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Conference of the Parties to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal
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Agenda item 4 (b) (iii)

Matters related to the implementation of the Convention: scientific and technical matters: national reporting

Practical guidance on the development of inventories of plastic waste

Note by the Secretariat

At its fifteenth meeting, the Conference of the Parties to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal took note of, in decision BC-15/13 on national reporting, the practical guidance on the development of inventories of plastic waste, on the basis of the draft guidance contained in document UNEP/CHW.15/INF/19. The text of the final version of the practical guidance, as taken note of by the Conference of the Parties, is set out in the annex to the present note. The present note, including its annex, has not been formally edited.

* In accordance with decisions BC-15/1, RC-10/2 and SC-10/2 of the conferences of the Parties to the Basel, Rotterdam and Stockholm conventions, the 2021/2022 meetings of the conferences of the Parties are being held in two segments: an online segment held from 26 to 30 July 2021 and a face-to-face segment to be held from 6 to 17 June 2022 in Geneva.

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Annex

Practical guidance on the development of inventories of plastic waste

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1 Introduction

1. Parties to the Basel Convention are required under Article 13, paragraph 3 of the Convention to annually transmit to the Conference of the Parties a national report on information related to the measures taken towards its implementation. Undertaking inventories can be an effective way of gathering information on the generation, transboundary movements, and management of hazardous wastes and other wastes for the purpose of national reporting. Such information, and other relevant information, should be submitted through the Secretariat of the Convention, using the national reporting format.[1]

2. This guidance aims to provide practical instructions to assist Parties and others in developing inventories of plastic waste. It is meant to be used in conjunction with the Methodological guide for the development of inventories of hazardous wastes under the Basel Convention,[i] which provides complementary guidance on the methods of developing national inventories for the preparation of national reports. Accordingly, this guidance proposes an approach for developing an inventory that is consistent with the one contained in the Methodological guide.

3. The main objective of developing a plastic waste inventory is to obtain information on the amount of plastic waste generated at a country level, as well as its disposal and transboundary movement. Having a clear picture as to which wastes are generated and the quantities that need to be managed provides the basis for their environmentally sound management (ESM).[ii] This information can be used to develop appropriate strategies and policies including for the collection and disposal of plastic waste and is an important input into the planning of facilities for recovery and final disposal that require substantial financial investment and regular throughputs of wastes. In addition, the development of the inventory can provide insight into the effectiveness of the system in place in a country to regulate the transboundary movement of plastic waste. The conducting of inventories should be streamlined with the process of developing national policies, legislation, planning and implementation of environmentally sound management of hazardous wastes and other wastes.

2 Description of plastics and their wastes

2.1 Classification of plastic waste

4. For developing the inventory, establishing a classification of wastes that is used consistently will help ensure comparability of inventory information collected from various sources and over the years. Adopting a classification that is applied nationally to compile statistics on key parameters of the inventory methodology will also facilitate the development and regular update of the inventory. Wastes can also be classified in a way that serves the objectives of developing the inventory, such as for the planning of recycling and disposal facilities. The format for national reporting under the Basel Convention requires that some of the information provided be categorized according to the codes of Annexes I, II Annex VIII as well as Annex IX to the Convention. Understanding the correspondence between a classification used for the inventory and the annexes to the Basel Convention will therefore make it easier to integrate the inventory results into the national report. The Basel Convention contains three main entries on plastic waste: Y48 (Annex II), A3120 (Annex VIII) and B3011 (Annex IX). The Technical guidelines on the environmentally sound management of plastic wastes[iii] provide an indicative list of other entries in Annex I, II, VIII, and IX to the Convention that are relevant to plastic waste.

5. Information on the total amount of hazardous wastes and other wastes generated is requested in Table 6 of the national reporting format. Parties have the option of providing detailed information concerning specific hazardous wastes, categorized according to the codes of annexes to the Basel Convention or national codes. Further instructions can be found in the manual for completing the format for national reporting under the Basel Convention.[iv]

2.2 Plastics and their applications

6. Plastics consist of a variety of polymers that are mixed with many types of additives to achieve desirable quality in performance for use in various applications across many sectors, including: packaging, transportation, building and construction, electronic and electrical equipment, consumer and institutional, industrial machinery, textiles.[iii,v]

[1] UNEP/CHW.12/INF/16/Rev.1; available at: http://www.basel.int/Countries/NationalReporting/tabid/8754/Default.aspx.

