



Dynamic landfill management: an introduction to anthropogenic resource management

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Overzicht



- Rawfill-project
- Dynamic Landfill Management
- Geophysical investigation of landfills
- DST 1 : Cedalion
- DST 2 : Orion

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

Verdere acties



Project: RAWFILL NWE 37



Co-funded by the Walloon region

Landfill mining ambassador

Stimulating and Promoting widespread use of RAWFILL outputs

The focus of RAWFILL is on supporting a new circular economy for RAW materials recovered from landFILLS in the North-West Europe (NWE) region. In order for landfill mining to be widely implemented in this region LFM ambassadors, who received training by RAWFILL partners about the innovative landfill characterisation (coupling geophysical imaging and guided sampling) as well as its multi-criteria decision support tool for prioritising landfills, are needed.

Mail to m.popova@spaque.be

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.

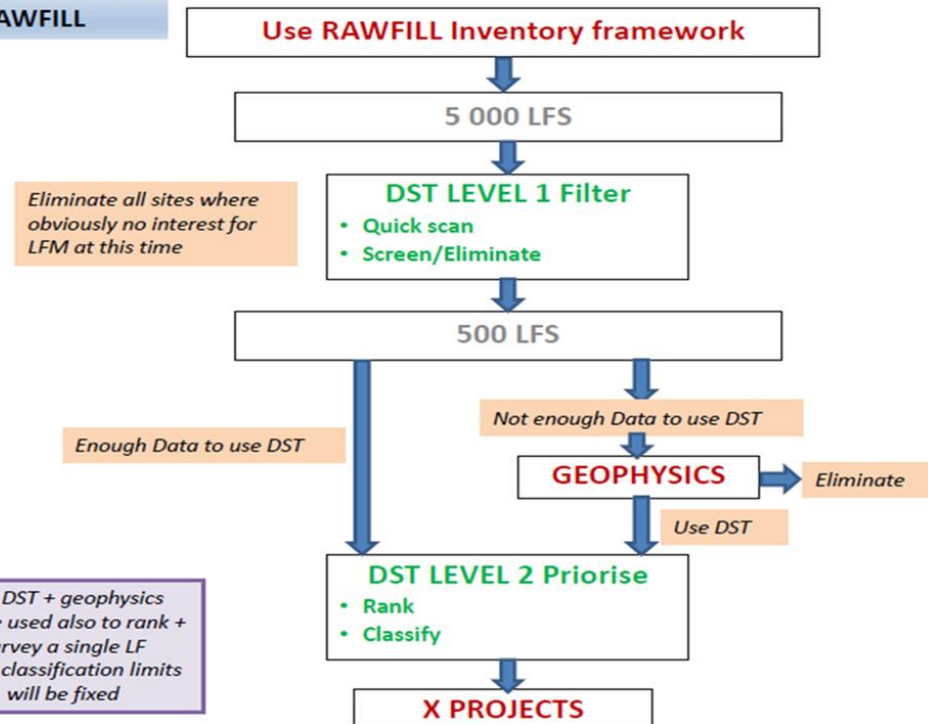
Fortunately, the large volumes of resources can be recovered through **Landfill Mining**.

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

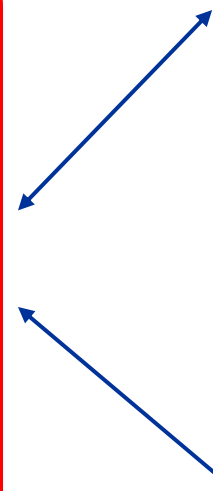
- enhanced framework for private/regional/transregional landfill inventories
- landfill geophysics
- decision support tool

HOW IT WILL WORK AFTER RAWFILL



COCOON & RAWFILL

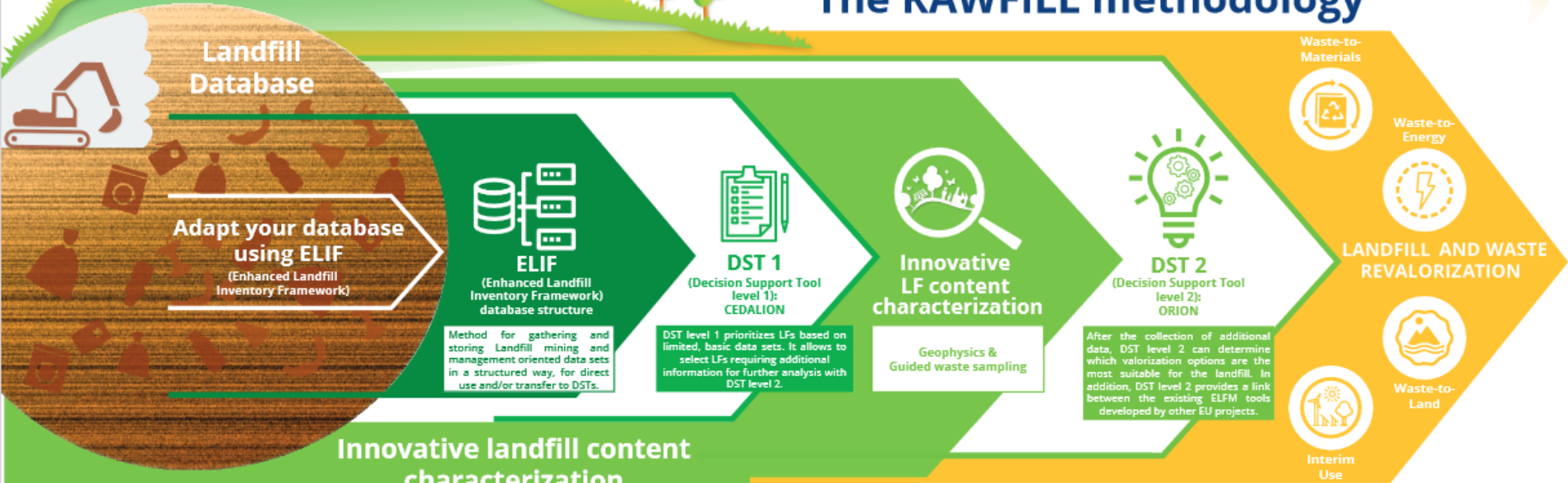
- Setting up a Conceptual Site Model :
 - Integrating multiple dimensions
 - Defining its purpose and applicability
- Feeding the model : Enhanced Inventory Framework
 - Detecting sources of data
 - Collecting data (Geophysical prospection)
 - Data quality control (Guidelines)
- Developing the Decision Support Tool :
 - Defining the output and outcome
 - Constraints for use
- Testing the DST in practice
- Feed back loops :
 - Adjustments DST, CSM, data requirements
 - Interactions (policies, legal aspects, economy,...)



