Detailed Sampling Protocol for the Analysis of Residual Municipal Solid Wastes

J. Faitli[1], R. Romenda[2]

[1]associate professor, [2]PhD student

[1,2]Institute of Raw Materials Preparation and Environmental Processing, University of Miskolc

3515 Miskolc-Egyetemváros, Hungary, email: eitfaitj@uni-miskolc.hu

HERAKLION 2019
26-29 June 2019

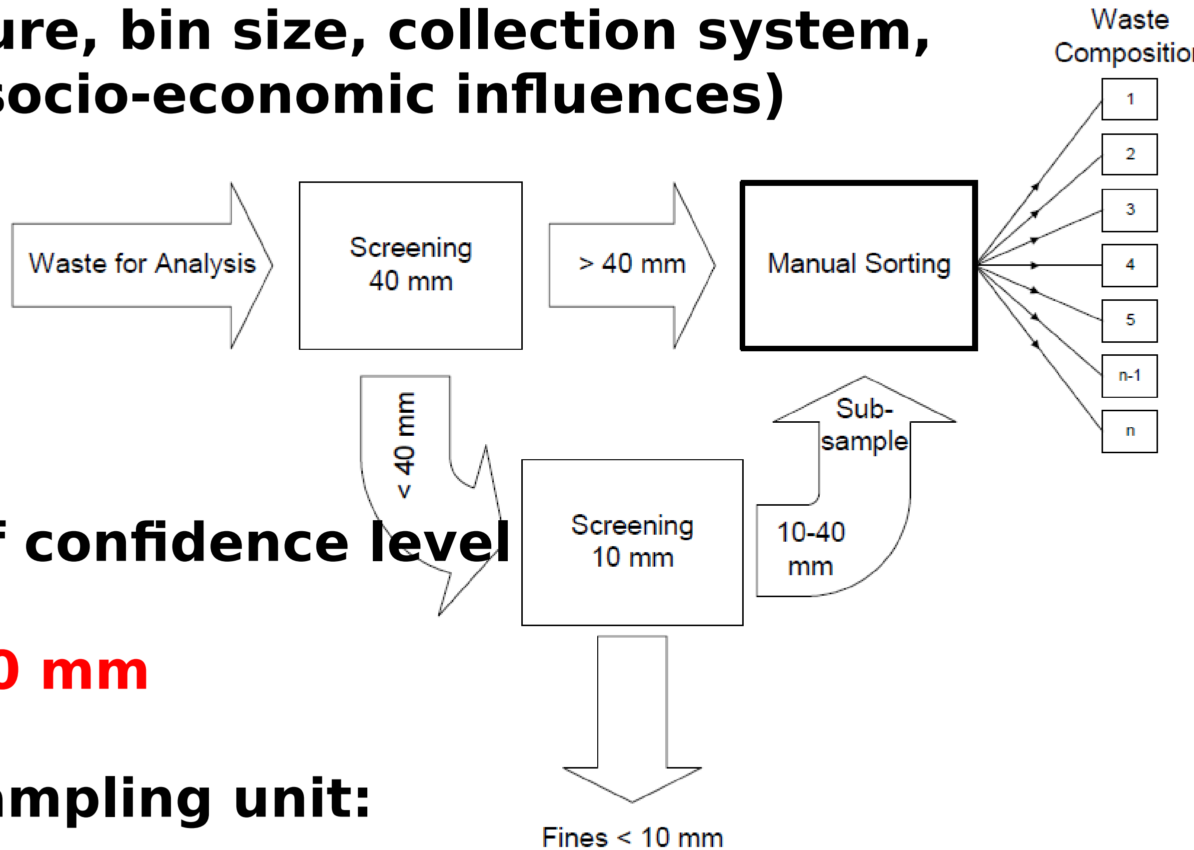
7th International Conference on Sustainable Solid Waste Management 26-29 June 2019, Heraklion, Crete

Content

- Shortly about existing MSW sampling standards
- Development of a new RMSW (residual municipal solid wastes) sampling and average sample preparation methodology
- Some data about the 2017/18 spring and winter Hungarian MSW characterisation campaigns
- Definition of key concentration parameters and their measured values

