RAWFILL WP T2
T2.1.1 Table of DST indicators

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1. Overview of involved workpackages

This document is related to the activities of the Interreg North-West Europe project RAWFILL. The target of RAWFILL is ameliorating the reuse of waste currently stored in landfills[1]. To achieve this, a multicriteria tool will be developed to support decisions of companies, governments, etc. The project is divided into several work packages, of which two are related to this document.

The rationale behind this research program is the large quantity of landfills to be managed. Estimations pointed out that the EU has about 350.000 to 500.000 landfills (Hogland et.al., 2010). Based on additional data in some (regions of) member states, a correlation between the number of municipalities and the mapped landfills was made. The extrapolation to the EU-level revealed an even higher number of potential landfill site: up to 1 million (E; Wille, 2015[2]). Most of them are no longer operational but the former exploitation and closure procedures were not always in line with the standards of sanitary landfills as described in the EU Landfill directive 1999/31/EC.

In order to set up sustainable and comprehensive management plans, data collection and data processing should be well established to make good decision making possible. Based on the detected (rather limited) practices worldwide, the objectives of RAWFILL were transformed in the several workpackages but also the large scale and easy applicability of the deliverables should be emphasized.

1.1. Workpackage T1

Citing the application form of the RAWFILL project:

"WP T1 develops a standard and comprehensive LF Inventory Framework (EIF) taking into account LFs resources. EIF will be used to describe LFs not only in terms of environmental & risk issues, but will focus on available dormant materials, so that it will be possible to economically evaluate later the resource-recovery potential of each LFs. EIF is the basis for DST LFs ranking and so a prerequisite to assess feasibility, business plan & business case for LFM projects."

[1] This aspect of valorizations was not only discussed with the RAWFILL-members but also with the partners of Interreg Europe COCOON. Limiting the valorization to the reuse of the landfilled waste was not considered as o good practice. In line with these discussions, the scope was broadened to the following aspects: Waste to Material, Waste to Energy, Waste to Land, Preservation of the Environment and the groundwater supplies.

[2] Estimations made in preparation of Eurelco workshop in EU-Parliament 20th October 2015.

1.1.1. Target of the ELIF structure

The ELIF, abbreviation of Enhanced Landfill Inventory Framework, is one target of the RAWFILL project. It was originally called EIF, Enhanced Inventory Framework. Its primary goal is combining innovative landfill geophysics methods with the DST prioritization tool.

1.2. Workpackage T2

Citing the application form of the RAWFILL project:

"The objective is that relevant stakeholders in NWE region use a standard information & decision framework for selecting optimal LFM projects. WP T2 provides public & private LF owners/managers, operators and potential investors in charge of LFMprojects with a standard Decision Support Tool (DST) to screen LFs and to select the most promising sites for resource-recovery projects according to RAWFILL methodology. In order to create consensus on the methodology, AdvB is shaped, involving a broader group of stakeholders providing feedback."

2. Brief introduction

After OVAM received the ELIF structure of PP 8 (ATRASOL) in late December 2018, we were able to continue with the selection of all environmental, social, economic and technical indicators we consider to be essential for the working of the first DST, called Cedalion.

Prior to the ELIF, we already wrote the report “Making of DST 1” in which we described the fundamental criteria of the FLAMINCO decision support tool, which will act as a base for Cedalion, and already introduced an extra category in view of the coming

In this short report, we will update the structural layout of FLAMINCO to comply with the ELIF structure and give the table of selected indicators, corresponding to deliverable T2.1.1 of the RAWFILL project.

3. Old FLAMINCO criteria and new ELIF sections

In FLAMINCO we defined six different important criteria necessary for a good, realistic opportunity-based ranking of landfills In one's possession. These sections were:

- Type: the sort of waste that was deposited;
- Age: when or during which period the waste was deposited;
- Volume: the amount that was deposited;
- Use: which function the landfill delivers to its environment today;
- Accessibility: how easy transport from and to the landfill can be performed ;
- Surroundings: (ecosystem)services that the landfill can give to society.

Apart from the suggestion of ELIF to include generic data and a landfill ID-card, ELIF mentions three sections that correspond to the level of the six aforementioned sections of FLAMINCO:

- Surroundings: i.e. land planning, territorial strategy, current use, …;
- Geometry: i.e. surface, volume, depths, stability, …;
- Wastes: i.e. types, density, water and gas content,…

OVAM suggests to merge both sets of criteria as follows:

ELIF sections	Old FLAMINCO criteria
Generic information	Colofon
Landfill ID-card	General identification data
Surroundings	Surroundings Accessibility Use
Geometry	Volume Surface area
Wastes	Age Type

4. Selected criteria per section

Apart from the suggested sections, ELIF also made a list of criteria that might be fundamental for a good working DST. In this chapter we will highlight and explain the criteria OVAM chose to be part of Cedalion. In addition, every criterion is labeled to the indicator(s) it belongs.