How to start a profitable landfill mining project? How to valorize a landfill ?



The RAWFILL methodology



Innovative landfill content characterization

GEOPHYSICAL SURVEY



Electro-resistivity methods



Seismic methods



Electro-magnetic methods



Boreholes



Trenches



Lab test

GUIDED WASTE SAMPLING

ADVANTAGES OF GEOPHYSICS

- ✓ Non-invasive
- ✓ Detailed landfill content mapping
- ✓ Faster and cheaper than traditional landfill content characterization method

Want to learn more about the RAWFILL tools ?



RAWFILL e-learning tool



For more information about the RAWFILL project, contact rawfill@spaque.be



The myth of Orion, Cedalion



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

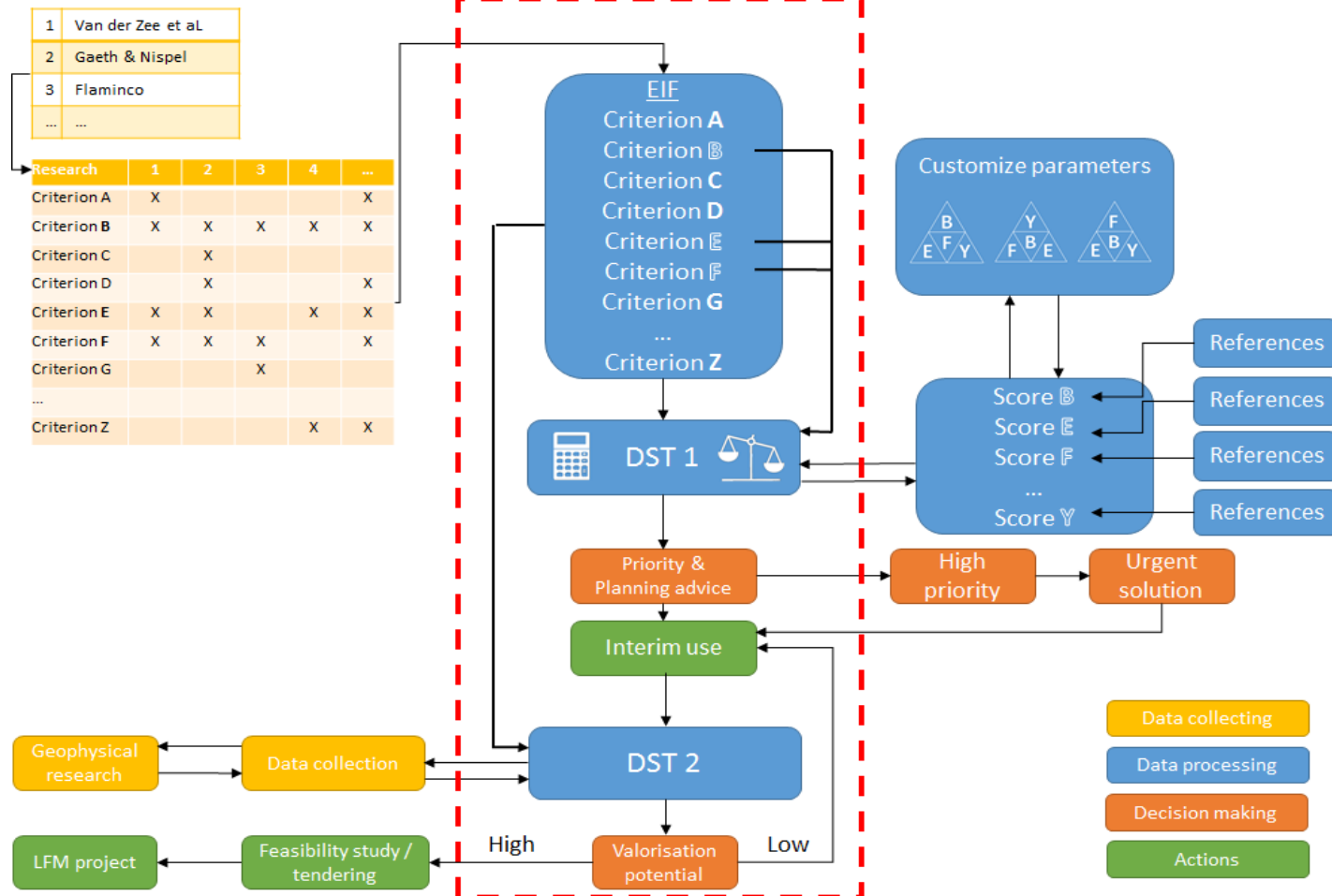
The metaphor of dwarfs standing on the shoulders of giants (Latin: *nanos gigantum humeris insidentes*) expresses the meaning of "discovering truth by building on previous discoveries".

