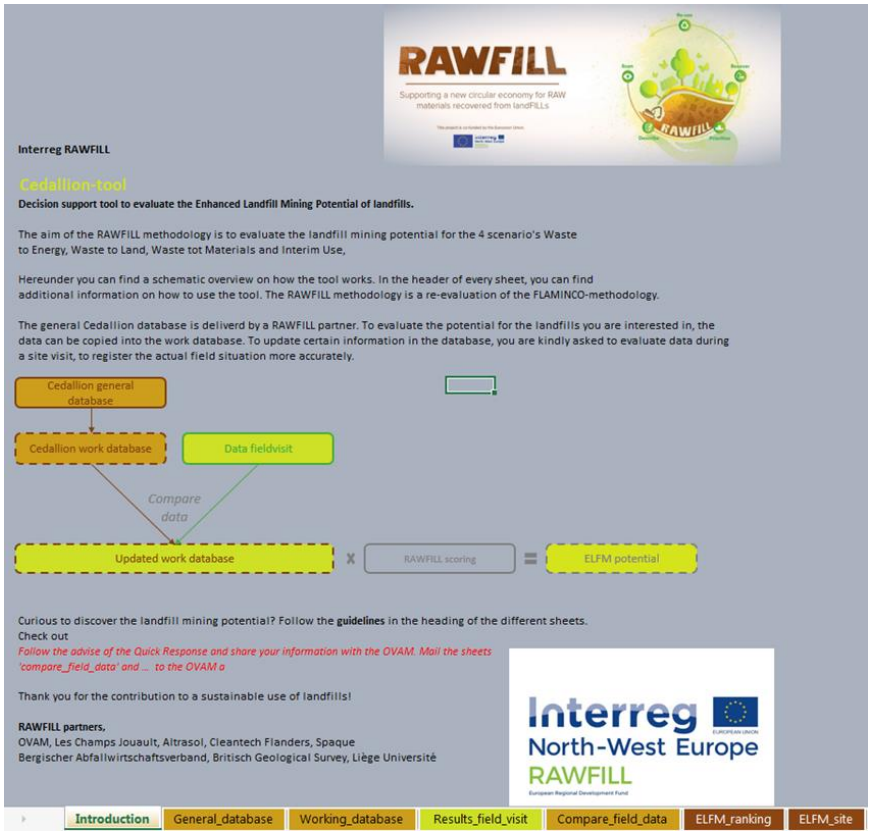
The myth of Orion, Cedalion



Cedalion: the ranking tool

Principle: basic criteria will give a scoring on 4 main concepts.

- Waste to Materials (WtM)
- Waste to Energy (WtE)
- Waste to Land (WtL)
- Interim Use (IU)

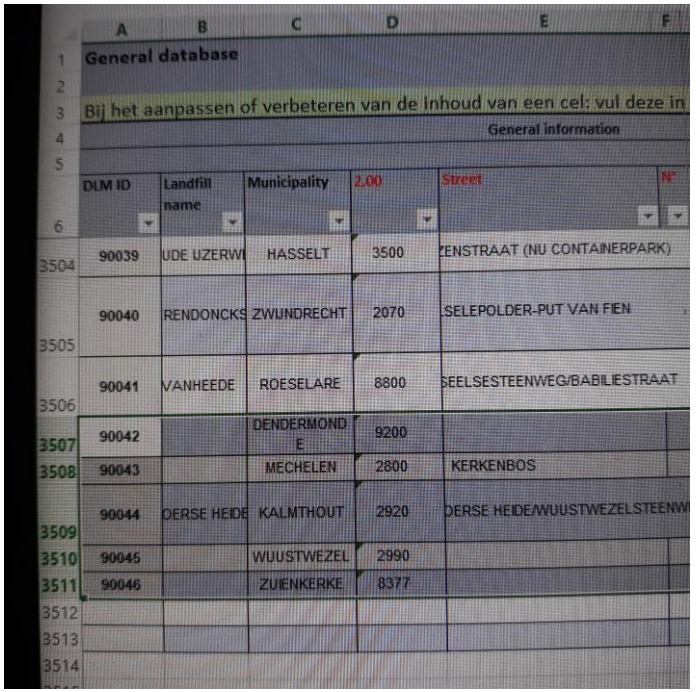


Cedalion: general database

- Capacity ? Huge : over 3.500 records in region of Flanders.

General database
You cannot change the content of the general database. Do not manually copy data from general to worki

General information								
DLM ID	Landfill name	Municipality	Postal code	Street	N°	Cadastral codes	X coordinate	Y coordinate
1	LF1	Vlierzele	9520,00	Street 1	2		0	0
2	LF2	Rumbeke	8800,00	Street 2	32		64516,75	176360,53
3	LF3	HouTHALEN-HELCHTEREN	3530,00	Street 3	Z/N		0	0
4	LF4	Antw ERPEN	2030,00	Street 4	99		0	0
5	LF5	ANTWERPEN	2030,00	Street 5	5		0	0
6	LF6	Doel	9130,00	Street 6			0	0
7	LF7	GENT	9000,00	Street 7	50		0	0
8	LF8	Zw evegem	8550,00	Street 8	1		0	0
9	LF9	OVERIJSE	3090,00	Street 9			157389,19	163106,69