SWA-Tool methodology

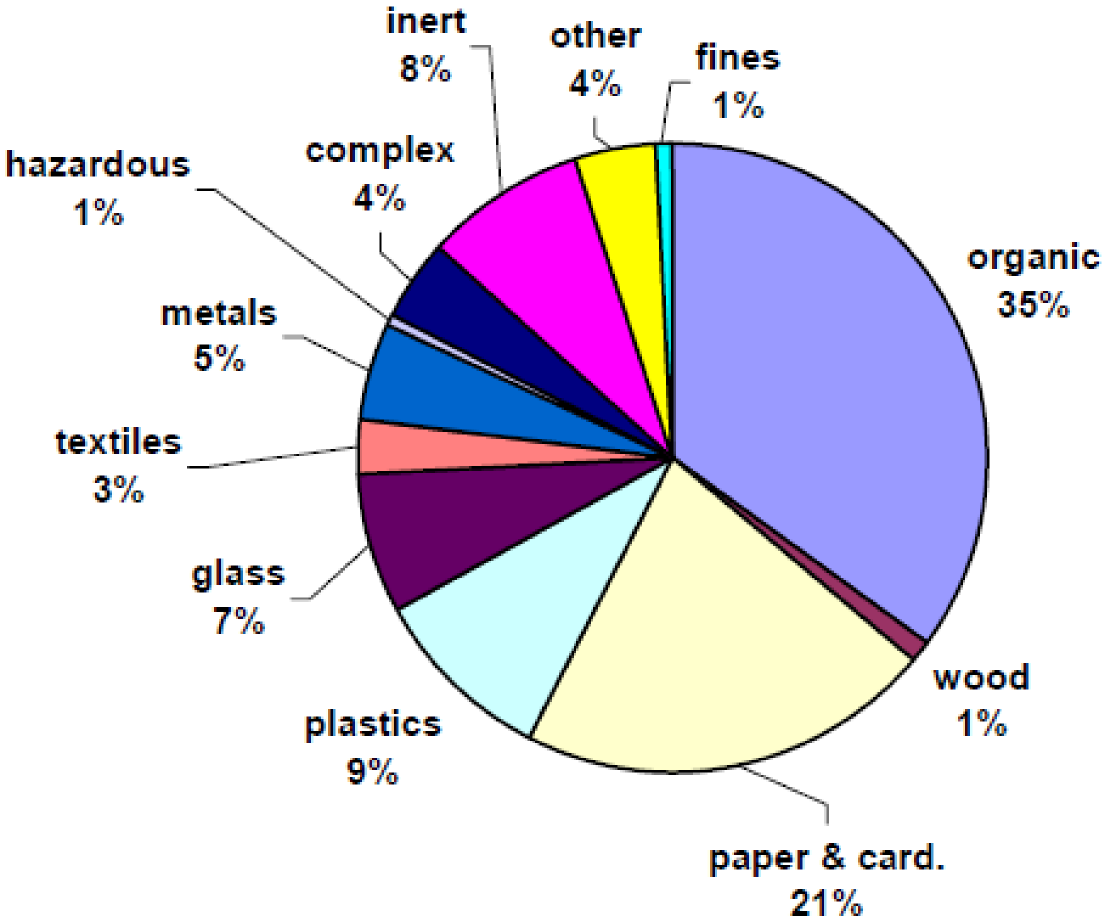
- **Fundament of sampling: BINS called as sampling units**
- **Stratified sampling (might based on: seasonality, residential structure, bin size, collection system, source of waste, socio-economic influences)**



- **Suggested 95% of confidence level**
- **Fine fraction: < 10 mm**
- **Processing of a sampling unit:**

SWA-Tool methodology

catalogue. Primary material categories according to SWA-Tool:



Remark: no composition data for discrete size fractions, therefore not suitable for waste preparation technological design!

The MODECOM methodology

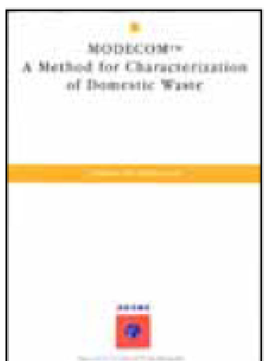
MISKOLCI EGYETEM
UNIVERSITY OF MISKOLC

NyKE 1923

MSW characterization in France

A little page of history

- 1993: MODECOM™ (French MSW characterization methodology).
  - Characterization made on the collection vehicle.
  - Mass of sample: 500 kg.
- 1993: First national campaign of MSW characterization in France, based upon MODECOM™
- 1994-1997: Development of selective collection schedules.
- 1997: Adaptation of the MODECOM™ methodology for the selective collection.



Géosciences pour une Terre durable
brgm

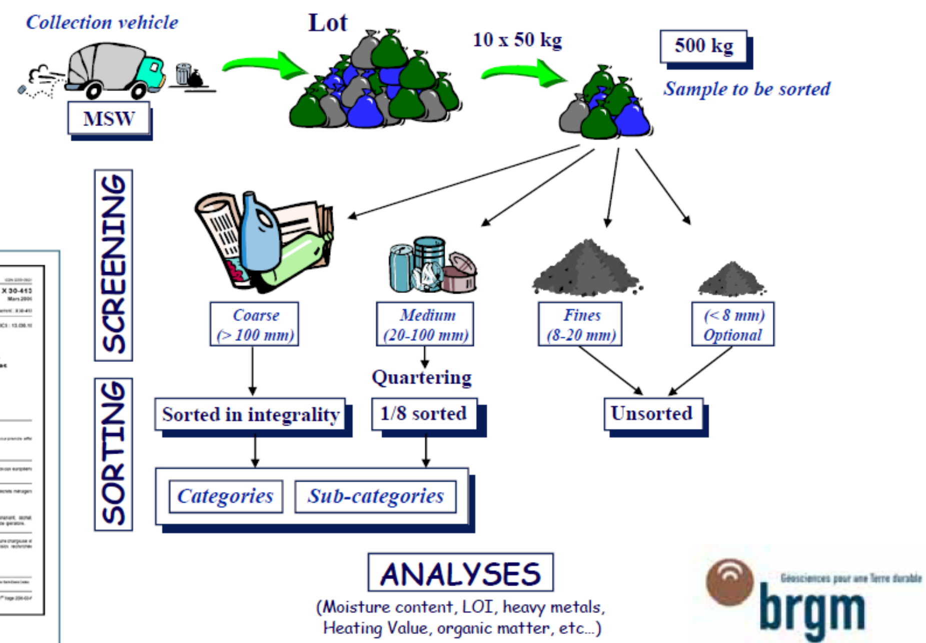
Ph. WAVRER: New MSW sampling and characterization methodologies. The dry product method. **RELIABLE DATA FOR WASTE MANAGEMENT.** September 25-26, 2008, Vienna, Austria