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

DST 1: Cedalion



Two-step DST



Cedalion: the ranking tool



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

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

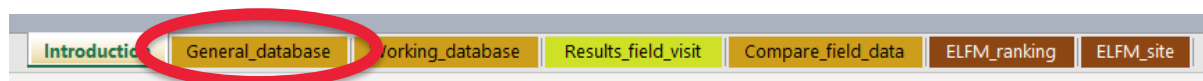
Cedalion: general database



- Info provided by the (governmental) institution that deals with landfills
- Criteria: general info, waste type, age, volume, land use, accessibility and surroundings
- Coupling with ELIF possible
- Capacity of more than 3000 landfills

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 | OVERUSE | 3090,00 | Street 9 | | | 157389,19 | 163106,69 |




Cedalion: working_database

- Copy from the general database until data were changed by the user (only administrator can change general database)
- Action buttons for selection, exchange and ranking

Working database
 Please select the landfill sites for which you would like to run the ranking tool. Select by 'Site ID' +
 Select by 'Municipality' +
 Copy all data
 Reset working database
 Show ELFM ranking without data field visit
 Or collect data through field questionnaire. <https://tinyurl.com/cedalionrawfill> or use QR code

Example: 1-10;12-14;36;115-129



| General information | | | | | | | | | Criteria 1 - Type | | | | | | | | | | | | | |
|---------------------|---------------|----------------------|-------------|----------|-----|-----------------|--------------|--------------|-------------------|------------|--------------------|------------|-------|---------|----------|-------------|--------------|----------------|-------|---------------------------|----------------|---|
| DLM ID | Landfill name | Municipality | Postal code | Street | N° | Cadastral codes | X coordinate | Y coordinate | M _{SW} | Industrial | Dredging materials | WWT sludge | Inert | Fly ash | Asbestos | Metal slags | Mining waste | Military waste | Other | Nature of mixed landfill? | Mono landfill? | |
| 1 | LF1 | Vlierzele | 9520 | Street 1 | 2 | | 0 | 0 | Y | N | N | N | N | N | N | N | N | N | N | N | Heterogeneous | N |
| 2 | LF2 | Rumbeke | 8800 | Street 2 | 32 | | 64516,75 | 176360,53 | Y | N | N | N | N | N | N | N | N | N | N | N | Heterogeneous | N |
| 3 | LF3 | HOUTHALEN-HELCHTEREN | 3530 | Street 3 | Z/N | | 0 | 0 | Y | Y | N | N | Y | N | N | N | N | N | N | N | Layered | N |
| 4 | LF4 | Antw ERPEN | 2030 | Street 4 | 99 | | 0 | 0 | Y | Y | Y | Y | N | N | N | N | N | N | N | N | Layered | N |
| 5 | LF5 | ANTWERPEN | 2030 | Street 5 | 5 | | 0 | 0 | Y | Y | Y | Y | N | N | N | N | N | N | N | N | Layered | N |

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)



français

Interreg RAWFILL outil Cedalion - Visite de site

Questionnaire à importer dans le tableur Cedalion

* Obligatoire

Information générale

1. DLM ID *
Comme mentionné dans la base de données "espace de travail"

2. Nom de la décharge *
Comme mentionné dans la base de données "espace de travail"

Suivant

Cedalion: comparing and controlling results



- The info from the excel sheet is copied and pasted in the tab 'Results_field_visit'
- The collected information will be checked and compared in the tab 'Compare_field_data'
 - In order to spot odd data and avoid corruption of your database

Compare data site visit and general database

Compare the data collected during the site visit with the data from the 'general database'.

If you want to make changes in the working database, please change the content in the pale **green** cells and press the button "change fields in working database".

| General information | | Criteria 3 - Volume | | | Criteria 4 - Use | | | | Criteria 5 - Accessibility | | Criteria 6 - Surroundings | | | | | | | | General remarks | | |
|---------------------|---------------|---------------------|------------------------------|-------------------------------|------------------|--------------------|---------------|---------|----------------------------|----------------------------------|---------------------------|------------|-------------|------------|-------------|------------|-------------|------------|-----------------|------------|------------|
| 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 | Paved roads? | Accessible with heavy equipment? | Present Res | Future Res | Present Rec | Future Rec | Present Agr | Future Agr | Present Ind | Future Ind | Present Nat | Future Nat | Remarks |
| 2 | LF2 | 86000 | | | Geomembrane | Shrubs | Flat | None | N | N | N | N | N | N | Y | N | N | N | N | N | |
| 2 | LF2 | 86000 | 4,0 | 2,0 | Soil | | Less than 15° | | Y | Y | N | Y | | | | | | | | | masterplan |

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 |

Ranking Waste-to-Energy

| | |
|---------|------|
| Minimum | 44,0 |
| Maximum | 63,0 |
| Average | 52,6 |
| Median | 52,0 |

Ranking Waste-to-Land

| | |
|---------|-------|
| Minimum | 64,0 |
| Maximum | 106,3 |
| Average | 91,1 |
| Median | 95,5 |

Ranking Intermediate Use

| | |
|---------|------|
| Minimum | 38,5 |
| Maximum | 63,0 |
| Average | 48,6 |
| Median | 45,0 |

| 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 |

| 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 |

| 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 |

| 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 |

| Landfill | Quick response | Reason |
|----------|----------------|---------------------|
| 9 | Orion | Land value/pressure |

Cedalion: report per landfill

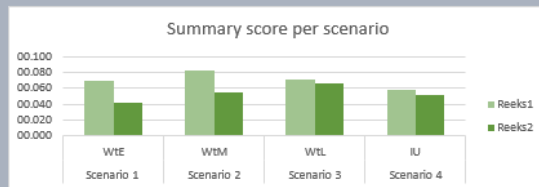
ELFM potential

DLM ID Landfill: 2

Quick response: Because of:

Summary score per scenario

| | Site ID | Average |
|----------------|---------|---------|
| Scenario 1 WtE | 70,0000 | 41,7361 |
| Scenario 2 WtM | 82,0000 | 54,8125 |
| Scenario 3 WtL | 71,0000 | 66,1667 |
| Scenario 4 IU | 58,0000 | 51,4792 |



Sum per criteria

| | WtE | WtM | WtL | IU |
|-----------------------------|--------|--------|--------|--------|
| Criteria 1 Type | 33,000 | 30,000 | 12,000 | 1,000 |
| Criteria 2 Age | 8,000 | 12,000 | 1,000 | 1,000 |
| Criteria 3 Volume | 0,000 | 9,000 | 2,000 | 1,000 |
| Criteria 4 Use | 11,000 | 9,000 | 11,000 | 2,000 |
| Criteria 5 Accessibility | 6,000 | 6,000 | 6,000 | 1,000 |
| Criteria 6 Surroundings | 0,000 | 4,000 | 27,000 | 51,000 |
| Criteria 7 Drink water zone | 4,000 | 4,000 | 4,000 | 0,000 |
| Criteria 8 Nature area | 4,000 | 4,000 | 4,000 | 0,000 |
| Criteria 9 Flooding risk | 4,000 | 4,000 | 4,000 | 1,000 |



Characteristics landfill:

The landfill consists of ... WWT sludge
 The landfill dates back to: >1999 documented
 Volume (m³): "Average" (default 35000-350000)
 Use of landfill: Grass

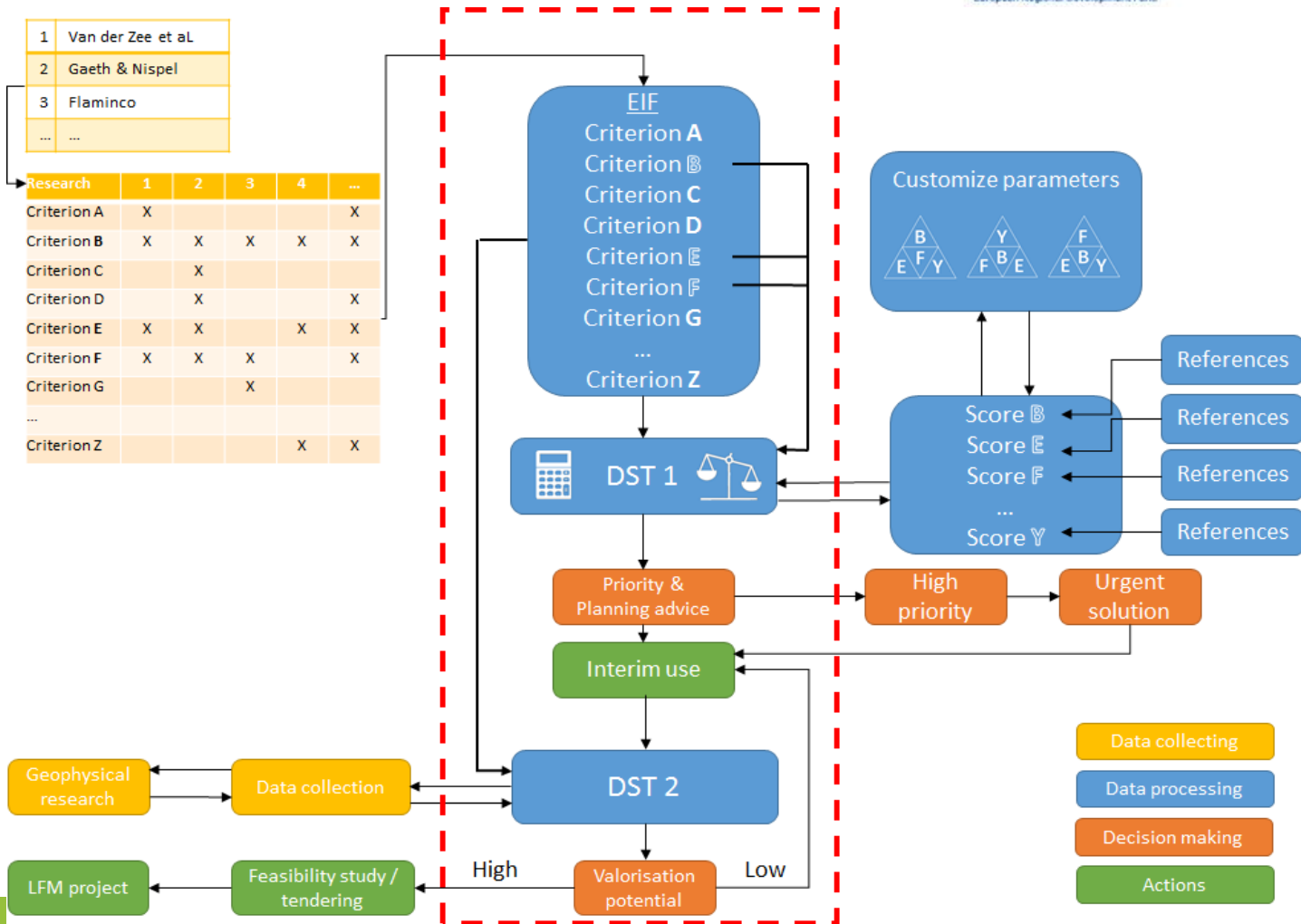
DST 2: Orion



The myth of Orion, Cedalion

| | | | | | | |
|-----|-------------------|--|--|--|--|--|
| 1 | Van der Zee et al | | | | | |
| 2 | Gaeth & Nispel | | | | | |
| 3 | Flaminco | | | | | |
| ... | ... | | | | | |

| Research | 1 | 2 | 3 | 4 | ... |
|-------------|---|---|---|---|-----|
| Criterion A | X | | | | X |
| Criterion B | X | X | X | X | X |
| Criterion C | | X | | | |
| Criterion D | | X | | | X |
| Criterion E | X | X | | X | X |
| Criterion F | X | X | X | | X |
| Criterion G | | | X | | |
| ... | | | | | |
| Criterion Z | | | | X | X |