Data management & Cedalion

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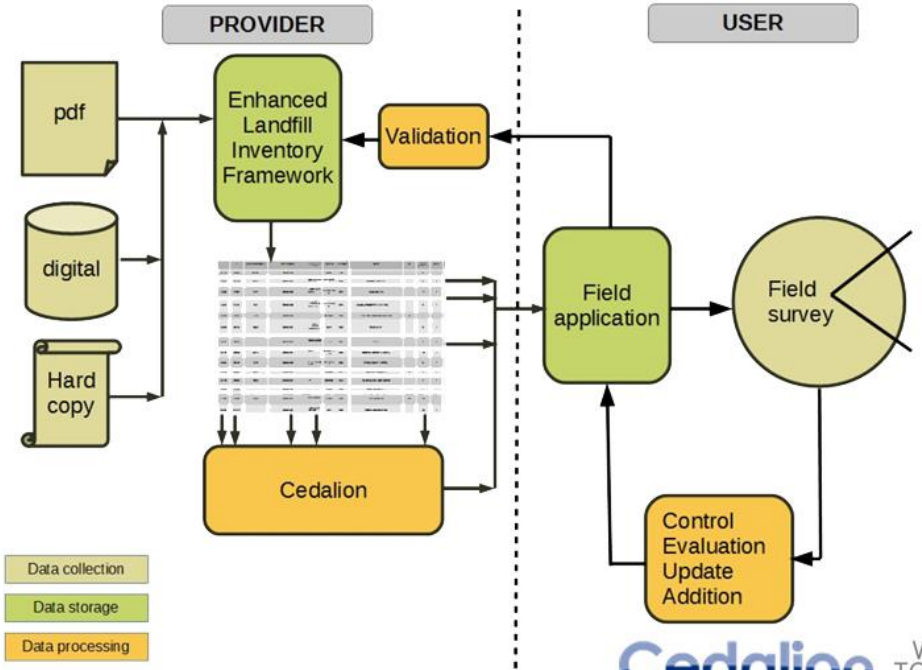
Objective : Getting actors interested in landfills by providing information and viable options which they can evaluate and customize.

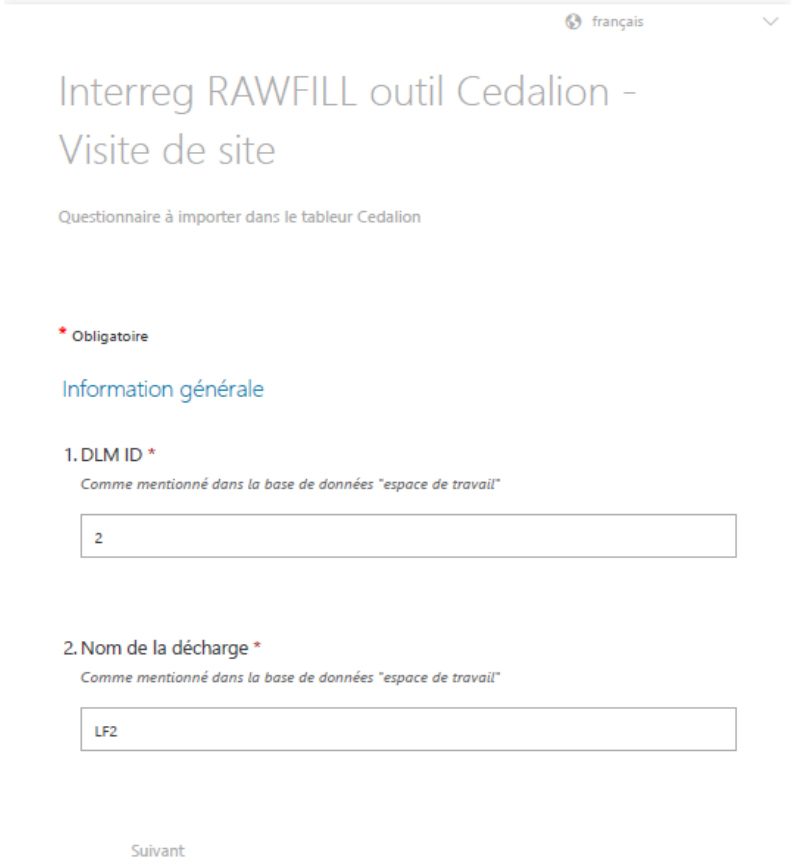


Cedalion developed by OVAM

WE MAKE TOMORROW BEAUTIFUL

Cedalion: online questionnaire

- Application: smartphone, tablet, laptop,…
- Target: collect up to date info about the landfill, by doing a 360° prospection on site
- Output: mail with Excel-file
- Receivers: user of field app (and administrator)

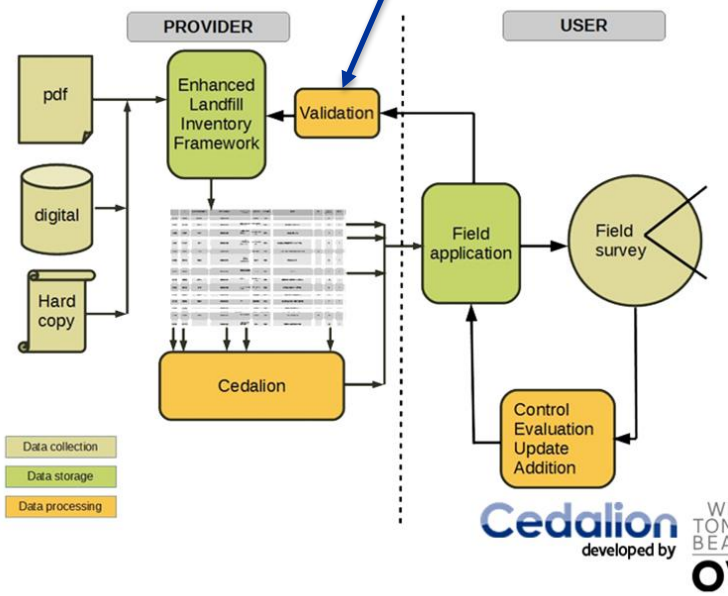


Cedalion: online questionnaire

Results of the site visit

Please copy the results of your site visit here. An Excel table has been sent to your e-mail address, after submitting the form. If you haven't received

General information		Criteria 3 - Volume			Criteria 4 - Use			
DLM ID	Landfill name	Surface area (m²)	Depth below ground level (m)	Height above ground level (m)	Type of cover	Surface conditions	Slope angle	Erosion
2	LF2	86000	4		2	Soil	Less than 15°	



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European Regional Development Fund

Cedalion Survey Response for 8-IMOG

Van : Microsoft Power Apps and Power Automate <microsoft@powerapps.com> — di 15 sep 2020 14:29

1 bijlage

Onderwerp : Cedalion Survey Response for 8-IMOG

Aan : eddy wille <eddy.wille@ovam.be>

Cc : donotsend@any.one

Externe afbeeldingen worden niet weergegeven. Afbeeldingen onderaan weergeven

Dear user,

Thank you for using the Cedalion tool developed by the RAWFILL project. To use the data acquired during your field visit, please follow the instructions:
1. Open the attached spreadsheet.
2. Paste the single row in the attached spreadsheet in on the Results_field_visit" sheet of the Cedalion tool.
3. In the "Compare_field_data" sheet of the Cedalion tool, press the button "Get data from field visit" to compare the data collected on site with the original data from your database.
4. If you want to update your database with the new data, change the content of the pale green cells and press the button "change fields in working database".
5. Start the ranking calculation.