4.1. The landfill ID-card

The landfill ID-card contains all necessary information to correctly locate and name a landfill. Following criteria are added to Cedalion:

- Ranking number in the Cedaliondatabase
- File number or another regional indentification code
- (In)formal name of the site
- Location
  - City or municipality
  - Postal code
  - Street
  - Number
  - Number of involved land plots
  - X coordinate
  - Y coordinate
- Owner
- Operator
- Permit references

4.2. Selected criteria for Surroundings

Groundwater (environmental)

OVAM opinion is that the possible threat of groundwater is an important decisive factor to perform a landfill mining activity (and therefore proceed to DST 2, Orion) in stead of some other form of dynamic landfill management. To be able to introduce this criterion with objective data, we suggest to use the concentric areas defined in groundwater source protection zones.

Regional policies vary because other definitions are used and consists up to three different zones (Vlaamse Milieumaatschappij, s.a.; Chelmi, 2015; InfoMil, s.a.). To give a practical example: in Flanders, the urgence of contaminations of landfills can be separated into three categories:

- Critical, corresponding to the smallest zone: contamination can reach the source of drinking water within 24 hours;
- Severe, corresponding to the second zone: contaminations can reach the source within a certain number of days or lays within a certain radius;
- Acceptible, corresponding to the largest zone: contaminations are present somewhere in the basin of the source or within a certain margin of distance.

Spatial development type (technical/economic/social)

The spatial development type is strongly correlated with the value of the ground and therefore can be vital for a profitable landfill mining activity. However, in case the conditions are not favorable enough and interim use is necessary, it can also help determine with form of interim use suits best for the surrounding neighbourhood.

There are eight types of land use (LUCAS, 2009) of which seven are relevant to the context of landfills in Europe. The seven types are:

- Artificial land
    - Residential areas: houses, appartments,…
    - Commercial areas: parkings, malls, hotels,…
    - Industrial areas
    - Recreational land: resorts, golf cources, ball fields, campings,…
- Cropland: permanent crops, arable land,
- Grassland: same function as pastureland, but with native vegetation;
- Woodland: deciduous, coniferous and mixed forests;
- Water: streams, canals, lakes, reservoirs… ;
- Wetlands: marches, coastal and tidal wetlands,… ;
- Bareland: including beaches, quarries, gravel, sand and clay pits.

For more than one reason, this classification is usefull to categorize certain aspects of the landfill:

- Landfills categorized in wetlands might be threathened by higher sea levels and/or changed precipitation patterns, thus leading to more flooding;
- Landfills categorized under barren land might be very deep and therefor not interesting to be mined, excluding those that might endanger the environment or human health;
- Landfills categorized under urban and bilt up land might be interesting to mine because of the value of the land and/or urban planning projects

Flooding areas (environmental)

Climate change affects affects landfill management in many ways. One of them is water. Over time, landfills located in lower areas can get susceptible to flooding due to prolonged periods of rainfall or extreme rainfall locally. Also the sea level rising is a problems for landfills close to the coast or tidal rivers.

Therefore, another criterium for Cedalion will be those zones sensitive to flooding in the future. Nowadays, many EU countries have data or models in use that can predict the situation at a certain point in the future, or use the approach of a thousand year storm (Vlaamse Milieumaatschappij, 2018; UK Government, 2019; Bij12, 2018).
To

Transport by road (technical/environmental)

Transportation via road is the most obvious way in delivering goods or removing waste from a site. However, not every road type is suitable for trucks and other heavy equipment. To indicate how easy and fast large quantities of material can be transported away from a landfill site, the distance to the nearest highway or regional access roads is taken or estimated and converted into a score.

Transport by train (technical/environmental)

Transport by train was already incorporated in FLAMINCO, but was limited to the shortest possible distance to a railway in general, without taking into account there was infrastructure for the trains to stop and receive excavated materials. This distance was reinterpreted into a score via a formula.

Making use of open data, Cedalion will improve the opportunity of railway system by calculating the shortest distance to a railway station, based on coordinates of almost 27.000 railway stations throughout Europe (OpenDataSoft, 2015). Cedalion will advise the user to consider using transport by rail by naming the three closest train stations and the maximum distance as the crow flies to reach these three points:

> “This landfill is closest located to the stations X, Y and Z at a maximum distance of A kms.”

It’s up to the user whether the volumes encountered on the specific landfill site in relation to the distance of the stations makes it worth to use transport by train.

Transport by ship (technical/environmental)

Currently two scenrio’s are being considered to define the criterion transport by ship:

The possibilities for transport by ship are considered by using the postal code from the section landfill ID-card and link it to its two digit postal code region. Within this region all canals and and navigable waterways indicated in one of seven CEMT classes are listed.