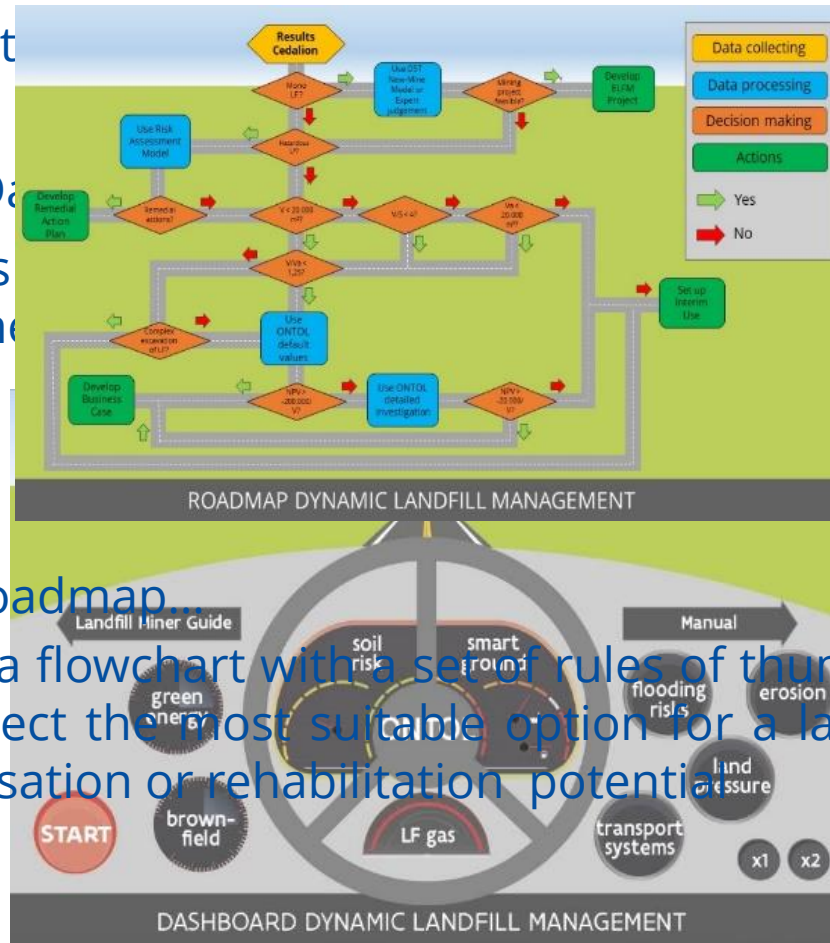


Introduction

What? *Concept behind Orion.*

Orion is an integrated system consisting of two main components:

1. The Orion Decision Support System... provides a flowchart to evaluate the



... consists of two main components that could be used to evaluate the potential of landfills

2. The Orion Roadmap... provides a flowchart with a set of rules of thumb that will guide the user to select the most suitable option for a landfill in terms of resource valorisation or rehabilitation potential

Introduction

Why? *Philosophy behind Orion.*



- Many interesting models/tools available for LF analysis (often EU funded)
 - *Orion = assembling good ideas*
 - Orion guides you through these models/tools, in function of the most suitable valorization or rehabilitation strategy for your LF
 - *Orion = guidance towards relevant good ideas*
- * The dashboard contains all the references of these models/tools
- * Possibilities to integrate regional tools

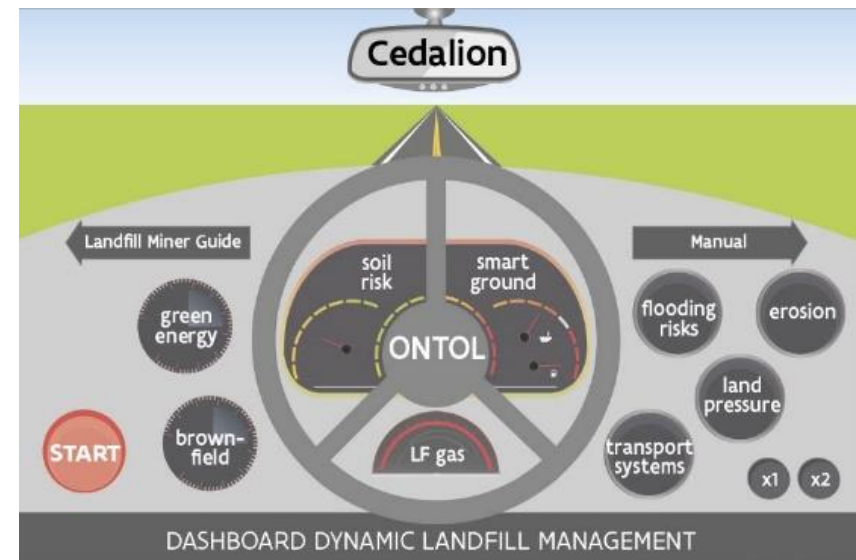
Concept behind Orion

Dashboard

1. The Orion Dashboard...

... provides the necessary tools to evaluate the mining opportunity of a LF:

- Rearview mirror: **Cedalion**
- Steering wheel: tools to assess **content** of the LF (ONTOL, Smart-ground, ...)
- Dashboard buttons: tools to assess the **context** of the LF (land pressure, erosion, ...)
- Manual & LF Miner Guide provide **general** information