The MODECOM methodology

MISKOLCI EGYETEM
UNIVERSITY OF MISKOLC

NyKE 1923

MODECOM™ sampling & sorting operations



brgm
Géosciences pour une Terre durable

2 French AFNOR standards

Derived from the MODECOM™ methodology

- **NF X30-413: Constitution of a sample of household waste contained in a waste collection vehicle**

  Rules for sampling MSW from a collection vehicle.
  - Sampling of 500 kg formed by ten 50 kg increments.
  - Random sampling.
  - …

- **NF X30-408: Characterization of a sample of household related waste**

  Rules for characterization of MSW.
  - Characterization made on wet (raw) material.
  - Screening with a double-screen (20 & 100 mm) sorting table.
  - Quartering of the 20-100 mm fraction.
  - Etc.

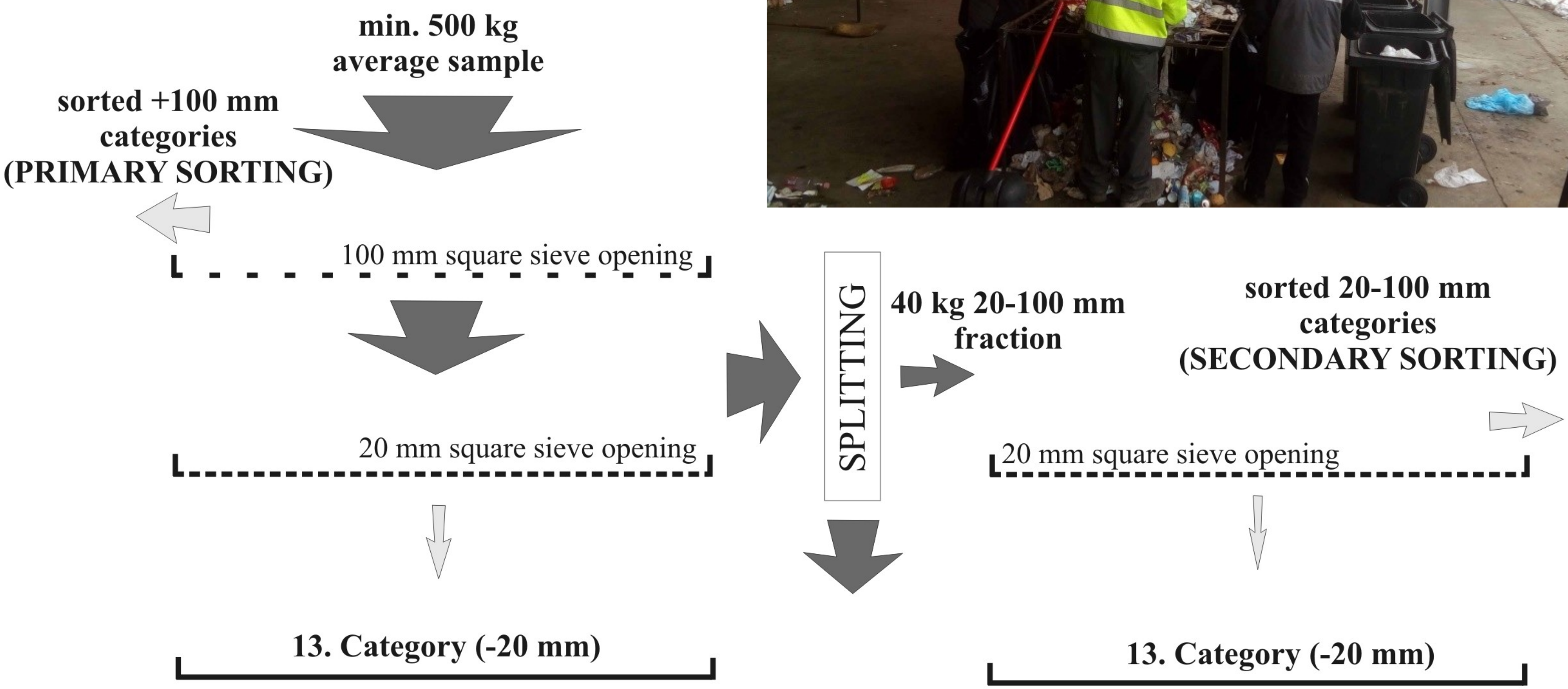
brgm
Géosciences pour une Terre durable

Ph. WAVRER: New MSW sampling and characterization methodologies. The dry product method. **RELIABLE DATA FOR WASTE MANAGEMENT.** September 25-26, 2008, Vienna, Austria

Current Hungarian Standards MSZ 21420 Parts: 28 and 29 for MSW sampling were introduced in 2005

Fundament of sampling: waste collecting vehicle!