7. Polypropylene (PP) and low-density polyethylene (LDPE) account for estimated 21% and 20%, respectively, of the global plastic production, followed by high-density polyethylene (HDPE, 16%), polyvinylchloride (PVC,12%), and polyethylene terephthalate (PET,10%). The total primary production of plastics used by economic sector is estimated as follows: packaging (163 Mt), building and construction (73 Mt), textiles (67 Mt), consumer and institutional products (47 Mt), transportation (30 Mt), electrical/electronic (20 Mt), and industrial machinery (3 Mt).[vi]

8. For the development of an inventory and the assessment of its results, it is helpful to identify the main actors involved and understand their role in the waste management system, how they are organized and their impact on the flow of waste. An overarching framework is presented in figure 1 to visualize the plastic material flows through the economy. In the framework, four phases are considered: production, consumption, waste generation and waste management.

9. Plastic waste generated during the production phase is industrial or manufacturing waste (flow ‘c’ in figure 1). Such waste, also sometimes referred to as pre-consumer plastic waste, is generated during the manufacture of virgin plastics from raw materials (oil, natural gas, bio-based etc.) and from the conversion of plastics into plastic products. Examples of industrial plastic waste are off-specification material and/or might include material that has the wrong color, wrong hardness, or wrong processing characteristics. In the consumption phase, products consisting of or containing plastics are consumed (flow ‘a’ in figure 1). When products are disposed of by consumers, they become post-consumer waste (flow ‘b’ in figure 1). The larger fraction of plastic waste is comprised of post-consumer waste, with the largest share originating from the packaging sector in many countries.[v]

10. A proportion of the plastic waste is unmanaged (flow ‘d’ in figure 1). The remaining proportion of the plastic waste is collected and managed through waste management channels (flow ‘e’ in figure 1), through recycling (flow ‘g’ in figure 1), incineration, or landfilling (flow ‘h’ in figure 1). Imports and exports of plastic waste are shown as flow ‘f’.

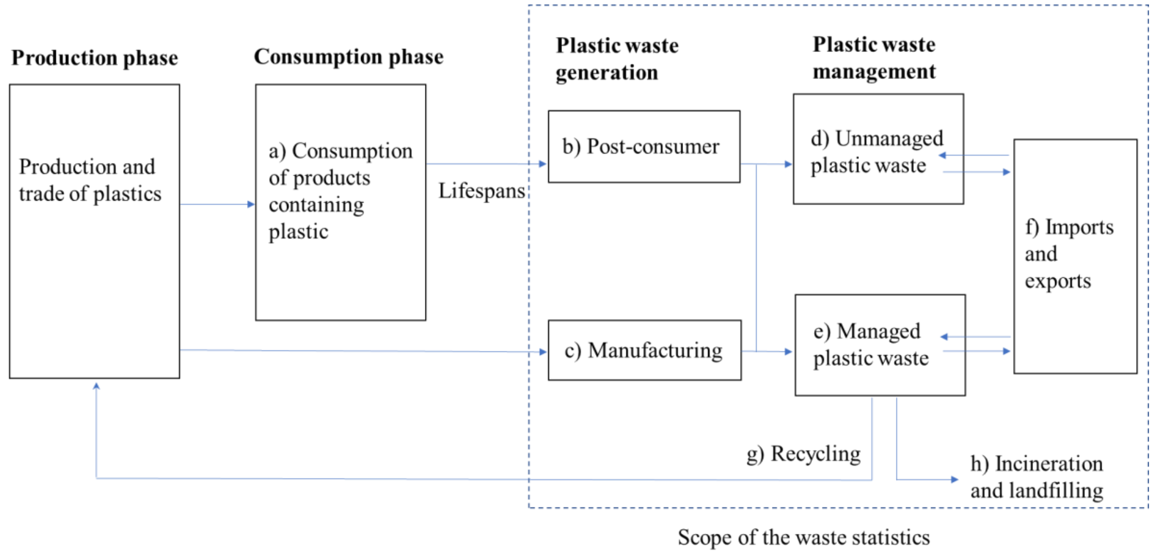

Figure 1. Framework for the flow of plastic through the economy

11. Compiling waste statistics for the flows illustrated in figure 1, typically uses a variety of methodologies and data sources. The process can be rather complex and resource-intensive, as several data sources must be integrated, and remain a challenge in many countries.[vii] The data sources can vary from business and household surveys to the use of administrative records. Many countries that currently compile waste statistics have mechanisms for data collection based on mandatory reporting requirements and monitoring of national waste management plans.