Concept behind Orion

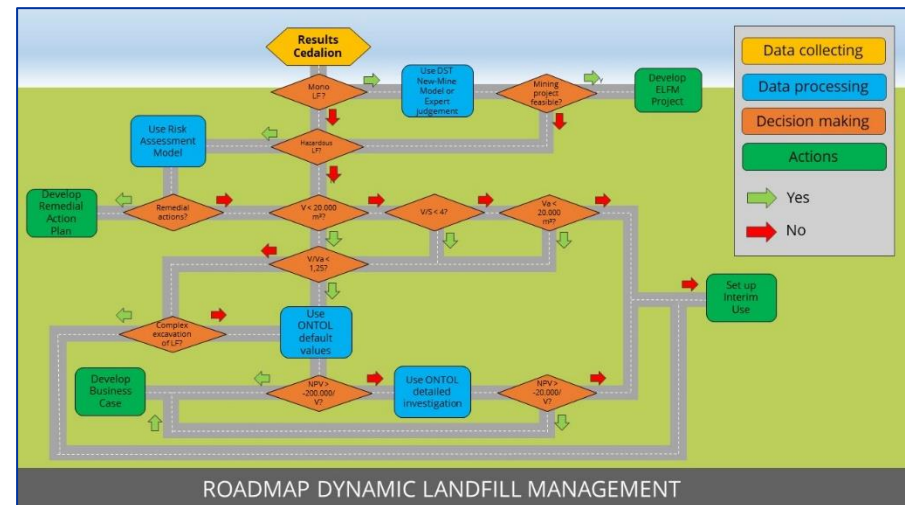
Roadmap

2. The Orion Roadmap...

... provides a flowchart which enables the user to select the most relevant tools to evaluate the mining opportunities of a LF.

The relevant tools depend on the end-point on the roadmap:

- Develop ELFM project
- Develop remedial action plan
- Set up interim use
- Develop business case



Concept behind Orion

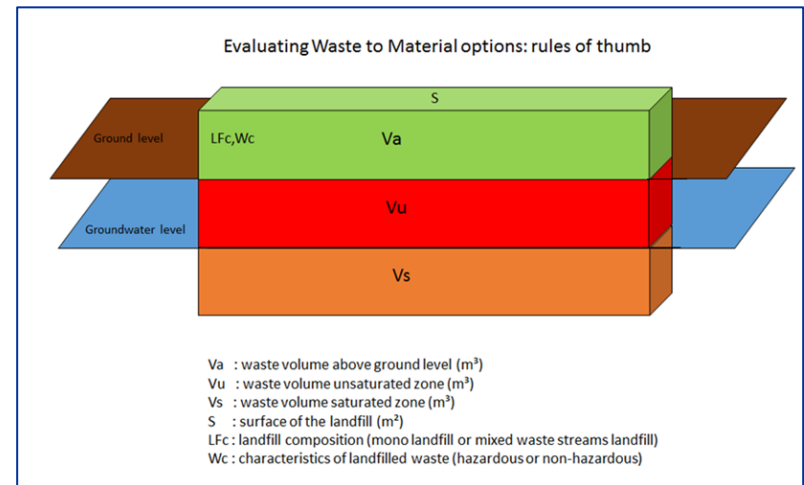
Conceptual site model

The Orion roadmap is mainly based on the conceptual site model of a landfill, which includes information on:

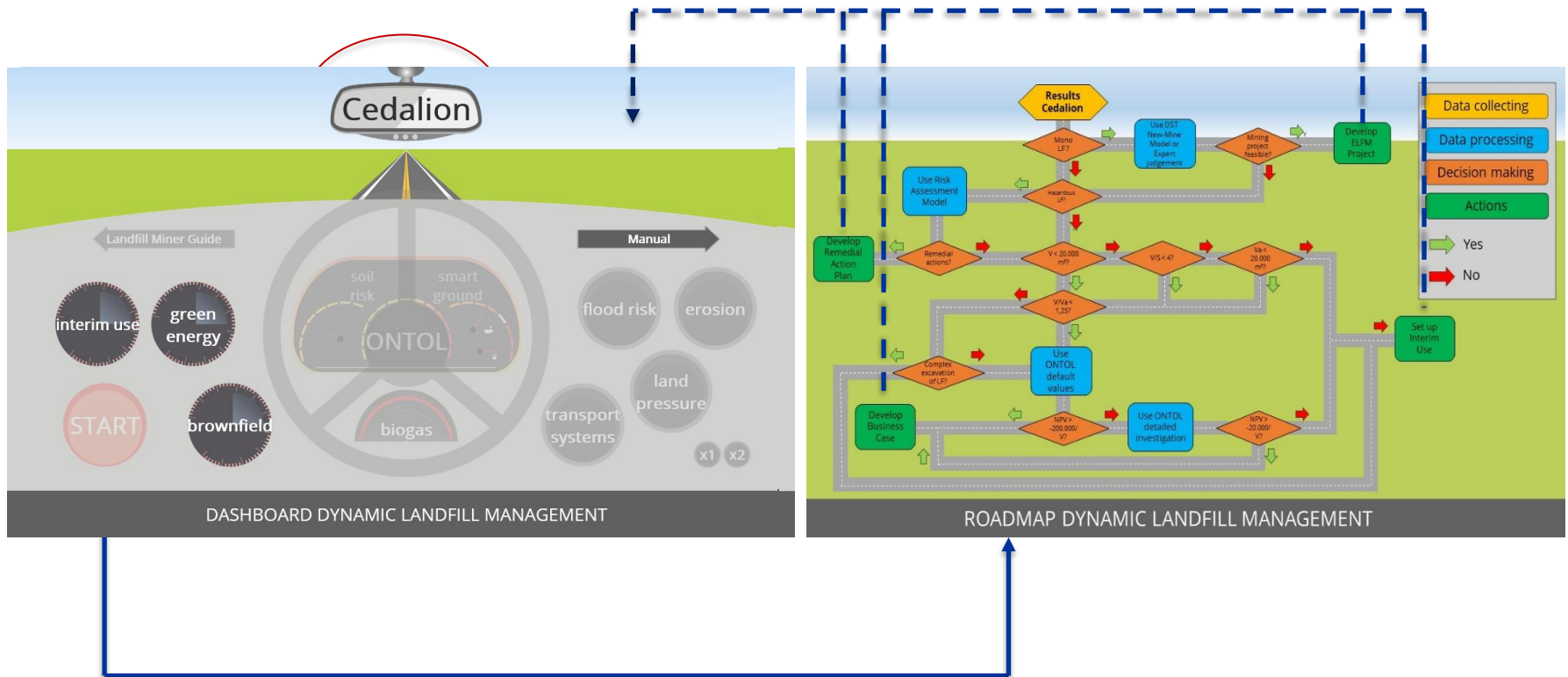
- the relative distribution of the landfill over the different soil layers,
- the surface and volume of the landfill,
- the type, characteristics and heterogeneity of the waste within the landfill.

