OPERATIONAL

RECYCLING ACADEMY.

Mini-guide

How & why characterize a waste feedstock?

Practical guide - Case study

Key learning outcome:

- *Understand the purpose of characterization*
- *Know how to perform a characterization (quick or more in-depth)*
- *Visualize the process using an example*

PLASTIC ODYSSEY

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The contents of this guide are proposed in **open source**

Contributions to this mini-guide are welcome → please send an e-mail to jean-baptiste@plasticodyssey.org

Introduction et résumé

Introduction

Definition and goal

In order to solve a plastic pollution or waste management problem, it is important to better understand the problem by carrying out a deposit study.

This type of study can be carried out at different scales and for different purposes. Here are a few examples (non-exhaustive list):

- a **national characterization** to define a strategy and appropriate public policies,
- a more **local and decentralized** characterization to define a waste management plan for a city, for example,
- specific characterization of a **company or industrial site** to define treatment and reduction solutions.

If you have a recycling project in mind and would like to know more about your waste (volumes, types, origin, etc.), there are two options:

(i) refer to an existing study covering the area of interest. Some countries or municipalities or development agencies carry out this kind of study, but it is not systematic and not always up to date or very comprehensive.

(ii) carry out a characterization on your own or in partnership with stakeholders in the study area (town hall, companies, communities). That's what this mini-guide is for!

The following paragraph summarizes the steps involved in doing your own characterization, and will be developed point by point in this document.

Summary

<u>Prerequisites:</u>

1. Define the **purpose(s) of the characterization,** define the **geographical area** to be studied and **check local regulations,**
2. **Choose the methodology and protocol** best suited to the need (complete study for an institution, or more targeted study to answer specific questions). The level of precision required will directly influence the methodology.

Implementation:

3. **Collect waste samples** (depending on the chosen methodology)
4. **Sort and study waste composition.** Sort according to different categories, then analyze waste composition. This may include sampling and analysis to determine the proportion of different types of waste (organic, recyclable, hazardous, etc.).

Analyses and conclusions:

5. **Quantify** waste types, extrapolating results if necessary in relation to demographic or other data on the study area
6. **Additional analyses** (if necessary) depending on the final goal (physical and chemical characterizations: toxicity, identification of environmental risks)
7. **Conclusions** (assessment of management methods, awareness-raising, reduction, etc.)

Monitoring and assessment:

8. **Monitoring and assessment :** setting up an ongoing monitoring system to assess the effectiveness of the measures taken.

1. Prerequisites

In order to characterize the deposit, it is first necessary to :

- define the aims of the characterization,
- clearly define the study area
- verify local waste management specificities and policies.

Define the purpose(s) of my waste characterization

There can be several reasons for characterizing waste deposits:

- **Waste type identification:** Determine the different types of waste produced by a specific activity or process. This can include solid, liquid, hazardous, non-hazardous, organic waste, etc.

- **Quantifying waste production:** Measure the amount of waste generated on a regular basis. This information is crucial for assessing the scale of the waste problem and developing appropriate management strategies.

- **Chemical and physical characterization:** Analyze the chemical and physical composition of waste. This helps determine the presence of hazardous substances, recyclable materials, reusable materials, etc.

- **Toxicity and risk assessment:** Evaluate the potential risks to human health and the environment associated with waste. This includes identifying toxic substances, contaminants and other risk factors.

- **Identify recycling opportunities:** Identify recyclable materials present in the waste stream. This enables effective recycling programs to be set up to reduce the amount of waste sent to landfill.

- **Determination of waste management options:** Propose appropriate waste management solutions, including recommendations on source reduction, reuse, recycling, treatment and disposal.

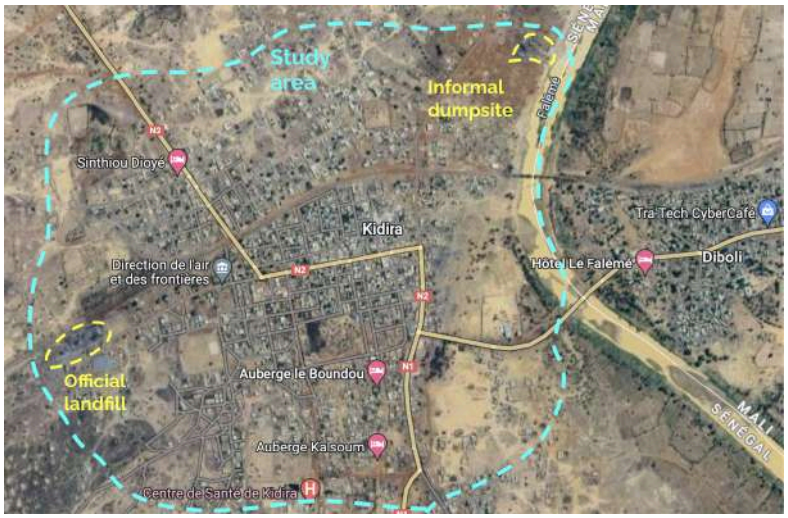
- **Regulatory compliance:** Ensure compliance with local, national and international waste management regulations. Characterization helps identify the legal requirements with which the company or activity must comply.