3 Defining the scope of the inventory

12. Important considerations in defining the scope of the inventory include: its purpose (including for completing the national report under the Basel Convention), desired outcomes, category of applications of plastic waste to be included, geographical area to be covered and specific exclusions and limitations due to e.g. access to information sources.

4 Methodologies for developing the inventory

13. Given the scale of pollution arising from the mismanagement of plastic waste and the urgency of addressing this problem, many approaches have been developed in recent years to assess the generation of plastic waste and its fate. These approaches vary in their objectives, scope of plastic waste addressed, the complexity of methodologies proposed and the amount of information needed for their implementation. An overview of some of these approaches is presented in annex 1 to this guidance. Two main types of methodologies, sometimes applied in combination, are typically applied for preparing plastic waste inventories:

(a) A 'product lifetime' approach which entails using production and trade data, from sources such as national production statistics and international trade datasets, and combining this with product lifetimes to estimate likely plastic waste generation by sector;

(b) A 'material flow analysis' (MFA) approach which focuses on estimating the flows of plastic waste within the boundaries of a system, with reliance on data from field studies of the generation of waste and its management and/or proxy data from similar contexts.

14. The product lifetime methodology provides information on plastic waste generation. It uses existing production and trade data sets and therefore typically requires less time and resources but does not consider how wastes are managed. The MFA methodology can be more resource intensive as it requires information from various points in the waste management system and its accuracy relies on primary data collection. It describes how plastic waste flows from the point of generation and into the waste management system, and thus provides an insight into its 'management and potential leakage into the environment. The choice of methodology is to be considered during the scoping phase of the inventory preparation taking into account the purpose of the inventory and resources available.

15. This guidance proposes three practical methodologies for the inventory of plastic waste, to provide flexibility to a wide range of Parties with varying priorities and capacities. The first two methodologies (sections 4.1 and 4.2) aim at estimating plastic waste generation and the third (section 4.3) aims at mapping of flows of plastic waste arising from sources of generation. The methodologies draw on several approaches that have been applied in various countries. Considering the complexity of plastic waste and its flows through the economy, applying the methodologies can be challenging. Practical tools have therefore been developed that should facilitate the use of these methodologies for developing first-generation inventories of plastic waste (see below).

4.1 Product lifetime methodology

16. This methodology uses existing data on domestic production and trade statistics for products containing plastic to compute modeled data on plastic waste generation for a region or a country. This approach is also sometimes referred to as the consumption-lifespan method. An advantage of this methodology is that the needed statistics (such as customs data) are available in most countries. It thus provides the basis for a harmonized approach for estimating plastic waste generation that can improve data comparability among countries and contribute to monitor progress towards the achievement of Sustainable Development Goals. An overview of the methodology is provided below and illustrated in more detail in annex 2. To assist Parties in applying the methodology, a spreadsheet-based tool and user manual have been developed and are accessible on the website of the Basel Convention.[2]

17. The inventory is developed in two steps:

Step 1: Estimation of plastic products put on the market (consumption) based on import/export and production statistics;

Step 2: Calculation of plastic waste generated based on the age of products (lifespan) and the probability of such products becoming waste.

4.1.1 Collecting information on plastic consumption

18. The product lifetime methodology determines the consumption of products using the 'apparent consumption methodology' as shown in equation 1.

Eq. 1 Apparent consumption = Domestic production + Imports – Exports

19. For a first-generation inventory, data can be obtained from existing statistics on trade and production of plastic products, possibly complemented by scenario-based expert estimates where data gaps are found.

[2] http://www.basel.int/Countries/NationalReporting/Toolkitsforwasteinventory/tabid/9043/Default.aspx.

20. Information on the trade of products is recorded on the basis of the Harmonized Commodity Description and Coding System[3] (HS) in most countries. The data on imports and exports of products classified in the HS can be retrieved from the Comtrade Statistics database.[4] In addition, individual countries may collect data in a more detailed national classification that is conceptually harmonized and consistent with the HS. National statistical offices, customs authorities and ministries of finance are typically the holders of such information. Examples of relevant HS codes used for classifying products in the packaging category include: 3923.10 (Boxes, cases, crates and similar articles for the conveyance or packaging of goods, of plastics) and 2201 (Waters, including natural or artificial mineral waters and aerarated waters, not containing added sugar or other sweetening matter nor flavoured; ice and snow).