→ all important parameters that should be taken into account within the budget and time management, concerning:

- Complexity of excavation
- Stability issues
- Extra measures to be taken
- ...



Dashboard + Roadmap = Interactive web application



Andere RAWFILL tools



<https://www.nweurope.eu/media/13061/rawfill-landfill-miner-guide.pdf>



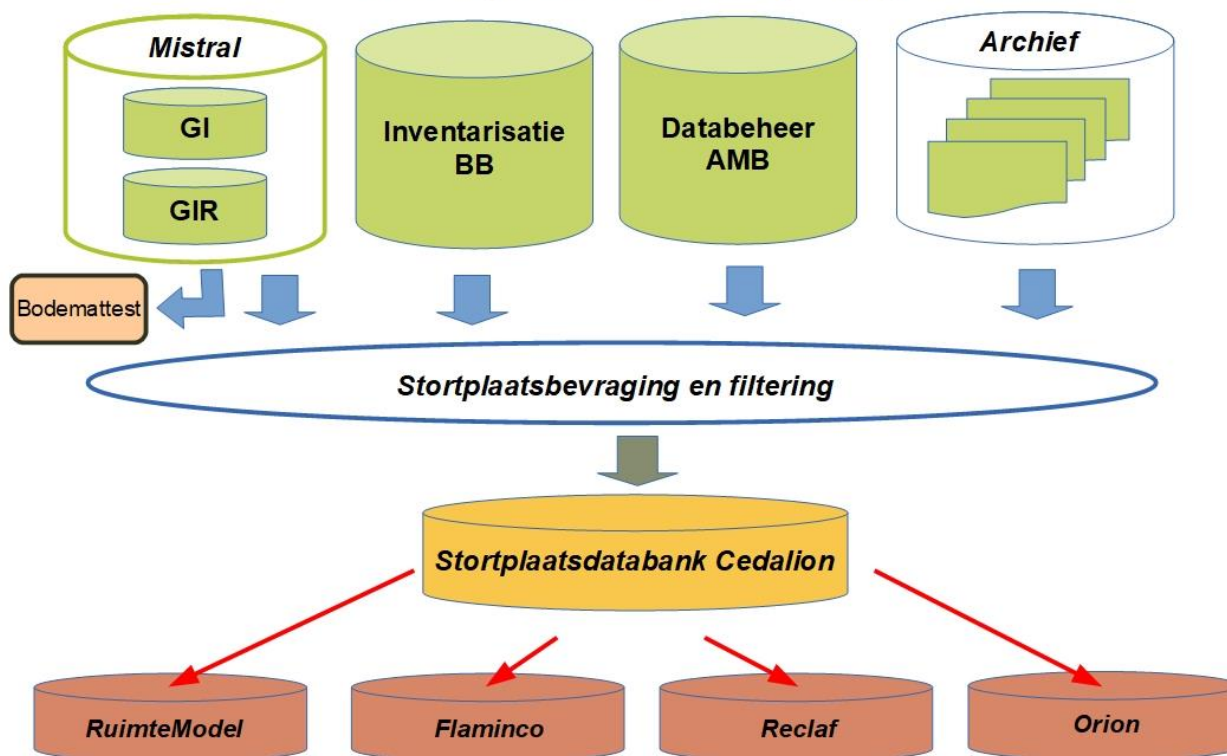
<https://www.rawfill-elearning.eu/en>



Toepassing in de praktijk?

Stap 1: inventarisatie

Relatie OVAM-gegevensopslag en beschikbaarheid voor beslissingsondersteunende toepassingen.