A copy of your field observations have been also sent to the organisation managing the Cedalion in your region. These data will help them to update their database.

For more information regarding the RAWFILL project, please visit the RAWFILL website.

Thank you again for using our tool,

The RAWFILL project partners.

If you want to unsubscribe from these emails, please use this form.

RAWFILL Interreg NWE - Cedalion - Field visit results.xlsx
23 kB

Cedalion: ranking sheet

Ranking per ELFM scenario

Recalculate ranking

Ranking based on data in working database

Ranking Waste-to-Material	
Minimum	46,0
Maximum	72,5
Average	63,9
Median	66,0

Landfil	WtM
4	72,5
5	72,5
3	68,0
6	66,0
9	66,0
1	65,0
7	62,0
8	57,0
2	46,0

Ranking Waste-to-Energy	
Minimum	44,0
Maximum	63,0
Average	52,6
Median	52,0

Landfil	WtE
1	63,0
4	60,5
5	60,5
3	54,3
7	52,0
6	47,0
8	46,3
9	45,5
2	44,0

Ranking Waste-to-Land	
Minimum	64,0
Maximum	106,3
Average	91,1
Median	95,5

Landfil	WtL
6	106,3
4	106,3
5	106,3
7	98,7
9	95,5
8	91,0
3	85,3
1	67,0
2	64,0

Ranking Intermediate Use	
Minimum	38,5
Maximum	63,0
Average	48,6
Median	45,0

Landfil	IU
1	63,0
2	58,0
9	56,5
7	52,3
3	45,0
8	44,7
6	40,7
4	38,5
5	38,5

Ranking per ELFM scenario

Recalculate ranking

Ranking based on da

Ranking Waste-to-Material	
Minimum	57,0
Maximum	74,0
Average	67,0
Median	66,0

Landfil	WtM
2	74,0
4	72,5
5	72,5
3	68,0
6	66,0
9	66,0
1	65,0
7	62,0
8	57,0

Ranking Waste-to-Energy	
Minimum	45,5
Maximum	65,0
Average	54,9
Median	54,3

Landfil	WtE
2	65,0
1	63,0
4	60,5
5	60,5
3	54,3
7	52,0
6	47,0
8	46,3
9	45,5

Ranking Waste-to-Land	
Minimum	67,0
Maximum	106,3
Average	94,1
Median	95,5

Landfil	WtL
6	106,3
4	106,3
5	106,3
7	98,7
9	95,5
2	91,0
8	91,0
3	85,3
1	67,0

Ranking Intermediate Use	
Minimum	38,5
Maximum	63,0
Average	47,8
Median	45,0

Landfil	IU
1	63,0
9	56,5
7	52,3
2	51,0
3	45,0
8	44,7
6	40,7
4	38,5
5	38,5

Viability of the LFM-Project

DST 2 is a tool in the evaluation process of a potential Landfill Mining Project.

Main Question :

Will the LFM-project be viable?

3 sets of criteria must be evaluated :

- Technical criteria. Is the project technically feasible?
- Socio-economic criteria. Is the project sustainable and economically viable?
- Information-quality criteria. Is there enough info to make a reliable evaluation ?

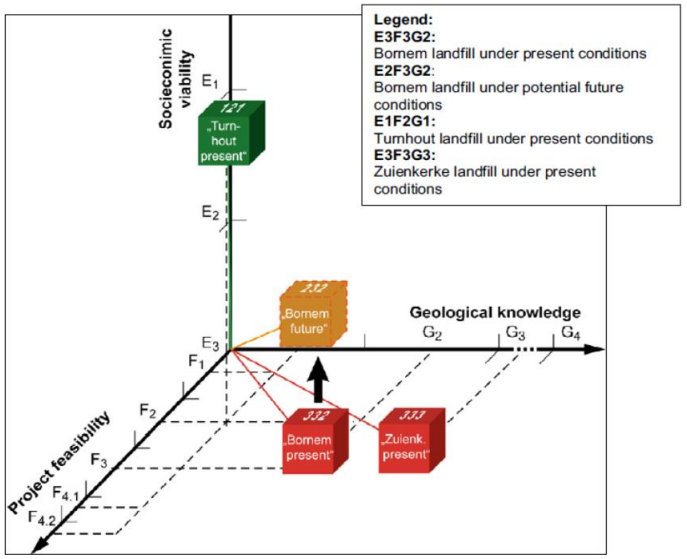
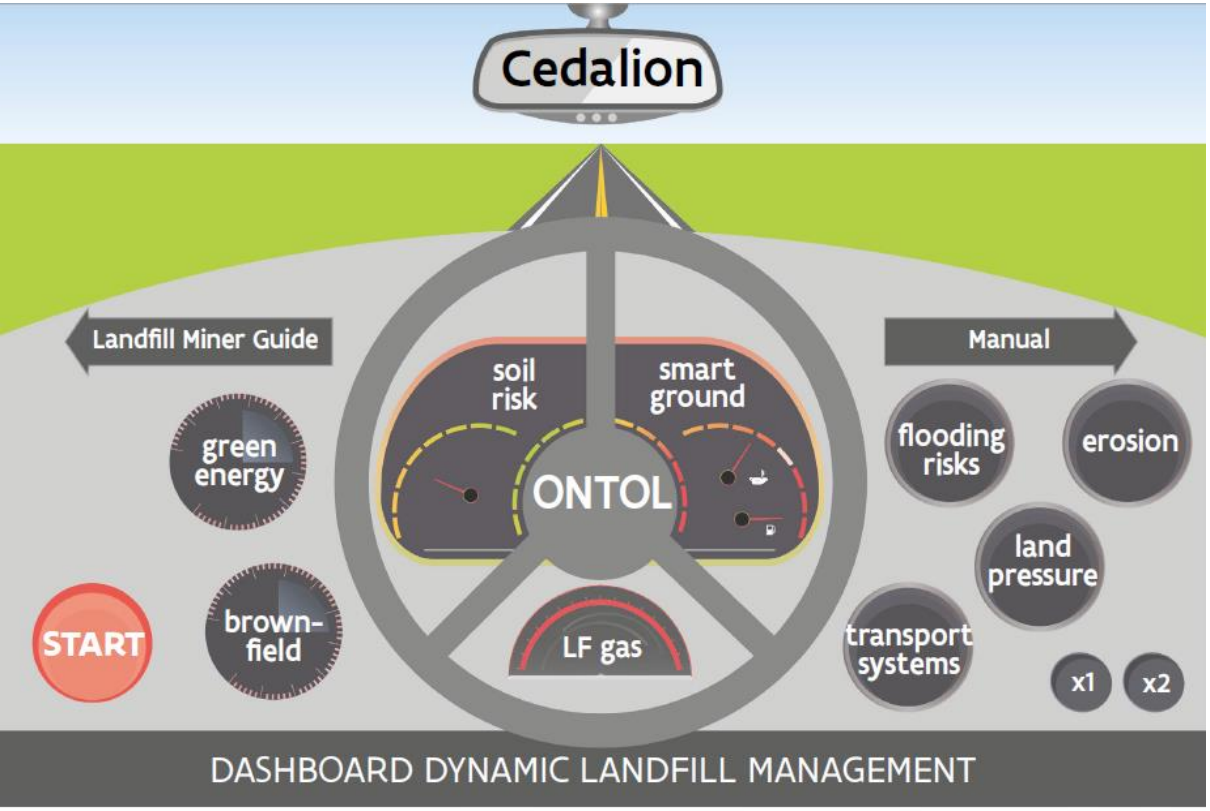