Sample preparation of the 500 kg average sample:

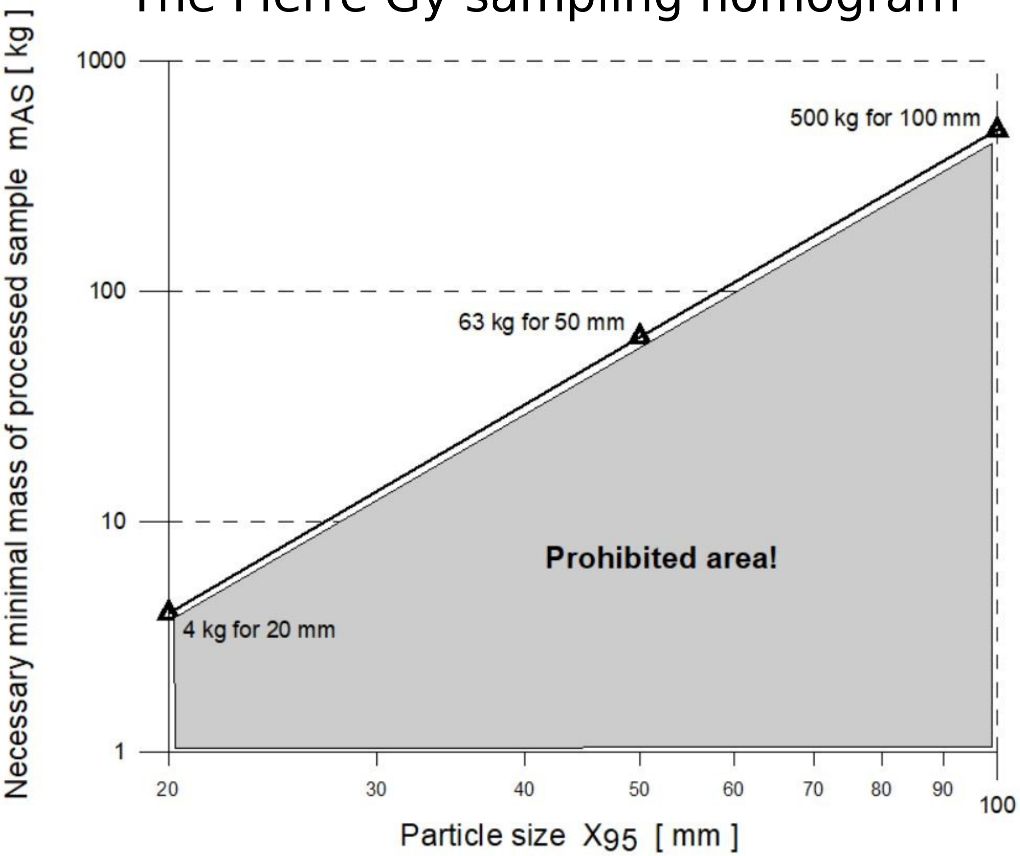


Problems and situation.

- More than 3000 old landfills had been closed and re-cultivated and only a few but modern and big regional landfills and waste processing plants had been built in Hungary.
- As a consequence there are machines, such as mobile drum sieves everywhere available for the MSW analysis.
- Another consequence, that the waste is transported into regional plants, therefore the analysis can be carried out in one spot for a complete region.
- The food content and the packaging materials content of the residual municipal solid wastes are requiring more and more attention recently.
- A very important issue, namely more detailed information about the **MSW composition for many discrete particle size fractions is necessary for advanced technological design**.
- All these arguments made the improvement of the standard sampling protocol to be important.

eories behind the new sampling protocol

The Pierre Gy sampling nomogram



$$m_{AS} = C \cdot X_{95}^{3} \qquad C = 500\ t/m^3$$

What is the theory behind the well-known Quartering?

The circle symmetrical segregation if the sample is poured into the centre point of the cone.

How can w
splitting?