21. Data on domestic production can in some countries be obtained from national statistical offices. At the global classification of goods and services is based on the Central Product Classification (CPC)[5] which constitutes a complete product classification covering goods and services. It serves as an international standard for assembling and tabulating many types of data requiring product detail, including statistics on industrial production. It provides a framework for international comparison and promotes harmonization of various types of statistics related to goods and services. Statistical offices may maintain national version of the CPC which are linked at national level to domestic industrial production statistics. Statistical offices or the ministry of industry are typically the holders of such information.

22. At the global level, there exists correspondence table between the CPC and HS classifications.[6] The linkages of the national nomenclatures to those used at the global level provides a common basis for collecting the information needed for estimating apparent consumption of plastic products, as illustrated in figure 2.

23. For selected HS codes relevant for the inventory, annual trade data in the relevant units (weight or number of items) are collected. For corresponding CPC codes, the country specific linkage to the national version of industrial production statistics is to be established, so as to retrieve the data on domestic industrial production. These steps are illustrated in the practical example in annex 2.

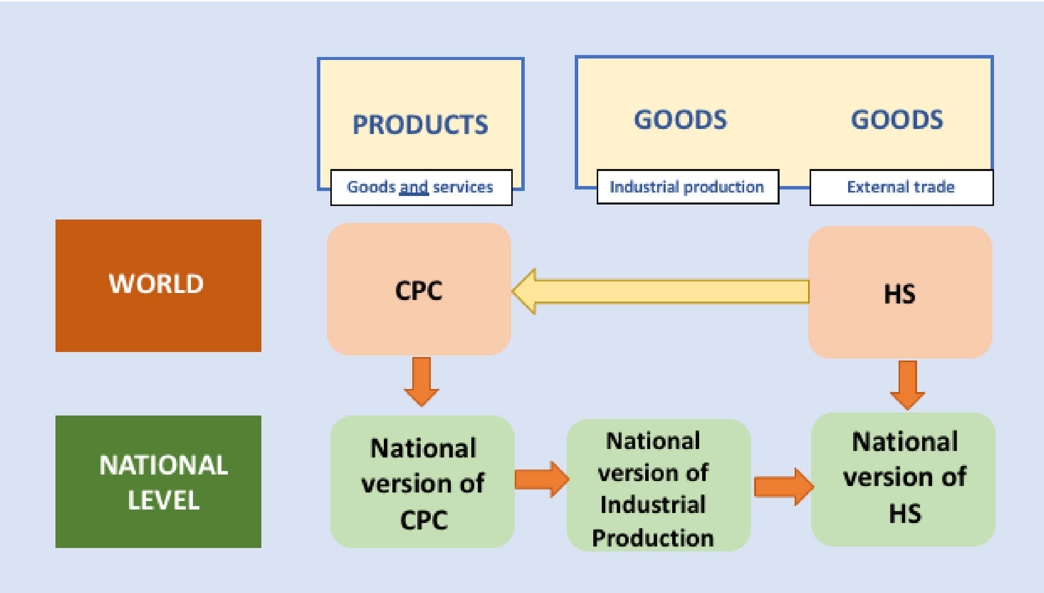

Figure 2. Relations between product classifications. Adapted from Eurostat[7]

4.1.2 Estimating plastic waste generation

24. In the next step, the plastic waste generated in year *n* is calculated by applying a probability function that relates the consumption to the moment of disposing of plastic products. This is often referred to as the lifespan distribution. In this step, the fraction of plastics (f) in the product, the

[3] http://www.wcoomd.org/en/topics/nomenclature/overview/what-is-the-harmonized-system.aspx.

[4] United Nations Comtrade Database, https://comtrade.un.org/.

[5] https://unstats.un.org/unsd/EconStatKB/KnowledgebaseArticle10133.aspx.

[6] https://unstats.un.org/unsd/classifications/business-trade/correspondence.asp.

[7] EUROSTAT. Integrated System of Activity and Product Classifications. https://ec.europa.eu/eurostat/ramon/miscellaneous/index.cfm?TargetUrl=DSP_GENINFO_CLASS_3.

consumption of the product in the previous years and the lifespan per product are multiplied, as shown in equation 2.