Fig. 6. Classification of the three landfill-mining projects under UNFC.

DST 2: optimizing good ideas



powered by

developed by

- Not reinventing the wheel but acting circular;
- Look back and use results of Cedalion;
- Dashboard offers you a set of valuable tools;
- Press start to take control and get customized info.

DST 2: optimizing good ideas

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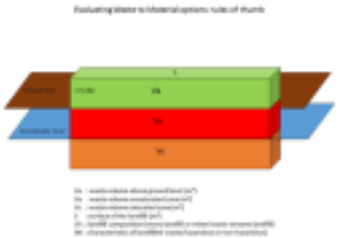
RAWFILL
European Regional Development Fund



Select landfill with high scores in Cedalion.

Mono landfills indicate high grade content; prospective projects. Specific approach required unless small volume.

New-Mine aims specifically at Waste to Materials. Types of waste define viability.

If not feasible, use other criteria in flow chart.

Prevention of pollution remains essential goal. First step is defining risks and remedial actions.

If no remedial actions needed, investigate redevelopment potential of small volume landfills.

If larger volumes, low thickness might offer opportunities for evacuation of landfilled waste.

High volumes below ground level have negative impact on feasibility.

In order to lower costs, first assessment uses ONTOL default values. If losses lower than 200.000 euro/total volume, a business case is set up. The Orion Dashboard guides the users to relevant (free) models detected by Rawfill.

If losses are bigger, invest in more detailed research and refine the ONTOL-input.

Non-viable projects will be submitted to the analysis of interim use.

Orion: assembling good quality

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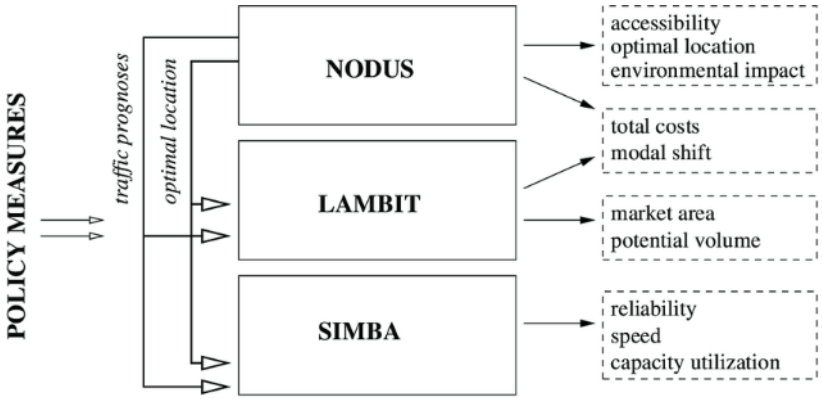


Cranfield University

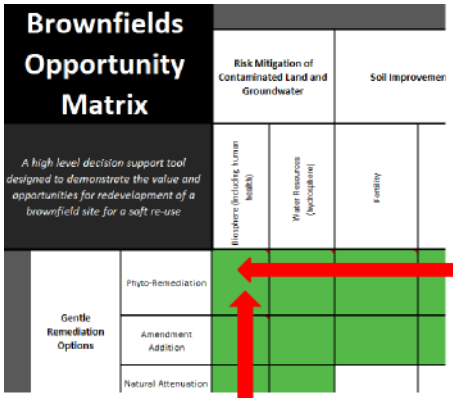
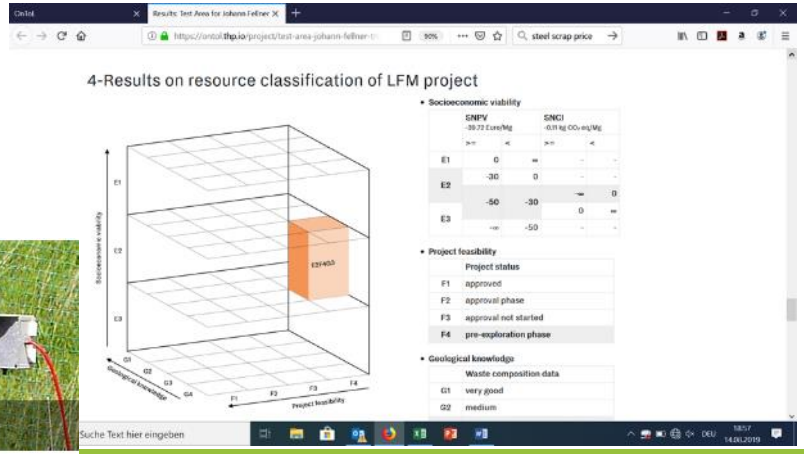