HERAKLION 2019
26-29 June 2019

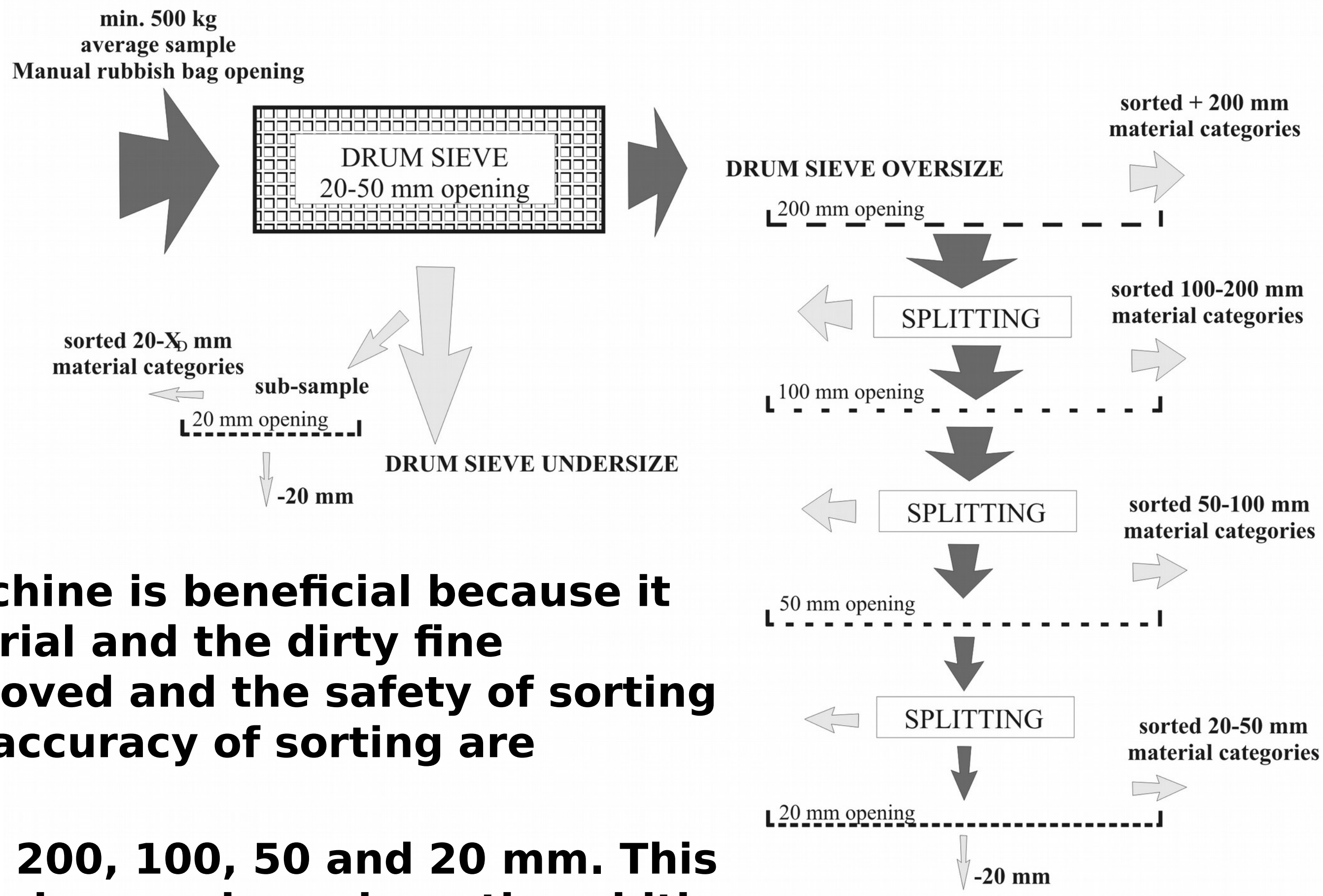
7th International Conference on Sustainable Solid Waste Management 26-29 June 2019, Heraklion, Crete

The developed new protocol for the average sample preparation

Fundamental principle: the mass of fed materials (dark arrows) are not measured.

The mass of processed materials (light arrows) are measured.

Can the total mass balance be calculated? YES



- **A drum sieve machine is beneficial because it loosens the material and the dirty fine fractions are removed and the safety of sorting workers and the accuracy of sorting are increasing.**
- **Used sieves were 200, 100, 50 and 20 mm. This is a so called “2” sieve series, where the width of size fractions practically doubles.**
- **The developed sampling protocol is flexible because after each sieve the mass of the undersize fraction can be reduced by sample splitting.**

Drum sieving in Pusztazámor

ltaneous classification and sorting on different sieves.

200 mm

100 mm

50 mm

20 mm

HERAKLION 2019
26-29 June 2019

7th International Conference on Sustainable Solid Waste Management 26-29 June 2019, Heraklion, Crete

A composition data (example).
More then 1000 tables for the 2017/18 campaigns.

>200 mm

Category	1a food	1b non-food	1c mixed food	1d bio	2 paper	3 cardboard	4 composite	5 textile	6 hygienic	7a 2D	7b PET	7c 3D	8 combustible	9 glass	10a Fe	10b Al	10c Cu	11 inert	12 hazardous	13 <20mm	14 extraneous				
Total	0,47	0,13	0,01	0,88	0,86	0,93	0,16	1,87	1,23	2,42	0,23	0,42	1,09	0,26	0,25	0,06	0,02	0,38	0,12	0,00	0,16	%	∑	**11,94**	%
Packaging from this	0,00	0,00	0,00	0,00	0,19	0,80	0,16	0,01	0,01	2,41	0,26	0,25	0,08	0,25	0,13	0,04	0,00	0,00	0,08	0,00	0,00	%	∑	4,68	%