Eq. 2 $$Plastic\ Waste\ Generated\ (n) = \sum_{t=t0}^{n} f * Apparent\ Consumption(t) * L^{p}\ (t,n)$$

25. The lifetime $L^{p}\ (t,n)$ is the lifetime distribution of a plastic product P sold in year *t*, which reflects the probable rate of becoming waste in evaluation year *n* of the inventory. The lifetime distribution for a product could be modelled using several probability functions. For the current guidance, a Gaussian distribution, is used, as shown equation 3 and illustrated in figure 3. This is similar to the approach applied by several studies [iv, viii,ix,x,xi,xii]. Estimated values for the parameters of equation 3 for products in the key economic sectors are provided in table 1. [viii, ix,x,xi,xii,xiii] The parameters vary with country, usage habits and technological advances. They can be determined based on findings from investigations of local and/or national level or adapted from findings of countries with similar condition.

Eq. 3 $$L^{p}(t,n) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{1}{2}\left(\frac{t-\mu}{\sigma}\right)}$$

Table 1. Lifespans of plastic products per sector for reference

Sectors	***μ*** (mean, in years)	***σ*** (standard deviation in years)
Packaging	0.5	0.1
Transportation	13	3
Building and Construction	35	7
Electrical/Electronic	8	2
Consumer and Institutional Products	3	1
Industrial Machinery	20	3
Other	5	1.5
Textiles	5	1.5

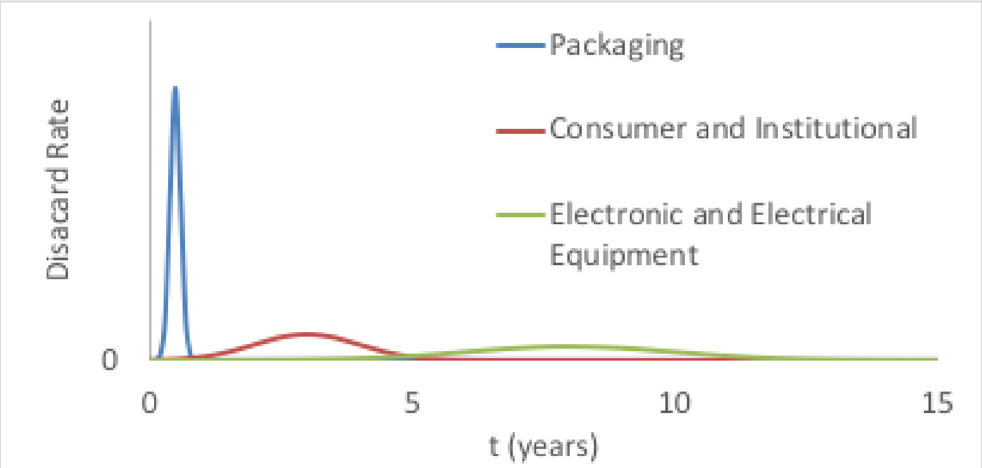

Figure 3. Example of lifespans distributions for the sectors packaging, consumer and institutional products and electronic and electrical equipment

26. Results of applying equation 2 above for estimating waste generation from packaging plastics and textile articles containing plastics in Romania in 2010-2018 are presented in tables 1 and 2 of Annex 2.

27. Table 2 shows the waste generated from textile articles containing plastics, with an average lifespan of 5 years. This example illustrates the relation between the year of consumption, and the year when the articles become waste. The total waste generated in a year is calculated by summing up the values for all the years for which data on consumption have been collected. The example also illustrates how the results on plastic waste generation depends on the accuracy of the consumption data.

Table 2. An example showing the relation between the quantity of products placed on market between 2010-2020 and the amount of waste generated for a product with a lifespan of 5 years

		Waste generation (tonnes)										
Year	Consumption (tonnes)	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
2010	10	0	0	1	2	3	3	2	1	0	0	0
2011	50		0	1	3	8	13	13	8	3	1	0
2012	100			0	2	7	16	25	25	16	7	2
2013	110				0	2	7	18	28	28	18	7
2014	150					0	3	10	24	38	38	24
2015	300						1	5	20	48	75	75
2016	500							1	9	33	81	126
2017	570								2	10	38	92
2018	640									2	11	42
2019	710										2	12
2020	780											2
Total waste generation		0	0	2	7	20	42	74	116	178	270	384

28. The data collection and calculation steps are to be undertaken for the all the products considered within scope of the inventory. Thus, to get the total waste generated for the packaging category, the apparent consumption methodology and calculation of waste generated has to be repeated for each product and summed up afterwards.