Figure 6: Simple Brownfield Opportunity Matrix Variant ©

EPA United States Environmental Protection Agency

RE-Powering America's Land



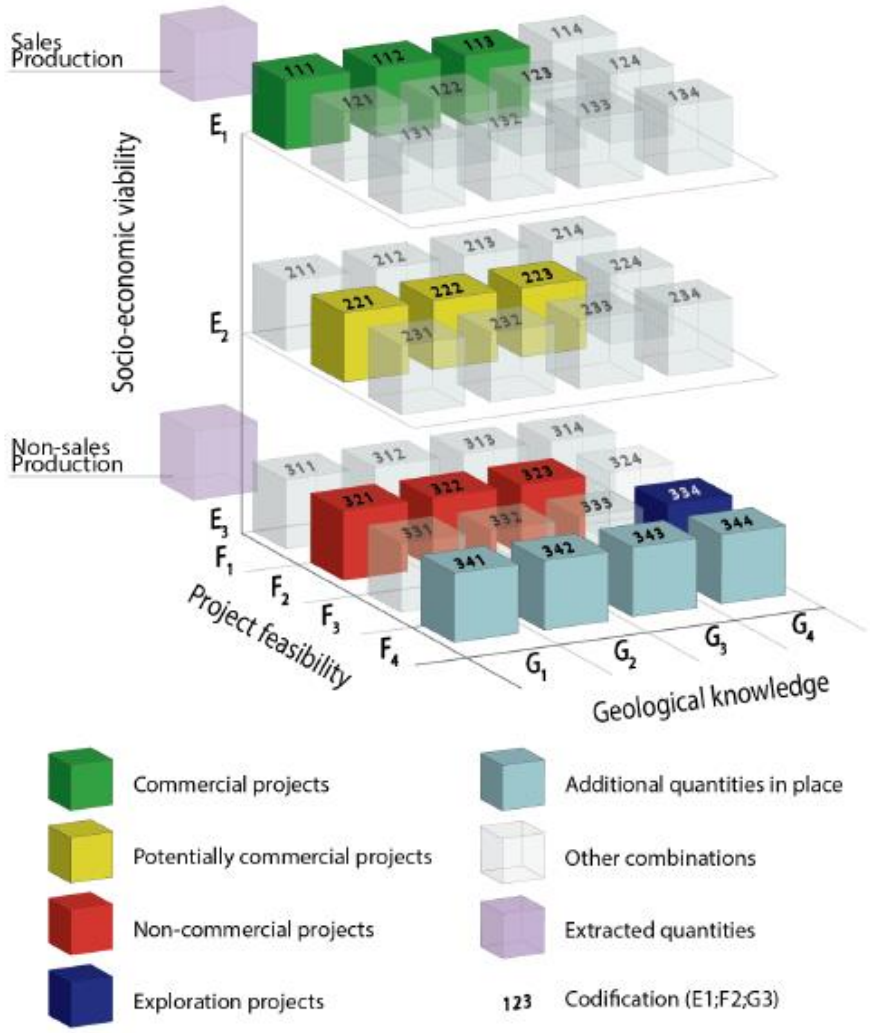
Orion in detail: OnToL

Online Tool for the Evaluation of Landfill Mining Projects

- **Rapid** environmental and economic **evaluation** of LFM- projects;
- Facilitating of further **prioritization of LFM-projects;**
- **Comparison of different scenarios** for implementing a LF-mining project;
- Streamlined format (e.g. agreed economic calculation methods; United Nations Framework Classification for Resources (UNFC))
- **Provision of default datasets** (e.g. waste composition, sorting technology efficiencies, waste-to-energy efficiencies, etc.; Orion provides guidance to more specific tools & models)
- screening assessments without the need for extensive data generation
    - ➢ Free software available at : https://www.ovam.be/landfill-mining

Ontol : developed by team of prof. Johann Fellner (Christian Doppler Laboratory for Anthropogenic Resources, TU Vienna - Austria), in collaboration with prof. David Laner (University Kassel - Germany) and Dr. Andrea Winterstetter (University Antwerp & VITO – Belgium). Co-Funded by OVAM (Public Waste Agency of Flanders – Belgium) & BMNT (Austrian Federal Ministry for Sustainability - Austria).