Cedalion will generate a pop-up or note on the page that displays a summary per landfill:

> "Cedalion noticed your landfill might by close to canal X / river Y so you might consider transport by ship"

If no canal is present within the postal code region, Cedalion will also indicate this to the user:

> "Cedalion didn't find a waterway close to your landfill."

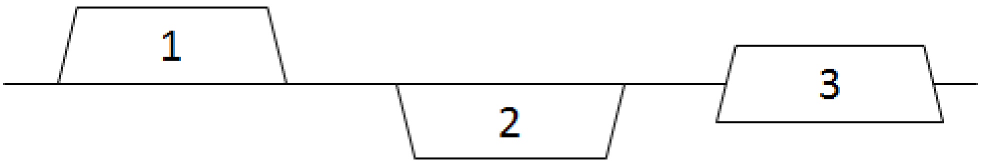
4.3. Selected criteria for Geometry

Surface area (technical)

Surface area is a component to calculate the volume and will be used in Orion to determine the value of the land on which the landfill is located.

Depth (technical)

This component is also used to calculate the volume. The thickness of the waste material depends on how the waste was deposited in relation to the ground level. Three categories can be distinguished.



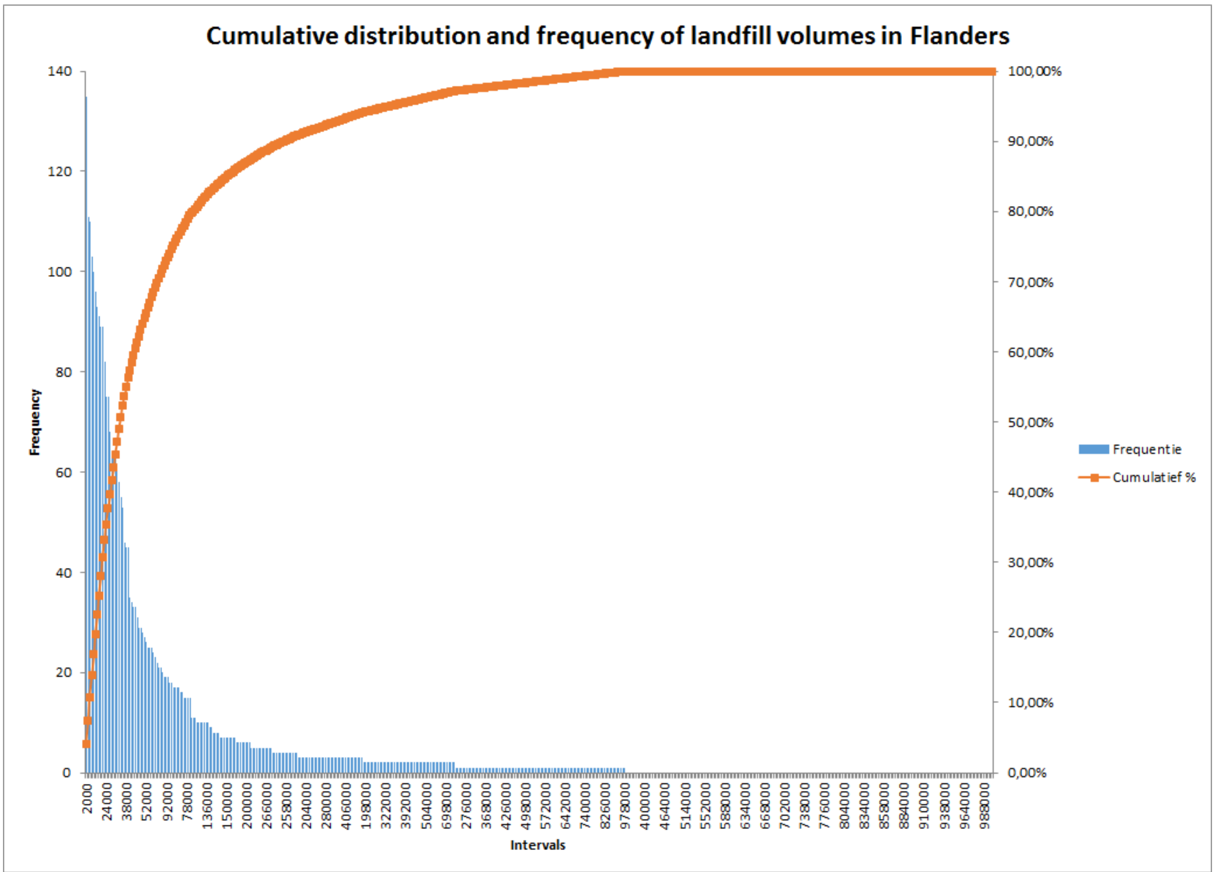
1. A heightened landfill: in this case, waste was deposited on top of the original ground level;
2. A landfill, originating from a natural or artificial depression that was filled up over time;
3. An intermediate form, where both a (small) depression was filled and afterwards some heightening was done.