100 - 200 mm

Category	1a food	1b non-food	1c mixed food	1d bio	2 paper	3 cardboard	4 composite	5 textile	6 hygienic	7a 2D	7b PET	7c 3D	8 combustible	9 glass	10a Fe	10b Al	10c Cu	11 inert	12 hazardous	13 <20mm	14 extraneous				
Total	2,42	0,98	0,21	0,63	2,29	0,73	0,78	1,09	3,67	3,21	1,75	1,47	1,09	1,45	0,87	0,36	0,01	0,82	0,36	0,00	0,13	%	∑	**24,31**	%
Packaging from this	0,00	0,00	0,00	0,00	0,43	0,63	0,77	0,01	0,11	3,15	1,72	1,21	0,07	1,43	0,76	0,34	0,00	0,02	0,27	0,00	0,00	%	∑	10,91	%

50 - 100 mm

Category	1a food	1b non-food	1c mixed food	1d bio	2 paper	3 cardboard	4 composite	5 textile	6 hygienic	7a 2D	7b PET	7c 3D	8 combustible	9 glass	10a Fe	10b Al	10c Cu	11 inert	12 hazardous	13 <20mm	14 extraneous				
Total	2,08	1,20	0,50	0,47	3,52	0,72	0,50	0,43	2,43	1,81	1,42	1,48	0,74	1,56	0,69	0,71	0,01	0,65	0,43	0,00	0,02	%	∑	**21,39**	%
Packaging from this	0,00	0,00	0,00	0,00	0,44	0,57	0,50	0,00	0,58	1,86	1,43	1,24	0,06	1,54	0,63	0,70	0,00	0,02	0,36	0,00	0,00	%	∑	9,91	%

20 - 50 mm

Category	1a food	1b non-food	1c mixed food	1d bio	2 paper	3 cardboard	4 composite	5 textile	6 hygienic	7a 2D	7b PET	7c 3D	8 combustible	9 glass	10a Fe	10b Al	10c Cu	11 inert	12 hazardous	13 <20mm	14 extraneous				
Total	0,55	3,16	0,16	2,34	3,40	0,14	0,22	0,11	0,33	0,91	0,06	0,67	0,56	1,58	0,24	0,37	0,00	0,51	0,46	0,00	0,02	%	∑	**15,80**	%
Packaging from this	0,00	0,00	0,00	0,00	0,46	0,13	0,22	0,00	0,05	1,01	0,06	0,42	0,03	1,37	0,16	0,35	0,00	0,02	0,30	0,00	0,00	%	∑	4,57	%

<20 mm

Category	13 <20mm				
Total	26,57	%	∑	**26,57**	%
Packaging from this		%	∑	**0,00**	%

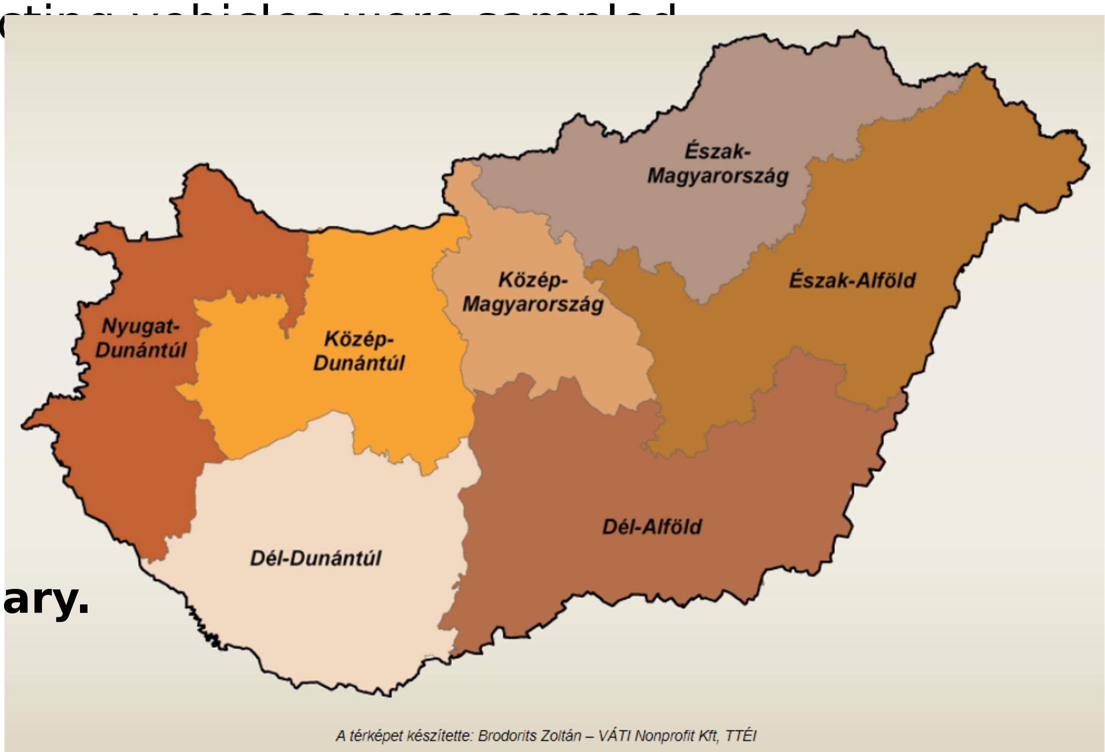
Category	1a food	1b non-food	1c mixed food	1d bio	2 paper	3 cardboard	4 composite	5 textile	6 hygienic	7a 2D	7b PET	7c 3D	8 combustible	9 glass	10a Fe	10b Al	10c Cu	11 inert	12 hazardous	13 <20mm	14 extraneous				
Total	**5,52**	**5,47**	**0,88**	**4,33**	**10,08**	**2,52**	**1,65**	**3,51**	**7,65**	**8,35**	**3,47**	**4,04**	**3,48**	**4,85**	**2,04**	**1,49**	**0,04**	**2,37**	**1,36**	**26,57**	**0,33**	%	∑	**100,00**	%
Packaging from this	**0,00**	**0,00**	**0,00**	**0,00**	**1,53**	**2,14**	**1,65**	**0,02**	**0,74**	**8,42**	**3,47**	**3,12**	**0,23**	**4,59**	**1,69**	**1,43**	**0,00**	**0,05**	**1,01**	**0,00**	**0,00**	%	∑	**30,08**	%