Classification of resources
A whole lotta Resources



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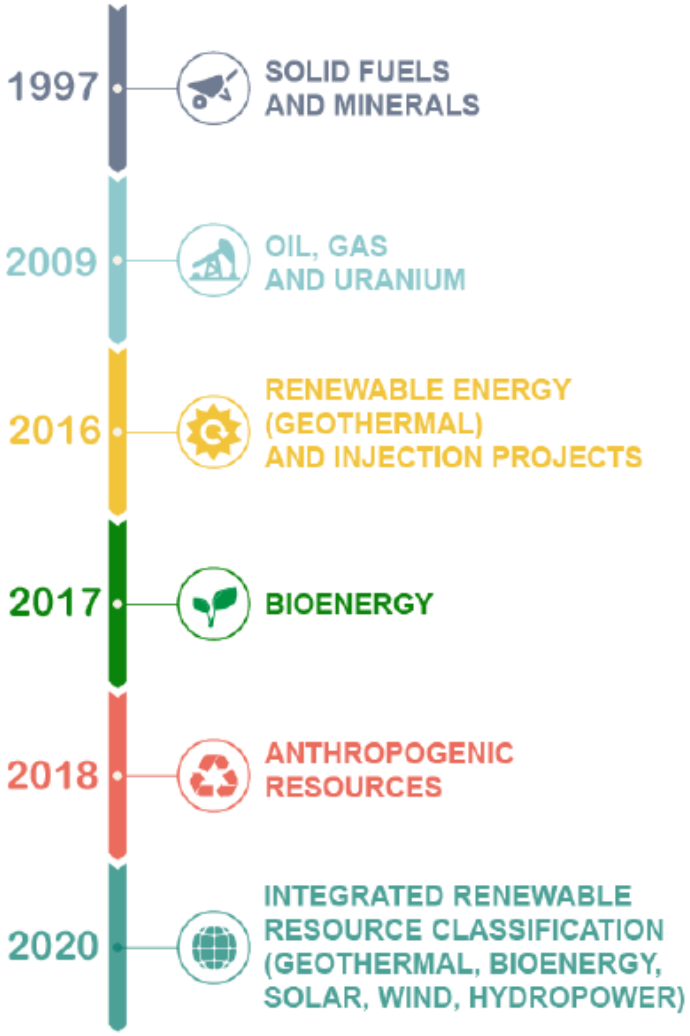
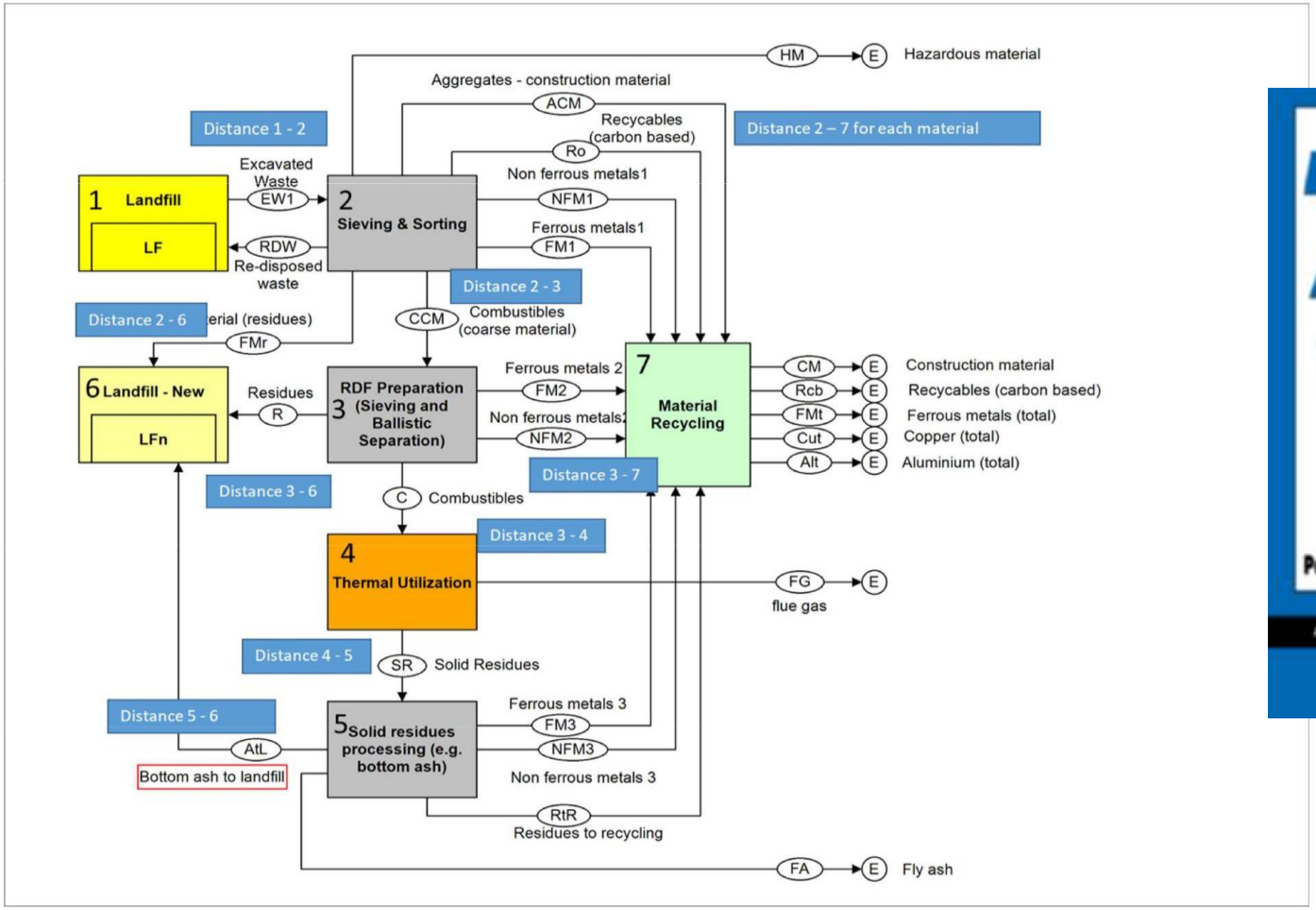
North-West Europe