29. It is important to apply the apparent consumption methodology only to final products, as only the final products are disposed of by the consumer. Semi-finished goods, such as parts or components, or plastic pellets, or other raw materials are also identified in the HS and in production statistics, but have to be excluded, as they will be an input for further manufacturing and will not be disposed of as such by consumers.

30. The product lifetime approach can be used to obtain estimates of domestically generated post-consumer plastic waste and is generally easy to implement. However, the accuracy of the results depends largely on several factors including the accuracy of the trade and domestic production statistics, lifespans that may differ per region and the plastic content of plastics embedded in products. If there is no reliable data on domestic industrial production in the country, then the result of the apparent consumption methodology will provide an underestimate of plastic waste generated at the national level. Stakeholder consultations and surveys can be undertaken to obtain more accurate data on key variables such as material composition, the plastic content of products and on national production.

31. The methodology does not consider the imports and exports of plastic waste. Plastic waste is classified under heading 3915 in the HS. Incorporating information on the import and export of plastic waste available e.g. from customs authorities into the results from applying the product lifetime methodology can provide a more complete picture of plastic waste flows in a country.

4.2 Estimate based on surveys

32. Plastic waste generation can also be estimated on the basis of primary data collection. Surveys are conducted to collect data from sectors that generate plastic waste such as households and businesses. Sub-national data from for instance a city or a region can be collected and extrapolated to the national level.

33. For surveying households, data is collected from a representative sample from the population in the region of interest, stratified, if possible, according to socioeconomic factors such as the income

level. The households are requested to keep record and weight the waste they generate per day for one week. The outputs are processed to calculate the average generation of waste per day per person per group of income level. This value is then extrapolated to the entire population in the region by multiplying it with the number of inhabitants per group of income.

34. The Waste Wise Cities tool (WaCT)[xiv] provide step by step instructions for estimating municipal waste generation based on household surveys and data collected from commercial establishments and institutions. The tool includes instructions for undertaking a composition analysis of household waste, the results of which can then be used to estimate the amount of plastic waste generated. The WaCT aims at supporting assessment and monitoring of SDG indicator 11.6.1.[8]

4.3 Material flow analysis methodology

35. The MFA methodology allows:

(a) The mapping of flows of plastic waste arising from sources of generation (e.g., households and businesses), through the formal and informal waste collection systems, and to its final disposal and/or recovery, or leakage into the environment;

(b) The assessment of the degree of ‘leakage’ of plastic wastes from the waste management system.

36. The MFA methodology presented in this document draws mainly on two approaches that have been applied at the city or regional level in various developing countries: the WaCT[xiv] and the Waste Flow Diagram (WFD)[xv]. The modelling of flows is undertaken in a range of geographic archetypes (see e.g Pew Charitable Trusts, 2020;[xvi] GPAP, 2021[xvii]) and the results are scaled up to produce a national picture. An overview of the methodology is provided below and explained in more detail in annex 3. To assist Parties in applying the methodology, a spreadsheet-based tool has been developed and is accessible on the website of the Basel Convention.[9]

37. The methodology maps the flows according to a system map shown in annex 3. The flows of waste in the management system are typically very complex, involving many steps and numerous different actors. Representing these flows is very challenging and to do so at a detailed, actor-by-actor level of granularity would require a disproportionately large data collection and assessment exercise. The MFA framework developed for the methodology is a simplified version of the flows and is intended to identify the key parts the flow whilst being simple enough to be practicable to populate with data as part of the inventory preparation process. Since the components of the framework could differ among countries, the framework may need to be adapted to the national situation.

38. The methodology requires various key data points to be completed so that the MFA can be constructed. Other data points are calculated using a combination of these key values and other supporting data points (see annex 3). The MFA framework developed for this methodology has been designed so as to keep the number of data points that need to be completed to a relatively small number whilst providing a reasonable level of detail. It also focuses in on the data points that are most likely to be available from formal sources (e.g., records of quantities of waste collected and disposed of on landfills). Data from the informal system is less likely to be recorded so these data points are either calculated or estimated, although if primary data is available on these factors, then that can be incorporated into the model. The reality in a specific context may mean that a different set of data points is available. In this case, the calculation can be adjusted or overwritten to allow data points to be replaced with actual data. When possible, it is better to use actual data than rely on the MFA calculation. Much of the primary data collection needed for applying this methodology can be undertaken using the methodology and principles of the WaCT.[xiv] The reliability of data will vary depending on whether it is derived from primary sources, current records and studies or from older studies, outdated records or based on estimations.

