Implementation of the Shared Environmental Information System principles and practices in the Eastern Partnership countries (SEIS East) - Part on waste statistics

Waste Statistics Guidance:

Estimation of uncollected municipal waste

Framework Contract EuropeAid 132633/C/SER/multi,

LOT 11 - MACRO ECONOMY. STATISTICS, PUBLIC FINANCE MANAGEMENT

SPECIFIC CONTRACT NR 2015/367-903 - ESTAT NR CONTRACT 14465.2015.002-2015.829

February 2018

Contents

Preliminary remarks on the development of the guidance document 3
Guidance document on the estimation of uncollected municipal waste 5
1 Background 4
2 Objective 4
3 Terms and Definitions 4
4 Estimation approach 5
4.1 Relevant variables 5
4.2 The coverage of the MW collection service 5
4.2.1 Sources of information 6
4.2.1.1 Municipalities 6
4.2.1.2 Waste collection companies 6
4.2.1.3 Household surveys 7
4.2.2 Unit 7
4.2.2.1 Inhabitants 7
4.2.2.2 Households 8
4.2.2.3 Addresses 8
4.3 The generation of uncollected waste 8
4.3.1 Estimation of uncollected MW on the basis of the regular MW survey 8
4.3.1.1 Estimation based on the similarity of served and unserved areas 9
4.3.1.2 Estimation of waste generation by households 10
4.3.2 Estimation of waste generation on the basis of waste characterisation studies 11
5 References 12
5.1 Documents used for the preparation of this guidance document 12
5.2 Waste characterisation studies 13

Preliminary remarks on the development of the guidance document

Key to ensure consistency in waste reporting and comparability of municipal waste statistics is a precise definition for municipal waste (MW) that is generally applied. However, comparability also requires the adoption of a common methodology to estimate MSW generation in "areas not covered by official waste collection schemes", which are mainly but not exclusively rural areas.

In the ideal case, the estimate should be made as a function of a set of economic and social factors (coefficients, variables or characteristics - indicators), i.e. by modelling. Factors that are known to have an impact on waste generation include:

- Household characteristics: gender, age, education, location of residence, and household size
- Income: in principle, high-income families consume more and thus produce more waste
- Residential structure and population density
- Weather/seasonal variations

A research for models for waste generation was conducted in order to assess whether existing modelling approaches could be used for the guidance document. The results of the research can be summarised as follows:

- A lot of models to estimate waste generation (per capita) have already been developed. Already a study of 2008 at the University of Wien reviewed 45 existing models, which were very heterogeneous.
- Most of these models are a result of research projects and have the ambition to result in exact figures.
- None of these models are applied by statistical offices or policy makers. This may be because they are not user-friendly enough.
- There is thus not one internationally, widely accepted methodology.
- The development of a user-friendly model would require a large project, by a team of researchers and waste management practitioners, and with extensive consultation of the potential users of the model.

As such a research is not part of the SEIS waste project it was concluded that a more pragmatic approach should be followed. The aim of the work should be to propose a methodology that helps the countries to produce an approximate figure on the waste generation per capita which then can be multiplied by the number of population that is not served by a regular collection service. The methodology should be user-friendly, and therefore simple, but sound. A key requirement is that the possibilities and the limitations of the methodology are transparent.

The following activities were carried out:

1. Literature review
2. Review of the approaches that are adopted in countries that are reporting to Eurostat, based on a review of the Quality Reports (QRs) that they submit to Eurostat and based on the overview of waste collection coverage.
3. Development of a draft methodology, for consultation with the 6 EaP.

The draft guidance document is presented in the following sections.

Guidance document on the estimation of uncollected municipal waste (draft)

1 Background

Eurostat collects annually a set of municipal waste data for the compilation of the indicator "Municipal waste generation & treatment, by treatment method". The municipal waste indicator is part of the EU Sustainable Development Goals (SDGs) indicator set which was established to measure progress towards the SDGs in an EU context.
The annual data collection of Eurostat on municipal waste (MW) covers the EU Member States, the EFTA countries and candidate countries.

The data collection asks for the amount of *'municipal waste (MW) generated'* which comprises the amount of *''MW collected''* plus the amount of *'MW from areas not served by a municipal waste collection service'* (referred to as *"uncollected municipal waste"* in the following).