- **Improving environmental efficiency:** Identify opportunities to improve environmental efficiency by reducing the amount of waste produced, promoting recycling and minimizing environmental impacts.

In short, waste characterization provides essential data for **developing sustainable waste management plans, reducing an activity's environmental footprint and complying with current regulatory standards.**

Clearly define the study area

To be very clear about the study, it's essential to clarify from the outset what the precise study area is. This could be a company, a district, a town, a group of towns or a region. In some areas, for example, a landfill is shared by several towns, so it's difficult to divide it up using a global approach, where the study is carried out directly at the landfill (definition in the next paragraph).



Choice of methodology

Characterization can be carried out in different ways, depending on the goal(s) being pursued.

There are two main approaches:

- A **global approach**, which involves taking samples of waste arriving at the landfill site by truck or other collection vehicle. The mass/volume of waste over a given period can then be calculated. This value can be reduced to the quantity of waste per inhabitant if we know the demographics and the area covered by the collection method.

- An **individual approach**, which involves collecting waste from a representative sample of households (randomly selected if possible). In this way, the waste produced by each household can be collected over a period of time (2 weeks minimum if possible) and weighed (noting the number of inhabitants per household). It's important to note which bag corresponds to which household, and to weigh the bags systematically.

It is important to carry out the study at a significant point in consumption over the year, and not during a festive period or a period when consumption is abnormal in relation to average consumption.

Note: The global approach has the advantage of avoiding the tricky aspect of adding households to the study process, which adds complexity and can sometimes be rather taboo (disclosure of consumption, risk that certain households hide certain waste, etc.). The advantage of the individual approach is that the correlation between the quantity produced and the number of inhabitants is better.

The methodology will also have to be based on several other choices:

- **Survey period** (e.g. once only for simplicity's sake, or once for 10 days in the dry season and once for 10 days in the wet season).
- **Sampling locations** (e.g. door-to-door, at landfill sites, etc.).

Note: If bags are collected from residents, they are weighed individually, but not sorted individually, but grouped together.

- **Sampling method and tools** (this is more a question of logistics in terms of collection methods and organization).
- **The minimum sample weight** (depending on the size of the population and the desire to collect a significant proportion of the rarer waste, larger or smaller volumes are required).
- **Number of samples to be sorted**
- **Sample sorting method** (number of waste categories considered and minimum size of waste considered)

- **Constituents taken into account**
- **Any additional analyses required**, such as physical or chemical analyses (toxicity, etc.).

NB: some approaches will give very approximate results, but these may suffice. The quality of the sampling is a determining factor in the accuracy of the results.

Another point: It's also important to distinguish between the two types of results required: the quantity of waste produced and the composition of this waste. If you want to do both, the sampling method can be the same.

Examples for the global approach:

Methods derived from the French MODECOM :

- "Case D5 - Objective: choose a treatment method adapted to the waste of Greater Tunis. **4 campaigns over 4 seasons**, 5 types of habitat or activity. **Samples of 200 kg** (10 elemental catches of 20 kg), dried, screened at 100 and 20 mm then sorted into **13 categories and 5 sub-categories**".

- "Case D13 - Objective: to identify the recoverable potential of collection centers in Ouagadougou. Sorting of cart contents (**approx. 500 kg**), not specifically for characterization (as part of the normal sorting operation) but according to MODECOM categories (fines < 8 mm as this fraction has recovery potential)."

Examples for the individual approach :

- "Case D4: 3 habitat types, approx. **30 households per type, for 3 weeks** (9 days for source-separated organic waste), 2 seasons (dry and wet). **Samples of 130 to 150 kg from randomly selected bags**. Sorting according to the 13 MODECOM categories and 4 plastic sub-categories."

- "Case D11: daily collection of bags for **6 weeks from 60 households**. **614 kg characterized**. Case D14: 72-hour bag collection, rainy season, 4 housing types, 168 bags, 3.6 tons characterized. Sorting according to MODECOM.