39. The methodology allows for the extent of plastic waste leakage from the waste management system to be estimated. This leakage can be due to a range of factors including the rejection of non-recyclable plastic wastes during sorting or poor handling practices during waste collection that causes plastic wastes to escape during storage, transportation or from disposal sites. A leakage factor describing the percentage of plastic waste leakage is estimated for each stage of potential leakage. These leakage factors are estimated using an approach developed within the WFD.[xv]

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[8] Proportion of municipal solid waste collected and managed in controlled facilities out of total municipal solid waste generated, by the city.

[9] http://www.basel.int/Countries/NationalReporting/Toolkitsforwasteinventory/tabid/9043/Default.aspx.

40. To deal with variations in waste management systems and trends in different geographic regions (e.g. urban vs rural), the methodology uses archetypes to allow estimates to be scaled up to the national level. Archetypes are sub-divisions or representative regions of the country that share similarities in waste generation and management systems which may be based on factors such as population density and demographics. The methodology uses the following archetypes:

(a) Mega – large, metropolitan urban areas;

(b) Medium – smaller urban areas;

(c) Small – small towns and rural areas.

41. By populating the MFA for each of these archetypes, an analysis of plastic flows for each of these archetypes can be scaled up, using population data, to produce a national inventory.

5 Preparing National Summaries and Forecasts

42. The inventory based on the product lifetime methodology directly provides a national estimate of the plastic waste generated. In the second methodology, based on field surveys, the inventory starts from a limited geographical area, such as at the city-level and the results can be extrapolated to obtain national level estimates. Another possibility is to repeat the surveys for all regions in a country, and to add up the sub-national data into national data. For the MFA methodology, information on plastic flows for each archetypes can be scaled up to produce a national inventory. Establishing historical databases for the previous 5 to 10 years can be useful for examining the trends in plastic consumption and flows and for preparing a forecast.

6 Obtaining data on options for final disposal and recovery

43. Information on options for the final disposal and recovery of hazardous wastes and other wastes available in a country is requested in table 2 and table 3 of the national reporting format, respectively. In some countries, waste management enterprises and disposal facilities, such as landfills have a reporting obligation to an authority, such as the ministry of environment or the national statistical office, on the amounts of waste they collect and process. These records can provide information on existing facilities such as those involved in the disposal and recycling of plastic waste. Alternatively, surveys of key facilities can be undertaken to obtain the necessary information.

7 Obtaining data on the transboundary movements of plastic waste

44. Parties to the Basel Convention have the obligation of designating one or more (competent) authorities for approving the transboundary movements of hazardous wastes and other wastes. As such, competent authorities should maintain a record of annual imports and exports of plastic waste under the scope of the Convention (see paragraph 4). Parties should provide this information in table 4 (export) and table 5 (import) of their national report.

8 Updating the inventory

45. Applying the methodologies outlined above provide an estimate of the amount of plastic waste generated in a given year in a country and an estimate of flows through the waste management system. To update the plastic waste inventory and make use of its results, it is useful to establish a procedure for collecting the necessary information from sources on a regular basis and implement nationally approved monitoring protocols.

46. The updating process would benefit from cooperation among several agencies in a country, from data providers, data processors to data users (e.g., policy makers). A working group of key stakeholders can be established to first assess the data needs to support waste management policies and reporting obligations. These needs can form the basis of a waste monitoring plan in which the priorities, scoping, methodologies, frequency of data collection, responsible agencies, funding mechanisms, linkages to policies and future work are established. The data collected can be used e.g. to support decision making and to monitor the effectiveness of relevant policies.

9 Assessment of results and conclusions

47. It is important to assess the results of the inventory. Key elements to be assessed include the reliability of the data collected and the accuracy of the results. The assessment may also identify potential gaps in implementing the control system for the implementation of the Basel Convention.