Obviously, the amount of uncollected waste cannot be directly measured. Therefore, Eurostat asks the countries to produce an estimate on uncollected MW and to add this estimate to the amount of MW collected, as shown in Formula 1.

(1) $MW_{gen} = MW_{coll} + MW_{uncoll}$

with

MW_{gen} = municipal waste generated (t)

MW_{coll} = municipal waste collected (t)

MW_{uncoll} = uncollected municipal waste (t)

2 Objective

This document aims to give guidance on how to produce an estimate on the uncollected municipal waste in an efficient and effective manner.

"Efficient" means that the estimate can be produced in a relatively simple manner, without significant efforts. "Effective" means that the estimate will be relatively precise and in any case sufficiently precise to produce an indicator that is appropriate for statistical and policy purposes.

The guidance does not provide one standard approach but describes and discusses different options. The countries are asked to select the option that suits best their country specific context.

3 Terms and Definitions

Municipal waste collected: Municipal waste collected by or on behalf of municipalities, as well as municipal waste collected by private firms and private non-profit organisations, mainly as part of separate collection systems.

Uncollected municipal waste: Municipal waste from areas not served by a municipal waste collection service (mainly rural areas) even if they are disposed of by the generator himself.

Municipal waste generated: Municipal waste collected plus municipal waste from areas not served by a municipal waste collection service.

Coverage of the municipal waste collection service: Population served by a municipal waste collection service.

Municipal waste survey: Data collection for the regular production of MW statistics in a country. The municipal waste survey may be a statistical survey under the responsibility of the Statistical Office or an administrative data collection by the Ministry responsible for MW management.

Reporting unit: The legal or administrative unit that has to report data on MW collection in the frame of the municipal waste survey. The reporting units are either the municipalities or the companies that collect the waste on their behalf.

4 Estimation approach

4.1 Relevant variables

The estimate of the uncollected MW is based on two variables:

1. The population, i.e. the number of inhabitants, that is not covered by a MW collection service;
2. The average amount of waste generated per inhabitant not served by a MW collection service.

The uncollected MW is then calculated according to Formula 2:

(2) $$MW_{uncoll} = \frac{mw_{uncoll}}{1\,000} \times P_{nserv}$$

with

MW_{uncoll} = uncollected municipal waste (t)

mw_{uncoll} = estimate for the municipal waste generated per inhabitant not served, per year (kg/inh., a)

P_{nserv} = total population not served (no. of inhabitants)

Both variables have to be accurately determined in order to achieve an effective estimate. The determination of the two variables is discussed in the following two separate chapters.

4.2 The coverage of the MW collection service

In general, the non-covered population is determined indirectly by determining the population served and then subtracting the served population from the total population (see Formula 3).

(3) $$P_{nserv} = P - P_{serv}$$

with

P = total population (no. of inhabitants)

P_{serv} = total population served (no. of inhabitants)

P_{nserv} = total population not served (no. of inhabitants)

The most efficient way to determine the population served is to collect the required information as part of the regular MW survey. The advantages of this approach are obvious: the data collection requires no additional survey and the information is regularly updated.

The prerequisite for this approach is that the information is available to the reporting units of the MW survey in sufficient quality. Sufficient means that the information should be up-to-date and based on solid information like, for instance, client registries or contracts. The quality of the coverage data should be thoroughly checked in the course of the regular data validation, as inaccurate coverage information has a strong impact on the quality of the estimate. The data collection should consider which is the most appropriate unit to collect the information (i.e. the number of addresses, households or inhabitants). The different units and their pros and cons are discussed in section 4.2.2.

If it is not possible to collect the coverage information via the MW survey, the respective data have to be collected separately. The preferred source is the municipality which should have this information available, being the responsible body for waste management. Alternatively, the information can be collected directly from the households, e.g. as part of a census, a household budget survey or other household surveys. The different data sources are described and discussed in section 4.2.1.

4.2.1 Sources of information

Possible sources for information on the population served are:

- Municipalities (local governments);
- Waste collection companies, which can be municipal or private;
- Households.

4.2.1.1 Municipalities

The Municipalities are in general legally responsible for MW collection and management. Municipalities collect either the waste themselves (i.e. through municipal service departments or municipal waste collection companies) or contract a private company to collect upon their behalf. They will thus have or have access to the information on the coverage of the MW collection service. The municipalities are therefore the recommended source of information.