2. Implementation

Waste sample collection

Depending on the chosen methodology, we start by collecting plastic samples either from households (individual approach) or from the landfill (global approach).
For the individual approach, this may involve door-to-door collection on a regular schedule (e.g. once a week for 3 weeks).
For the global approach, this can be done, for example, when a truck arrives, by collecting a few samples.

What weight to collect for samples?

Generally speaking, the greater the volume, the greater the precision of the result. If you want an in-depth, detailed study, you'll need to aim for larger volumes than if you simply want orders of magnitude for the main categories of waste.

To give you an example: the **French standard ("MODECOM")**, based on numerous scientific studies, recommends taking samples of **500 kg**, from which elements that are too bulky or too dense are removed, then dividing into quarters) mass of 100 to 120 kg), and finally sorting all the elements larger than 100 mm (between 30 and 50 kg) and 7 kg of the fraction between 20 and 100 mm and weighing the elements < 20mm or, if you want to go finer, sieving to 8 mm and sorting around 500g of the 8-20mm. The initial mass of 500 kg is then calculated.

In developing countries, waste deposits are often more homogeneous than in France, with a lot of putrescible materials, plastics, etc., and so we can easily reduce them to smaller volumes with a good confidence index, for example **between 150 and 200 kg**.

Sample sorting and analysis

How do I sort samples?

The French "MODECOM" standard suggests sorting waste first by size/weight (**granulometric separation**) to facilitate subsequent sorting by category.
From a 500 kg sample, we remove the heterogeneous elements, which reduces the sample volume, and then extract a quarter, i.e. 100 to 120 kg.

We then take **3 main categories** and sort them separately:

- elements over **100 mm**,
- 7 kg of elements from **20 - 100 mm**,
- fine elements **< 20 mm** are weighed. A 20 mm grid can facilitate this sorting, particularly in Sahelian countries with a lot of sand.

Notes:

- heterogeneous elements are sorted and weighed, and the data integrated into the results.
- In developing countries, sorting is easier and particle size separation less justified, so it's common for the entire sample (150 to 200 kg) to be sorted.

List of material categories

The list of categories must be adapted to the characterization objectives. You need to be able to characterize everything, and avoid an "other" category that sometimes turns out to be not insignificant. Here is a suggestion of broad categories that can be subdivided into sub-categories according to the objectives:

- **Predominantly organic matter:** putrescible waste (food waste, vegetable waste), wood, paper, cardboard, sanitary waste (diapers, sanitary towels), textiles, plastics, other predominantly organic waste (composites, leather, rubber).
- **Predominantly inorganic material:** glass, metals (ferrous, aluminum, other), electrical and electronic waste, other predominantly mineral waste (broken crockery, rubble, stones).
- **Hazardous waste:** batteries, medicines, medical waste, fluorescent tubes and low-energy light bulbs, toxic product residues.
- **Fine elements:** fraction obtained using a sieve (generally 10 to 20 mm), whose elements are too small to be identifiable.

We can therefore extract the following categories, for example:

1. organic waste (food, plants)
2. wood
3. paper, cardboard
4. plastics
5. textiles
6. sanitary waste
7. glass
8. metals
9. electronic waste (e-waste)
10. other organic waste (composites, leather, rubber)
11. other mineral waste (dishes, rubble, stone, etc.)

Note: If you're specifically interested in plastics, you can then sort by category of plastic within the 7 categories (PET, HDPE, PVC, LDPE, PP, PS, Other) or make other

sub-categories for finer characterization (e.g. 11% by mass of plastics in the total sample, of which 22% PET, 17% HDPE, 15% LDPE, 16% PP, 3% PVC, etc.).

Basic equipment required

- a sorting table with a sieve to allow fine elements to pass through,
- bins or other containers for collecting sorted fractions,
- a scale with a capacity of 50 to 70 kg, and another with a capacity of 10 kg,
- tarpaulins for sub-sampling on the ground and collecting fine elements,
- shovels, broom, brush,
- anti-sting gloves (for pruning brambles or rose bushes),
- dust masks,
- work clothes (pants or overalls, closed shoes),
- first-aid kit.

Note:
If you take the sample with a shovel, you can't catch a bottle of soda - it'll fall out. So there won't be any in the sample. When you can, you take unit masses of around 50 kg with a backhoe bucket of at least 200 liters. Otherwise, you have to quarter the sample on the ground and take the whole of the retained fraction.