1. BIOLOGICALLY DEGRADABLE. 1a.eatable food waste. 1b. non-eatable part of food. 1c.non-dismantled food waste, 1d.other biologically degradable, 2. PAPERS. 3. CARDBOARDS. 4. COMPOSITES. 5. TEXTILES. 6. HYGIENIC WASTES. 7. PLASTICS. 7a. 2D plastics, 7b. PET, 7c.3D plastics, 8. OTHER NON-CATEGORISED COMBUSTIBLES. 9. GLASSES. 10. METALS. 10a. Fe, 10b. Al, 10c. Cu, 11. OTHER NON-CATEGORISED NON-COMBUSTIBLES (INERT) 12. HAZARDOUS. 13. FINE FRACTION (< 20 mm). 14. EXTRANEOUS MATERIALS.

e data of the Hungarian MSW Campaigns 2017/18

- The new sampling protocol was validated and confirmed by the Entruster in October 2017 in Miskolc - Hejőpapi.
- Samplings were carried out from January to May 2018.
- A regional waste management centre was selected from each of the seven EU statistical regions of Hungary, and at a time 17 RMSW (residual municipal solid wastes) collec
- 10 samplings from a +50000 habitants municipality. 3 samplings from 5000 to 50000; 2 from 1000 to 2000 and 2 from –1000 habitants municipalities.

TS EU statistical regions of Hungary.



e data of the Hungarian MSW Campaigns 2017/18

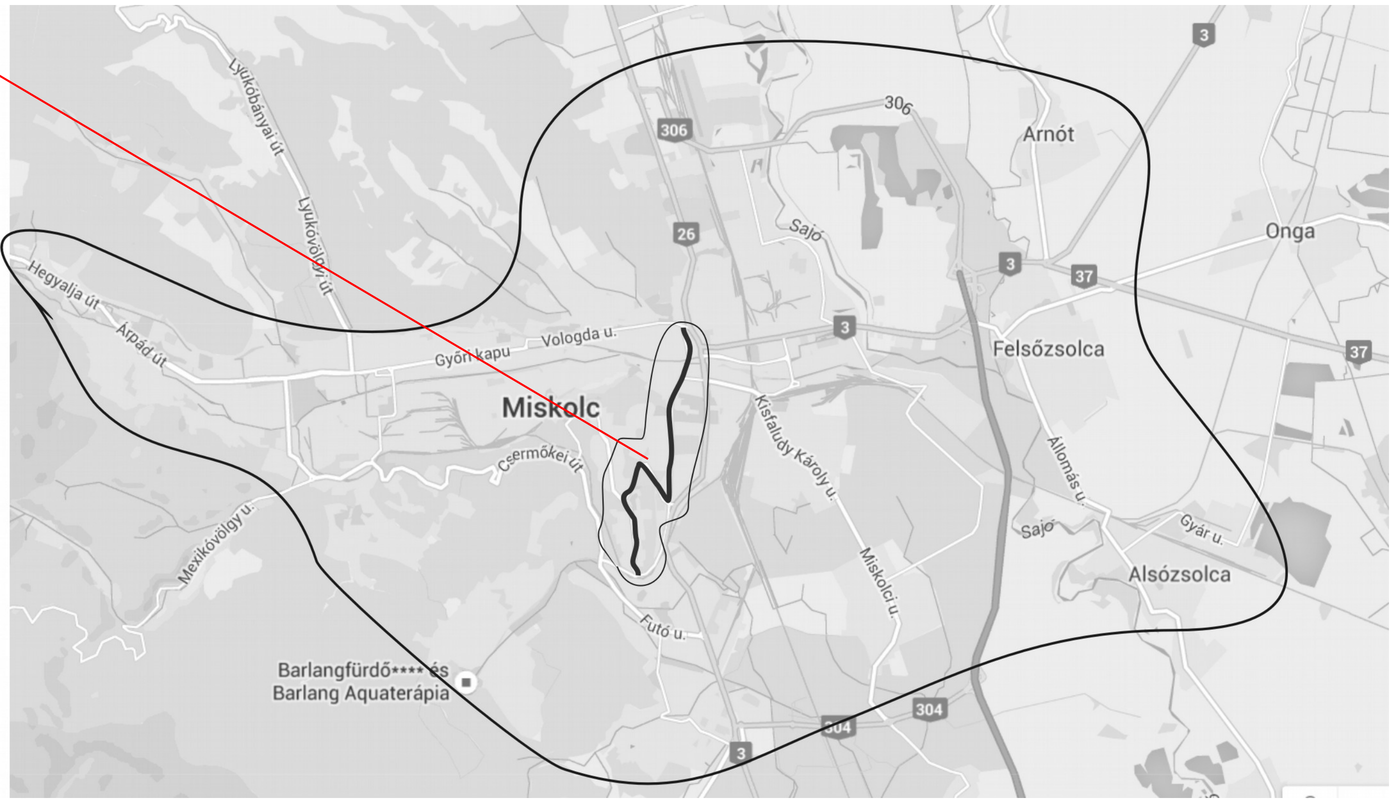
- Altogether 224 vehicles were sampled. The total processed sample volume was: 224 x 3 = **672 m^3**
- The selectively collected MSW streams were not sampled, but the main features of the selective collection (collection area of each SMSW collecting vehicle – called sector, the collected waste streams, their collection frequency, method, containers, etc.) were reported by the public service waste management companies.
- Sampling stratification was made by:
  - Season (2018 winter, 2018 spring)
  - Municipality (municipality level, county level, NUTS regional level, country)
  - Residential structure