Where the municipalities collect the waste themselves, the information should in principle be directly available in accurate and up-to-date form and in the unit '"number of inhabitants served". Where the municipalities have contracted private companies, they should contractually oblige them to provide the information on a regular basis.

The municipalities are thus the preferable information source for several reasons:

- They are in the best position to have the requested information available.
- They should have a strong own interest in this information.
- A complete list of municipalities is easy to obtain and to maintain.

4.2.1.2 Waste collection companies

If the information on the population served in a municipality cannot be collected from the municipality itself, waste collection companies may be an alternative information source, provided that they have a reliable information base for the required information

Waste collection companies know at least the areas and the addresses they serve. Whether they have reliable information on the number of households and / or the number of inhabitants that are living at the addresses and that they are serving depends on the assessment unit that is used to determine the level of the waste collection charges.

Waste collection charges require the waste generator to pay a rate to the waste collection service providers. These charges, which can be referred to as "user charges", are directed at full or partial recovery of the costs associated with the collection, recycling and disposal of waste for which (local) governments are responsible.

The level of the charges can be based on different assessment units:

- Flat-rate charges (per household).
- Variable-rate charges, which are not related to the service level, but are for example based on the size of the building or estate, on the household income or on the number of people living in a household.
- Service-related charges (often referred to as PAYT or "Pay-as-You-Throw"), that vary according to the level of service, the volume or weight of waste collected and or the level of segregation at source. Service-related rates are preferable, as they have the greatest potential to influence the behaviour of households (e.g. households can be rewarded for their segregation efforts, through a higher rate for mixed waste than for source segregated dry recyclable materials). However, service-related charges are not yet applied in the EaP countries.

To gather the information on the collection coverage from collection companies is certainly efficient where the collectors are the reporting units for the MW survey. An additional data collection can thus be avoided. To ensure the accuracy of the information, particular attention should be paid to the validation of the data through plausibility checks and comparison of data with previous years.

4.2.1.3 Household surveys

Information on the population served in a municipality may be collected directly from households as part of household surveys that are usually carried out in intervals by statistical offices to collect information on different aspects of life.

Advantages of a household survey are that it provides first-hand information on the number of persons served and allows to collecting additional waste-related information (e.g. information on the treatment of the uncollected waste) that is relevant for policy purposes.

Disadvantages are that household surveys are often carried out at longer intervals and will thus not provide recent information. Data collection is also more time- and labour-consuming and thus more expensive than the options discussed above.

4.2.2 Unit

The coverage of the MW collection service can be determined on the basis of different units:

- the number of inhabitants served;
- the number of households served;
- the number of addresses served.

4.2.2.1 Inhabitants

The number of inhabitants is the preferred unit for the determination of the collection coverage. Whether the number of inhabitants that are served is known will depend on the available sources of information and types of information as discussed in section 4.2.1.2.

The number of inhabitants can be directly used for the calculation of the uncollected MW (see Formula 2) and does not have to be converted as is necessary for information based on the number households or addresses.

4.2.2.2 Households

The 'households' may be the appropriate unit for the desired information where the number of inhabitants served is not known to the reporting unit. This may be the case where flat-rate charges are applied, or variable rate charges that are not based on the number of inhabitants.

To determine the number of inhabitants served or not served, it is necessary to convert the number of households into the number of inhabitants, e.g. by means of the average size of households. Information on the household size is usually available from official statistics (e.g. from the population census).

It has to be noted that the size of households may vary between urban and rural areas. The conversion should therefore be done at the municipal level if data on the average household size are available at this level. The conversion should at least consider the differences of the average household size between rural and urban areas. The lack of accurate and / or up-to-date information on the household size may lead to a significant error of the coverage information.

4.2.2.3 Addresses

The population served by municipal waste service can be calculated as the percentage of addresses within a municipality where regularly household waste is collected by or on behalf of the municipal authorities. This approach is recommended by the OECD/Eurostat Joint Questionnaire, presumably because the information on addresses served is usually available to waste collectors. Waste containers are usually assigned to an address so that the number of addresses equals the number of pick-up points for the collection vehicle.