Comprehensive, rapid approach to small-scale characterization

It is not always possible or necessary to follow an excessively heavy formalism or protocol, especially for fairly informal characterizations that do not require a high level of precision.
Here's a suggested methodology:

- Proceed with a **global approach** to the landfill (if available), using a homogeneous, representative sample of 150 to 200 kg if possible (or as close as possible). A second or third sample can be taken if there is any doubt about the 1st sample. However, this approach may involve a high degree of uncertainty (see note)*. Sort into the 11 categories mentioned above (sort by size beforehand if necessary, but not obligatory). This will give the percentages of each type of waste and the percentages of the different plastics.
- As a bonus if possible: carry out an additional characterization using an **individual approach**, taking a few households (10 at random, for example) to corroborate the initial results of the global approach and also to better estimate waste generation per inhabitant (storage of one or even two weeks' worth of waste per household, for example).

***Note:** Sample mass does not depend on population size. However, more samples are taken when the population is large. You still need to take a minimum number of samples (usually 5), even if the population is limited, and check the dispersion of the results (deviation from the mean). It's too random to characterize just one sample, even 2 or 3. If you can't do more, be aware of the great uncertainty of the data.

3. Simplified case study

In addition to the more traditional methodologies presented in section 2, it may be useful to present simplified alternatives where time and resources are limited.

Note: As a disclaimer, it is important to note that this is not a scientific method in the strict sense of the term, but rather a cross-fertilization of experience between household waste characterization and a beach clean-up characterization methodology involving the delimitation of random areas of a beach and the study of what each plot contains.

Section 3 describes an experiment carried out in January 2024 in a commune to the east of Senegal, giving a very quick idea of the deposit.

Protocol:

1. Choose an area of at least 2 x 2 m of a landfill or dump that looks homogeneous and representative of the waste from the whole dump (not a place where there's only plastics or only organic waste, for example).
2. Delimit the area with rope, stakes or other means at your disposal (use straight tree branches in this example!).
3. Collect the waste, separating it by category (plastics, cardboard, glass, metals, organic waste, etc.).
4. Once the area has been completely or almost completely cleaned (small pieces of less than 2 cm can be left), weigh each bag to obtain the weight per category.
5. By dividing the weight of each fraction by the total weight, we obtain the percentage of each fraction. For example, 15.5 kg of waste collected in all, including 2.1 kg of plastics, gives a total of 13.5% plastics.

The advantage of this method is that it can be carried out in around 30 minutes per 2 x 2 m zone (the experiment can of course be repeated several times and the results averaged).
On the other hand, it is based on a number of assumptions. The landfill studied may not be entirely representative of the waste consumed by the population.
For example, on this project, we realized that organic waste, notably peelings and food scraps, are fed to livestock. Also, cooking ashes (wood-fired cooking) are an important waste product put in the dustbins or in the garbage truck, but cannot be separated using this method. Finally, sand is often added to the mix, influencing weights and volumes.

This method is therefore quite interesting for inorganic fractions (plastics, metals, glass, cardboard/paper, ceramics, rubber, electronic waste, etc.), but much less accurate for putrescible waste. It should therefore be used with caution.

To characterize a plastic-only deposit, however, it remains interesting, as we can analyze the different types of plastic once the initial sorting has been carried out, and thus quantify the share of PET bottles, plastic bags (LDPE), etc., in the total waste stream.

Conclusion

Knowledge of the deposit is a determining factor in the sound structuring of a plastic recycling project in a given area.
It is not uncommon to extrapolate results too quickly on the quantity of waste or plastics consumed in a given area, only to find that there are major discrepancies, or that the quality of the deposit or types of waste are not compatible with the treatment solution initially envisaged. There may also be a significant discrepancy between the quantity of waste generated and the quantity of waste that could reasonably be collected (due to a lack of collection solutions, awareness-raising or topographical or infrastructure constraints).
For example, let's imagine that an area's plastic consumption is estimated at 300 tonnes a year, and that we therefore plan, with a margin, to recycle 100 tonnes a year to make sure we have enough plastics. It is possible that the quantity that can be collected or recovered in the short term is only 50 tonnes per year, of which perhaps only 25 tonnes can be recycled with the solution we are aiming for. This would jeopardize the project and would therefore require better network coverage, more collection at source, less burning, which takes time and is complex to implement...

So take the time you need for this preparatory phase of the project, or re-evaluate it if you've already started!

Bibliography and resources

Resources in French::
- Guide de caractérisation (plateforme Re-Sources)
- Fiche synthétique caractérisation (plateforme Re-Sources)
- Fiche technique “l’importance de la connaissance du gisement” (proget PAGEDS)
- Fiche synthétique “Réduction” (plateforme Re-Sources)

Boîte à outils de l'association AMORCE

Plateforme Re-Sources

It’s now up to you to take this knowledge and apply it to the environment around you.

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