tification on the basis of residential structure:

SECTOR (the served area of a waste collecting vehicle):

Number of habitants in a SECTOR from

- Family houses
- Block of flats
- Non-household source



Results: Key parameters of the 2018 winter RMSW campaign.

Dry matter mass concentration	Central-Hungary	North-Hungary	Northern Great Plain	Southern Trans-danubia	Central Trans-danubia	Southern Great Plain	Western Trans-danubia	Hungary
Total food waste content [%]	14.1	15.5	10.9	13.9	10.5	7.7	7.2	**11.9**
Eatable food waste content [%]	9.1	3.8	4.0	4.1	5.4	2.2	4.6	**5.5**
Biologically decomposable materials content [%]	21.1	26.2	21.1	26.8	23.4	16.3	20.3	**20.8**
Total packaging materials content [%]	34.6	28.6	31.8	23.8	32.4	23.1	27.8	**30.1**
Potential secondary raw materials content [%]	41.3	33.9	40.1	31.3	42.2	35.5	39.9	**31.6**
TOC of 13. fine fraction [%]	18.5	18.2	29.8	19.0	27.8	16.1	16.9	**17.3**

The **total food waste content** is the sum of the material sub-categories 1a- eatable food waste, 1b- non-eatable food waste and 1c- non-dismantled (eatable and non-eatable were found together).
The **eatable food waste content** is the material sub-category 1a.
The **biologically decomposable material content** was calculated as the sum of the mass concentration of the sorted 1- biologically decomposable material category plus the TOC times the concentration of the 13- fine fraction.

Results: Key parameters of the 2018 spring RMSW campaign.

Dry matter mass concentration	Central-Hungary	North-Hungary	Northern Great Plain	Southern Trans-danubia	Central Trans-danubia	Southern Great Plain	Western Trans-danubia	Hungary
Total food waste content [%]	11.2	5.6	14.9	14.2	8.1	5.7	15.5	**10.8**
Eatable food waste content [%]	7.8	3.7	3.3	5.9	4.7	2.4	5.7	**5.2**
Biologically decomposable materials content [%]	19.9	21.1	25.2	26.9	33.0	28.0	23.6	**23.4**
Total packaging materials content [%]	35.3	24.6	32.0	23.1	23.5	21.3	26.0	**28.4**
Potential secondary raw materials content [%]	47.8	38.4	38.9	36.6	31.2	28.6	43.1	**31.9**
TOC of 13. fine fraction [%]	27.5	19.7	26.1	29.7	30.2	25.9	30.3	**22.6**

The **total packaging material content** was determined during the processing of the average sample by the applied method described earlier. The **potential secondary raw materials content** was calculated as the sum of the mass concentrations of the 2- papers, 3- cardboards, 4- composites, 7- plastics, 9- glasses and 10- metals material categories.

Conclusion

- Since the introduction of the Hungarian MSW sampling standards in 2005 the waste management have been significantly improved in Hungary.
- A significantly improved average sample preparing protocol have been developed and applied.
- Two validation campaigns, - a winter and a spring time - have been carried out from October 2017 to May 2018. 672 m^3 averaged samples were processed.
- According to the standard protocol the mass of each sample portion is measured during the feed into analysis. According to the new protocol everything is weighted after processing.
- After some initial confusion among sampling experts, - because of this different strategy – the new protocol was successfully applied and results with low margin of errors have been achieved.
- Detailed results of the campaigns are still not public.

Thank You for Your attention!

The described work/article was carried out as part of the „Sustainable Raw Material Management Thematic Network – **RING 2017", EFOP-3.6.2-16-2017-00010 project** in the framework of the Széchenyi2020 Program. The realization of this project is supported by the European Union, co-financed by the European Social Fund.