However, the number of inhabitants under one address may be considerably higher in urban areas than in rural areas. The coverage per address will in this case deviate from the coverage related to inhabitants. As for the unit 'households', the number of addresses served has to be converted into the number of inhabitants served. For 'addresses', however, this conversion is more error-prone than for households as an average number of inhabitants per address can hardly be determined.

4.3 The generation of uncollected waste

This section describes different options how to determine the second variable, i.e. the average generation of waste per inhabitant. In the following, a distinction is made between the following two approaches:

- the estimation of the uncollected MW on the basis of the regular MW survey (see section 4.3.1);
- the estimation of the uncollected MW based on waste characterisation studies (see section 4.3.2).

To estimate the uncollected waste on the basis of the regular MW survey is certainly an efficient approach but has one major drawback: Inaccuracies or errors of the collected data will be incorporated in the estimate and may even be multiplied through the estimation. This problem can be avoided when the estimation is based on factors that are determined independently from the MW survey.

4.3.1 Estimation of uncollected MW on the basis of the regular MW survey

The regular MW survey provides information on the amount of MW that is collected by or on behalf of the municipalities. In combination with the information on the collection coverage the average waste generation per inhabitant served by the collection service can be calculated as follows:

(4) $$mw_{coll} = \frac{MW_{coll}}{P_{serv}} \times 1000$$

with

mw_{coll} = municipal waste generated per inhabitant served, per year (kg/inh., a)

MW_{coll} = municipal waste collected (t)

P_{serv} = total population served (no. of inhabitants)

Assuming that the collection service covers mainly urban areas, this average value will represent predominantly the waste generation in urban areas and may thus not be representative for the whole country.

Usually, it is assumed that MW generation in rural areas is lower than in urban areas, e.g. because of:

- different consumption patterns, e.g. more food self-supply and lower consumption of packaged goods;
- a lower share of municipal waste from commercial or administrative sources, given that there are less such sources.

The differences between rural and urban areas are therefore considered as an important aspect for the estimation of the uncollected waste.

In the following, two estimation approaches are presented:

1. An estimation based on the similarity of served and unserved areas;
2. An estimation for waste from households only.

The first approach requires data on MW collection from areas that are similar to those not served. The estimate includes all MW, i.e. the MW from households and from other sources.

The second approach produces an estimate for the MW from households only. It requires data on the amounts of MW that come from households and MW that comes from other sources. No data from similar regions are needed.

4.3.1.1 Estimation based on the similarity of served and unserved areas

The idea of this approach is to estimate the average waste generation per inhabitant in the areas not covered on the basis of data from 'similar' areas that are served by collection and for which therefore data are available. 'Similarity' is understood in the following mainly as similarity with regard to the typology of the region, i.e. the distinction between rural and urban areas. Similarity could also be defined with regard to the level of income or other factors that are known to correlate with the level of waste generation.

There are two prerequisites for this approach:

- Information on the collection coverage is available separately for urban and for rural areas;
- There are enough rural areas covered by collection to produce a stable and reliable estimate for the non-covered areas.

If these two prerequisites are present, the waste generation per inhabitant for rural areas can be calculated as follows:

(5) $$mw_{rural} = \frac{MW_{coll,rural}}{P_{serv,rural}} \times 1000$$

with

mw_{rural} = municipal waste generated in rural areas per inhabitant, per year (kg/inh., a)

$MW_{coll,rural}$ = municipal waste collected in rural areas (t)

$P_{serv,rural}$ = total population served in rural areas (no. of inhabitants)

In the second step, the total amount of waste generated in rural areas can be calculated as follows

(6) $$MW_{rural} = \frac{mw_{rural}}{1000} \times P_{rural}$$

with

MW_{rural} = municipal waste generated in rural areas (t)

mw_{rural} = municipal waste generated in rural areas per inhabitant, per year (kg/inh., a)

P_{rural} = population in rural areas (no. of inhabitants)

An estimate for waste generation in urban areas can be produced accordingly, if necessary.

Good-practice example: Turkey

In Turkey, MW collection is carried out in municipalities and covers 93% of the population (2014). MW collection does generally not exist in villages. In addition, there exist some municipalities that provide no MW collection services at all and some municipalities where the collection does not cover the whole population.