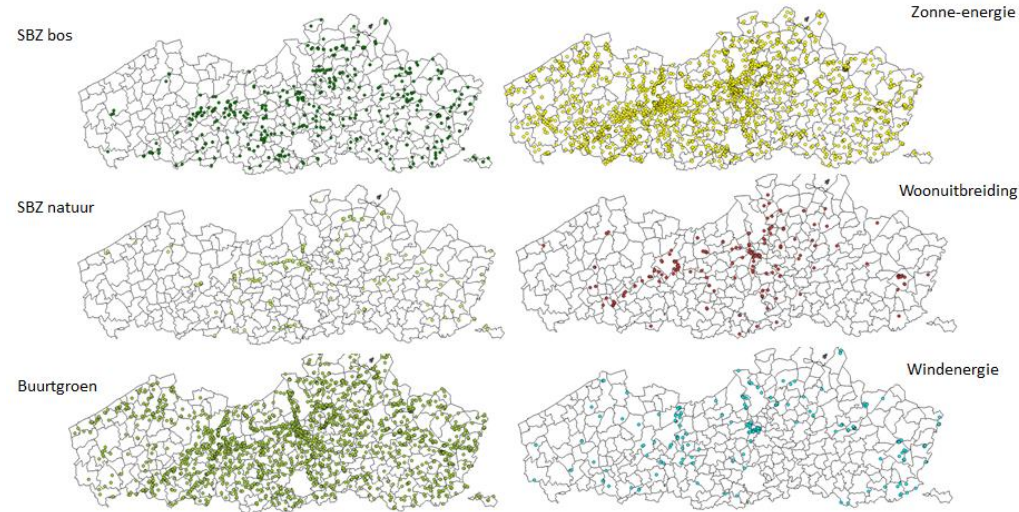
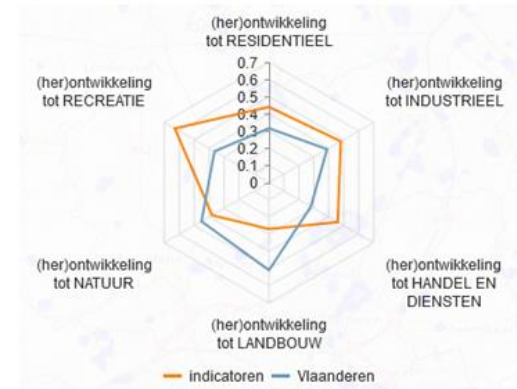
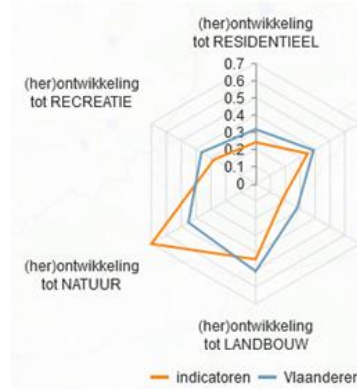
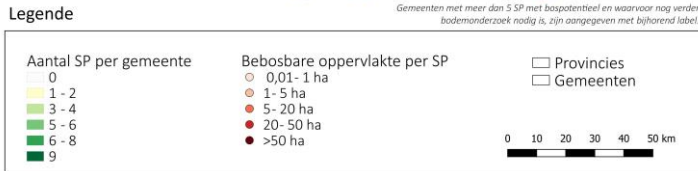
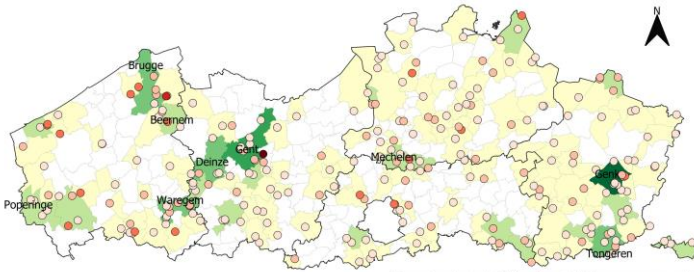


→ 3318 locaties

Toepassing in de praktijk?

Stap 2: prospectie

Kansenkaart: stortplaatsen (SP) met bospotentieel in eigendom van de gemeente, waarvoor verder bodemonderzoek nodig is.



Ranking per SP/SP scenario

Recalculate ranking

Ranking based on data in working database

| Ranking | Ranking | Ranking | Ranking |
|-------------------|-----------------|----------------|------------------|
| Waste-to-Material | Waste-to-Energy | Waste-to-Land | Intermediate Use |
| Minimum: 5,0 | Minimum: 6,0 | Minimum: 11,0 | Minimum: 9,0 |
| Maximum: 73,0 | Maximum: 55,0 | Maximum: 110,0 | Maximum: 83,0 |
| Average: 27,2 | Average: 18,7 | Average: 51,8 | Average: 51,4 |
| Median: 21,0 | Median: 11,0 | Median: 55,0 | Median: 52,0 |

| Landfill | Quick response | Reason |
|----------|-------------------------|---|
| 1 | Medium term interim use | Infrastructure development (e.g. solar panels) |
| 28 | Onion | Land value/pressure |
| 9 | Onion | Land value/pressure |
| 13 | Medium term interim use | Agricultural development |
| 13 | Onion | Land value/pressure |
| 22 | Medium term interim use | Potential ecological risk in the future (non-inert waste) |
| 22 | Medium term interim use | Nature development |
| 22 | Long term interim use | Nature development and conservation |
| 22 | Long term interim use | Nature development |
| 22 | Onion | Land value/pressure |
| 27 | Long term interim use | Nature development and conservation |
| 28 | Long term interim use | Nature development and conservation |
| 28 | Long term interim use | Nature development and conservation |
| 28 | Long term interim use | Nature development and conservation |
| 39 | Medium term interim use | Potential ecological risk in the future (non-inert waste) |
| 39 | Long term interim use | Nature development and conservation |
| 40 | Onion | Land value/pressure |
| 41 | Long term interim use | Agricultural development (e.g. agroforestry) |
| 43 | Medium term interim use | Agricultural development |
| 52 | Long term interim use | Agricultural development (e.g. agroforestry) |
| 52 | Long term interim use | Nature development |
| 58 | Onion | Land value/pressure |
| 61 | Onion | Land value/pressure |
| 66 | Onion | Land value/pressure |
| 72 | Onion | Land value/pressure |
| 74 | Onion | Land value/pressure |

Toepassing in de praktijk?

Stap 3: uitwerking aanpak



Interreg



EUROPEAN UNION

North-West Europe

RAWFILL

European Regional Development Fund

Thank you!