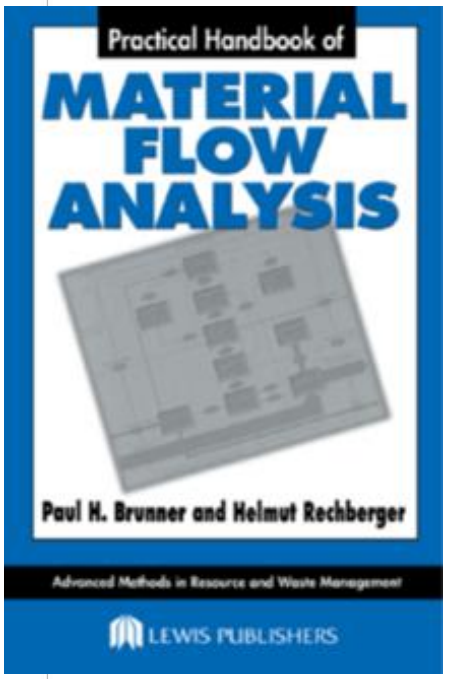


Growing Applications of UNFC

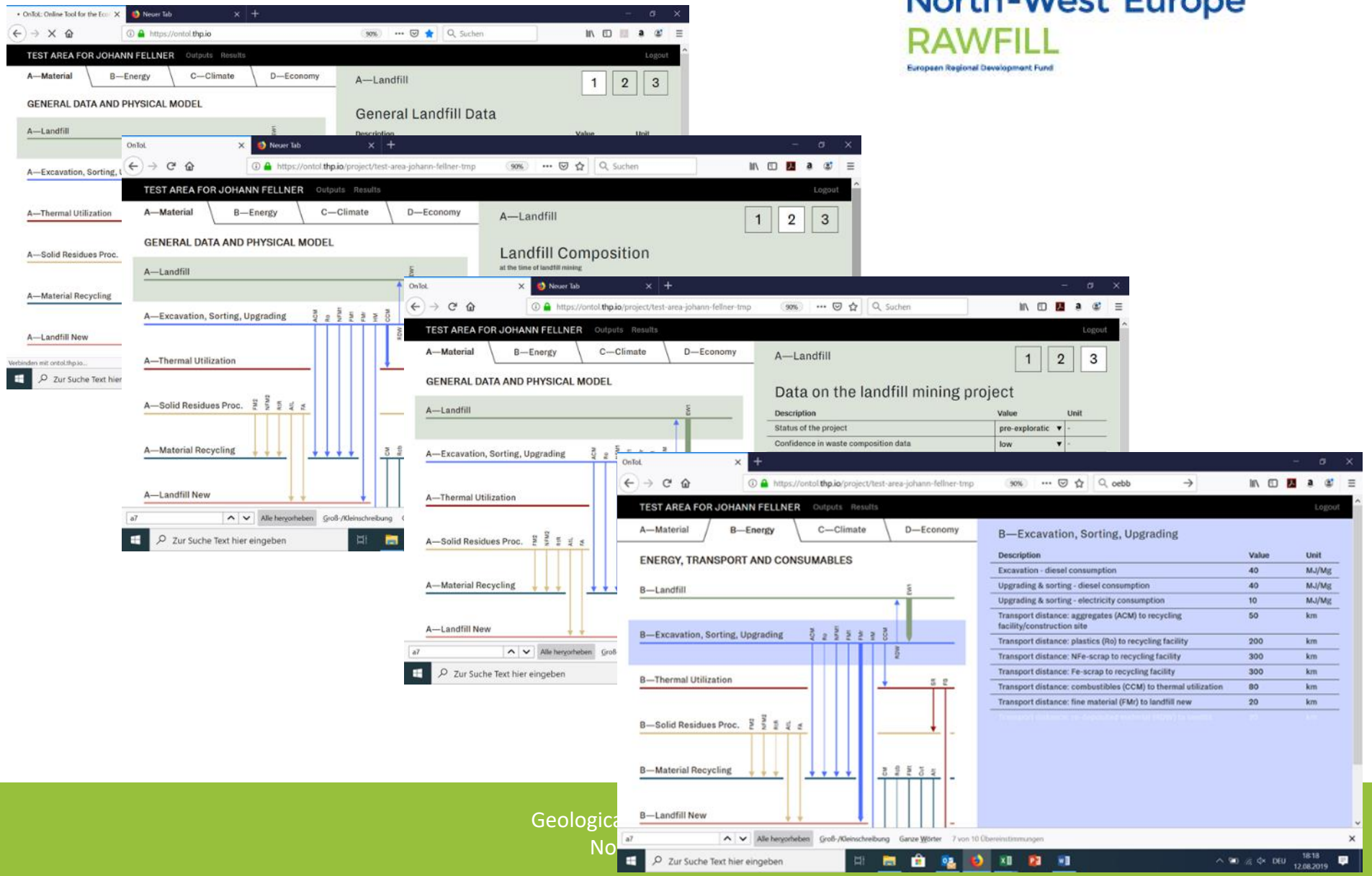
Standard MFA-scheme

Interreg North-West Europe RAWFILL





Input & output of OnToL



Geologica
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Input & output of OnToL