Turkey produces a specific estimate on the MW generation for each of the three cases as follows:

1. Uncollected MW from villages is estimated based on the median of the MW collected per inhabitant from municipalities having a population of less than 2 000 people.
2. For municipalities providing MW collection services but not covering the whole municipal population, estimations for MW generation are made by enlarging the collected amount to the total population for each municipality (i.e. if a municipality is serving 80% of the population and collecting 100 tonnes of MW, then the total MW generation is estimated to be 125 tonnes)
3. For municipalities not providing any MW collection services, the amount of MW collected per inhabitant in municipalities with a population between 2000 and 5000 inhabitants is calculated. The estimation is made by multiplying this per-capita amount with the population not receiving any waste collection services.

The three estimates are added to the total amount of MW collected and reported as estimate for the total amount of MW generated in Turkey.

4.3.1.2 Estimation of waste generation by households

This estimation is based on the assumption that the per-capita generation of waste from households is similar across the country but that the amount of MW generated by other sources may vary significantly (i.e. MW generated from other sources high in urban areas and low or insignificant in rural areas). Accordingly, one estimator for the MW generation by households is produced for all areas, excluding MW from other sources than households.

The prerequisite for this approach is that the MW survey provides information on the share of waste from households and from other sources. It is generally useful to collect this information but it should be taken into account that the information is usually not very precise as mostly based on estimates of the collection companies. The share of MW from other sources than households may vary

considerably from country to country. In OECD countries, for instance, the share of MW from other sources ranges between 8% and 48% of the total MW generated (2015)[1].

Based on these considerations the generation per inhabitant of MW from households can be calculated according to Formula 9:

(7) $$mw_{hh} = \frac{MW_{coll} - MW_{coll,other}}{P_{serv}} \times 1000$$

with

mw_{hh} = municipal waste generated from households per inhabitant, per year (kg/inh., a)

MW_{coll} = municipal waste collected (t)

$MW_{coll,other}$ = municipal waste collected from other sources than households (t)

P_{serv} = total population served (no. of inhabitants)

The uncollected waste is then determined as follows:

(8) $$MW_{uncoll} = \frac{mw_{hh}}{1000} \times P_{nserv}$$

with

MW_{uncoll} = uncollected municipal waste (t)

mw_{hh} = municipal waste generated from households per inhabitant, per year (kg/inh., a)

P_{nserv} = total population not served (no. of inhabitants)

As outlined above, this estimation approach neglects the municipal waste from other sources than households in the areas not covered.

4.3.2 Estimation of waste generation on the basis of waste characterisation studies

Waste characterisation studies are studies that aim to determine the amount and the material composition of municipal waste generated in a defined area. Waste characterisation studies are carried out to generate data needed for waste management policy and planning. Depending on the design, such studies can provide specific information on different types of areas that can be used to estimate the amount of waste generated in similar areas. If a waste characterisation study would be conducted in one or more rural areas, the resulting data could be used for all other rural areas.

Waste characterisation studies are based on the representative sampling and the subsequent sorting of waste. In order to determine the waste generation, it might be necessary to weigh the total collected waste in the surveyed areas in addition to the sampling. By sorting of the waste, the composition can be determined. In order to cover the seasonal variation of the amount and the composition of waste, a waste characterisation study usually consists of up to four sorting campaigns carried out over the period of one year.

The methodological framework of waste characterisation studies is complex. Different methodologies have been developed in different countries. A standardised methodology for the analysis of solid municipal waste, referred to as 'Solid Waste Analysis Tool' (SWA-Tool), has been developed and tested in a EU research project, carried out in the European Commission Fifth Framework Programme.

[1] OECD database (https://data.oecd.org/waste/municipal-waste.htm)

The methodology establishes minimum standards that a waste analysis should always meet, such as sampling approach, sorting procedures, sorting categories and definition of statistical accuracy and common reporting guidelines. The methodology takes into account the different conditions in the countries with regard to collection systems.

The article from ZWIESELE et. al (2013) on *"Waste characterization studies in waste management municipality unions in Turkey"* (see list of references in section 5.2) describes the performance of characterisation studies adapted to the conditions in Turkey and illustrates the information that can be obtained.

Section 5.2 of the reference list provides the link to the description of the SWA-tool and to documents on further methodologies for waste characterisation studies.