In case it is not possible to enter the correct figure, default values for the depth of the landfill can be chosen. This is seven metres for old mines and quarries and three metres for all other landfills.

Volume (technical)

Using the updated OVAM database as a reference, the old criteria of a small, medium and large landfill were redefined.

Since the actual volume of many landfills still needs to be collected, the following categorization is calculated by multiplying the surface area of land plots with known historical waste deposition with an assumed average waste depth of three metres (OVAM, 2013). The total number of records that was used is 3318. After this, the cumulative percentages of frequencies was used to determine the categories:



- All landfills with a volume less or equal to 29.999 m³, corresponding to 40% of the landfills is considered to be small;
- All landfills between 30.000 m³ and 299.999 m³, corresponding to 50% of the total is considered to be average;
- All landfills greater than 300.000 m³, corresponding to 10% of the total landfills is considered to be big.

The volume can be based on actual measuring data (e.g. geophysiscal imaging) or other forms of experimental determination. It is also possible to use default values.

With half of all sites in the database being smaller than 41.000 m³ it is clear that landfills with a limited amount of waste make up the vast majority of all sites that can be found.

Consequently, volume as a decisive factor for a landfill mining project will be rather rare. Instead, much will depend on the composition of the waste and the way it is distributed over the land plot.

A small landfill with a lot of metal content can have a higher priority than a large landfill filled with plastics. Or the surface area can be many times smaller/greater while containing the same amount of waste, influencing the return on investment strongly on the value of the reclaimed land.

Surface texture (technical)

Surface texture links to the accessibility of the terrain and diminishes certain interim uses in case of obstacles. The next step is to

4.4. Selected criteria for Wastes

Type (technical/ economical)

The type of waste is not changed compared to the original FLAMINCO tool. The following eleven types can be distinguished:

- Municipal solid waste
- Industrial waste
- Dredging materials
- Waste water sludge
- Inert waste
- Fly ash
- Asbestos
- Metal Slag
- Mining waste (high grade)
- Mixed waste
- Other

The type "Other" can be used for certain monolandfills that have a content not abundantly found in other landfills across the EU. For instance, Flanders reports to have monolandfills containing gypsum, whereas the state of Brandenburg possesses some kroon and steel deposits (COCOON, 2018).

Age (technical / economical)

To every type of deposited waste, a time span can be assigned which influences its content and potential. This time span in based known or documented activity of the landfill site. To work properly, DST users must indicate the period in which the landfill was most active, and thus received the most waste, in case the activity goes beyond the given timeframes. For DST, OVAM defined three to four timeframes:

- MSW, industrial, mixed and some landfills placed under 'others' with a peak activity before 1955. These landfills have a low economic value for LFM projects. Also the potential for energy recuperation is inert materials are abundantly present. The lower limit of each waste type is based on the oldest known landfills of that specific type in the databases of OVAM.
- The massive consumption of plastics can be taken as a first gamechanger in the composition of our wastes. Large scale production of the most common plastics we know today began in the 1950's (Wallace, 2017). Most of these plastics end their product cycle the same year they were produced (Dengler, 2017). OVAM took 1955 as reference year, halfway the plastic emerging decade.
- At the end of the seventies, the recycling of plastics took off (Geyer, Jambeck & Law, 2017), but a new type of waste emerged: electronic waste. The 'Kian Sea' waste incident in 1986, is still one of the best examples of the disposal attitude in that decade and lead to the Basel Convention to restrict countries in exporting their e-waste abroad (CDR Global, 2015). Therefore, 1980 marks the start of the third time interval.
- The Council directive 1999/31/EC of the EU (Eurepean Commission, 1999) marks the transition from a undocumented landfill policy to a controlled, consequent managing of waste streams. However, we can not avoid the fact that some regions like Germany, Flanders and the Netherlands already possed a well developed waste policy by that time (COCOON, 2018).

All together this gives following intervals per waste type to which a certain weight will be assigned in deliverable T2.2.1:

Waste type	Time intervals
Municipal Solid waste	1930-1955 1955-1980 1980-1999 >1999
Industrial waste	1910-1955 1955-1980 1980-1999 >1999
Mining (high-grade metals)	1960-1980 1980-1999 >1999
Waste water sludge	1950-1980 1980-1999 >1999
Metal slag	1960-1980

	1980-1999 >1999
Fly ash	1950-1980 1980-1999 >1999
Dredging materials	1940-1980 1980-1999 >1999
Inert waste	1950-1999 >1999
Asbestos	1930-1999 >1999
Mixed	1930-1955 1955-1980 1980-1999 >1999
Other	1900-1955 1955-1980 1980-1999 >1999

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