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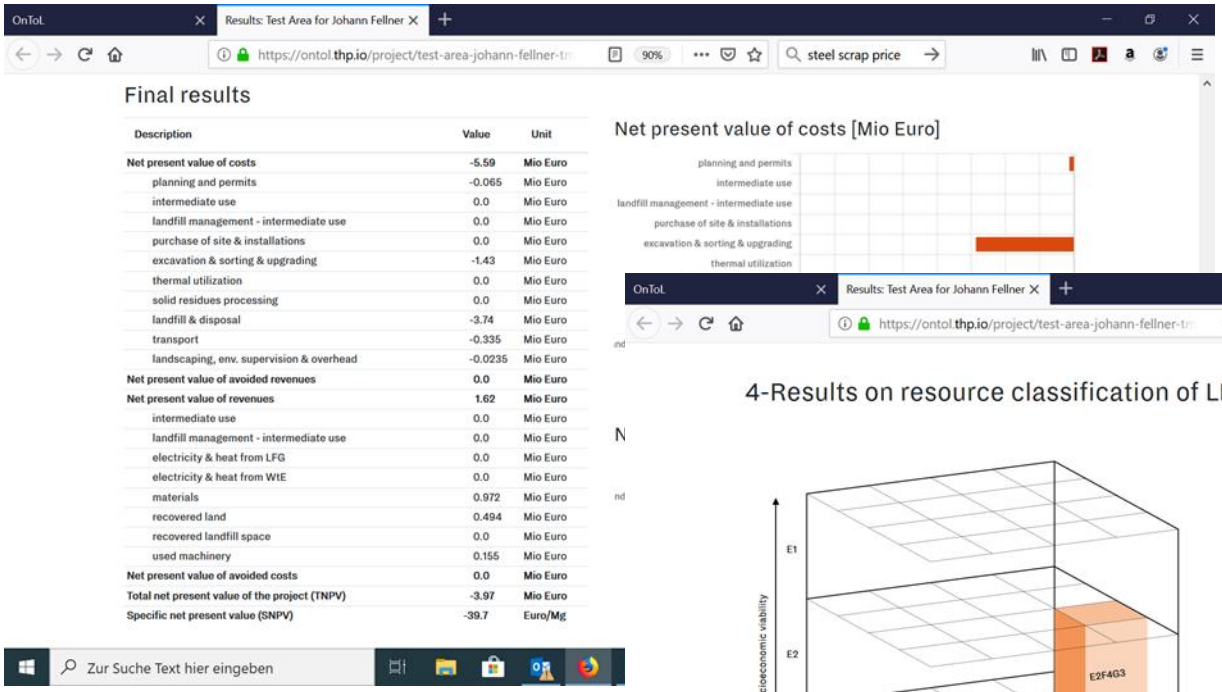
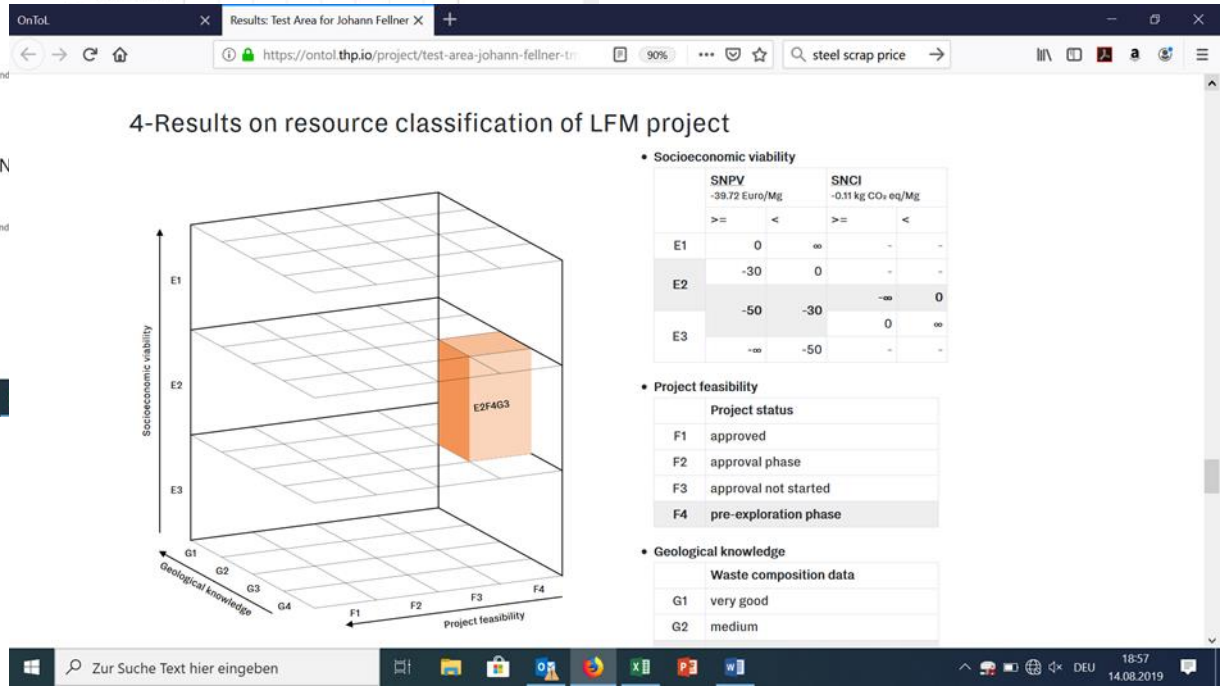
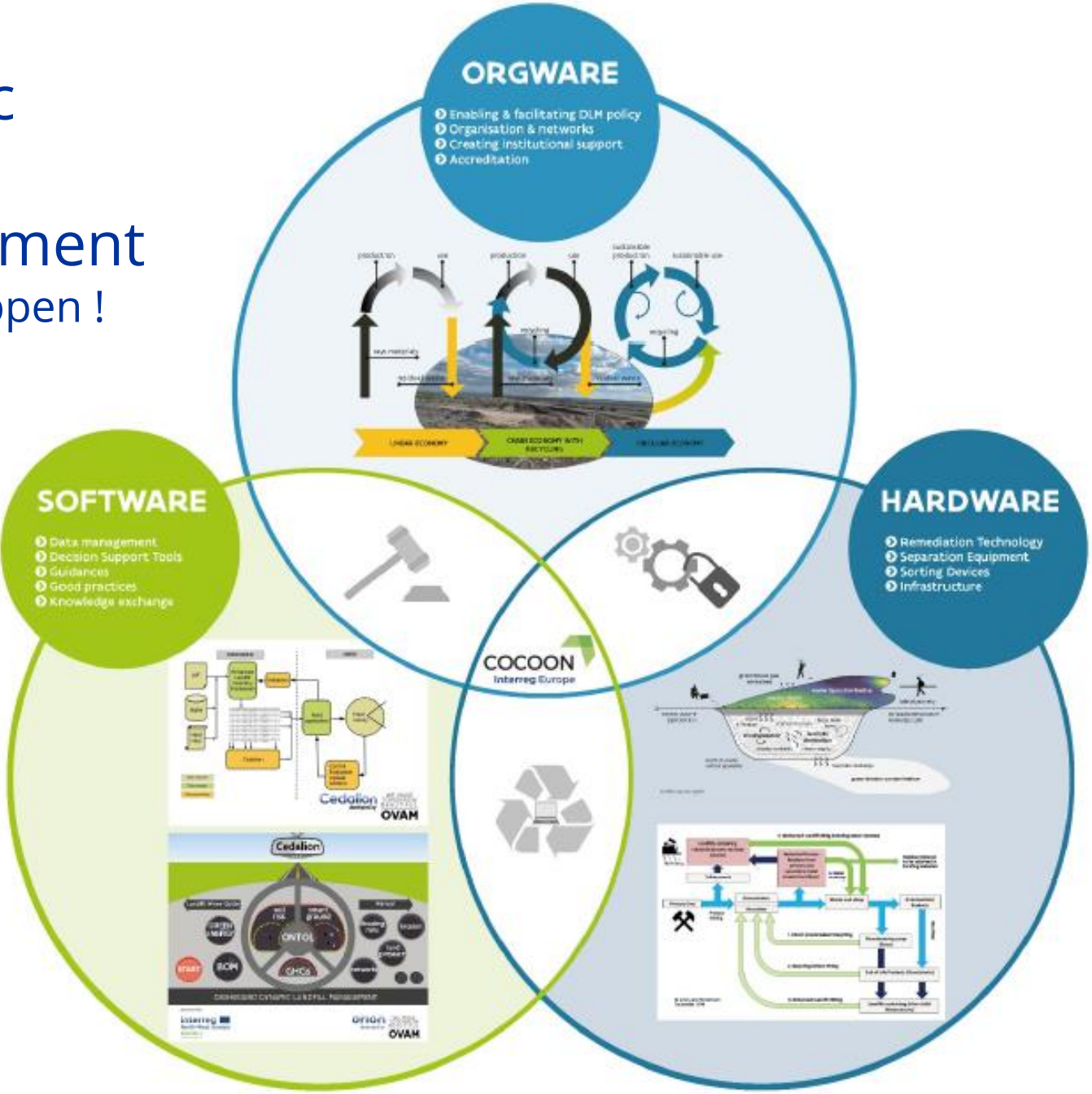
European Regional Development Fund





Dynamic Landfill Management

Make it happen !



Dynamic Landfill Management
A summary

Interreg North-West Europe
RAWFILL
European Regional Development Fund

Interreg

EUROPEAN UNION

North-West Europe

RAWFILL

European Regional Development Fund

Thank you!