5 References

5.1 Documents used for the preparation of this guidance document

- Eurostat, 2015: Municipal waste statistics – How to deliver data. Luxembourg, 18 September 2015
- Eurostat, 2017: Guidance on municipal waste data collection, May 2017
- Eurostat: Municipal waste reporting – Data quality / methodology report
- Joint OECD/Eurostat questionnaire on the state of the environment - Waste (Q14-8-SW.XLS)
- SALADIÉ, Ò. Determinants of waste generation per capita in Catalonia (North-eastern Spain): the role of seasonal population. *European Journal of Sustainable Development* (2016), **5**, 3, 489-504. DOI: 10.14207/ejsd.2016.v5n3p489
- Environmental Protection Agency (EPA) Ireland (2014) National Waste Report 2012 p.71-99. ISBN: 978-1-84095-550-7 08/14/250
- KAWAI, K. and TASAKI, T. (2015) Revisiting estimates of municipal solid waste generation per capita and their reliability. *Journal of Material Cycles and Waste Management* [2016], Vol. 18, Issue 1, pp 1-13. DOI 10.1007/s10163-015-0355-1
- ESTONIA, Statistical Office of Estonia (2002) Statistical work on development a methodology for determination of waste generated in non-covered areas by the waste collection system and the estimation of generated municipal waste quantities – Final report.
- European Commission DG Environment (2014) Development of a modelling tool on waste generation and management – Headline project report.
- DAS, S. and BHATTACHARYYA, B.K. (2014) Estimation of municipal solid waste generation and future trends in greater metropolitan regions of Kolkata, India. *Journal for Industrial Engineering and Management Innovation*, Vol. 1, No. 1 (October 2014), 31-38. DOI: 10.2991/jiemi.2014.1.1.3
- GRBEŠ, A. (2017) Selection of variables for the Croatian municipal solid waste generation model. *The Mining-Geology-Petroleum Engineering Bulletin*, pp. 55-69. DOI: 10.1177/rgn.2017.3.6
- BEIGL, P., LEBERSORGER, S. and SAHLHOFER, S. (2007) Modelling municipal solid waste generation: A review. *Waste Management (2008) 200-2014*. DOI: 10.1016/j.wasman.2006.12.011
- KOLEKAR, K.A., HAZRA, T. and CHAKRABARTY, S.N. A review on prediction of municipal solid waste generation models. *Procedia Environmental Sciences 35 (2016) 238-244*. DOI: 10.1016/j.proenv.2016.07.087
- KLOEK, W., KÜCHEN, V. and MEHLHART, G.F. (2010) Municipal waste in the EU 1995 to 2008: Progress towards sustainability? *ISWA World Congress – Urban Development and Sustainability – a Major Challenge for Waste Management in the 21st Century.*

- MIHAI, F., GHIURCA, A.A. and LAMASANU, A. (2015) Estimation of urban waste generated and uncollected in Romania. *Analele Universit_at_ii din Oradea, Fascicula Protect_ia Mediului, Universitatea Oradea, 2011, 17 (2), pp.719-724.* https://hal.archives-ouvertes.fr/hal-01151132
- The World Bank (2012) What a waste: A global review of solid waste management. http://siteresources.worldbank.org/INTURBANDEVELOPMENT/Resources/336387-1334852610766/What_a_Waste2012_Final.pdf

5.2 Waste characterisation studies

- European Commission (2004) Methodology for the Analysis of Solid Waste (SWA-Tool) - User version. https://www.wien.gv.at/meu/fdb/pdf/swa-tool-759-ma48.pdf
- *ASTM International (2008*) Standard Test Method for Determination of the Composition of Unprocessed Municipal Solid Waste. standard is issued under the fixed designation D5231
- Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft (2017) Leitfaden für die Durchführung von Restmüll-Sortieranalysen.
- DIN EN 14899 (2006) Characterization of waste - Sampling of waste materials - Framework for the preparation and application of a sampling plan
- CARADEME - Guide pour la réalisation de campagnes de caractérisation des Déchets Ménagers et Assimilés (DMA)
- ZWIESELE, Dr.-Ing. B., SCHWETJE, Dipl.-Ing. A. (May 2013) Waste characterization studies in waste management municipality unions in Turkey – methodology and results. *Istanbul International Solid Waste, Water And Wastewater Congress.*