48. One approach of assessing the accuracy is to assess the trend of time series. It may that plastic waste generated shows a stable upward trend, in which case, any sudden changes would be worth validating to verify that the observed trend is a real and not stemming from a reporting error in the trade or industrial production statistics. Another approach is to benchmark the outcomes relative to other comparable countries, e.g., one can calculate the plastic waste generated per inhabitant per year and compare it to similar data for comparable countries in the region.

49. Another approach is to make national mass-based material balances of plastic flows comparing the plastic waste generated to other information on the flows of the country's plastic waste such as the unmanaged plastic waste (flow 'd' in figure 1), managed plastic waste (flow 'e'). Examples of the additional validation steps are: for a country with a plastic recycling industry, the amount of plastic wastes managed (flow 'e') should be close to the sum of the amount imported (flow 'f') and generated domestically (flows 'b' and 'c') from which the amounts exported (flow 'g') and the unmanaged (flow 'd') are subtracted. If a country exports all of its domestically generated plastic waste, the amount of managed plastic waste generated should be close to the amount exported. The accuracy of this approach is reliant on several factors including the availability of data of high quality for estimating the flows through the system.

50. Discrepancies between the amount of plastic waste generated and the amount disposed/ recycled domestically and/or exported could be due to a number of reasons and worth investigating, for instance, potential gaps in the control system and areas where measures are needed to ensure the environmentally sound management of plastic waste. It could also indicate inaccuracies in the data collected, poor record-keeping, differences in classification, etc.

10 References

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Annex 1 to the guidance

Overview of existing approaches for plastic waste inventory

The table below provides an overview of approaches and tools for the inventory of plastic waste that have been developed and pilot tested in various countries. It does not aim to be comprehensive. A review of other methodologies is also provided in https://portals.iucn.org/library/sites/library/files/documents/2019-027-En.pdf

Name	Author/source entity	Scale	Objectives	Scope	Reference/source
Waste Wise Cities Tool	UN Habitat	Subnational	Inventory and fate of plastic waste	Plastic waste in municipal waste	https://unhabitat.org/sites/default/files/2021/02/Waste%20wise%20cities%20tool%20-%20EN%203.pdf
Waste Flow Diagram	GIZ, University of Leeds and others	Subnational	Fate of waste	Plastic waste in municipal waste	https://www.giz.de/expertise/html/62153.html
Evaluating scenarios toward zero plastic pollution -Breaking the plastic wave	-Lau et al. -Pew Charitable Trusts and Systemiq	National/global	Inventory and fate of plastic waste	Plastic waste in municipal waste	Science. 2020. 369(6510):1455-1461; https://www.pewtrusts.org/-/media/assets/2020/10/breakingtheplasticwave_mainreport.pdf
Marine plastic footprint	IUCN	National/subnational	Inventory and fate of plastic waste	Land sources of plastic waste	https://portals.iucn.org/library/node/48957
National guidance for marine plastic hotspotting and shaping action	UNEP and IUCN	National/subnational	Inventory and fate of plastic waste	All plastic waste	https://plastichotspotting.lifecycleinitiative.org/
National plastics inventory Nigeria	Babyemi et al.	National	Inventory	Waste from imported plastic	J Health Pollut. 2018. 8(18): 180601
Plastic material flow analysis for India	Mutha et al.	National	Fate of plastic waste	All plastic waste	Resources, Conservation and Recycling. 2006. 47(3):222-244

Annex 2 to the guidance

Product lifetime methodology

Example of applying the product lifetime methodology

1. The inventory is developed in two steps, as illustrated for plastic packaging made of plastics classified under HS code 3923.10 (Boxes, cases, crates, and similar articles for the conveyance or packaging of goods, of plastics) for Romania.

2. To obtain information on trade of the goods classified under HS code 3923.10, the data on their import and export are downloaded from the UN Comtrade database (https://comtrade.un.org/data/). For the plastic waste inventories, it is sufficient to extract the trade data from one country to the world (all other countries are aggregated) and for yearly trade data (all months are aggregated). In this example, import and export data have been extracted for 2010 to 2018 for Romania for both imports to and exports from "the world".

3. To obtain information on domestic production, data must be downloaded from relevant databases. Correspondence tables from HS codes to production classification can be retrieved from the Eurostat Ramon Server.[1] For HS code 3923.10, the corresponding CPC code at the global level is 36490. In Europe, the national classification for industrial statistics is called "PRODCOM". The corresponding PRODCOM code for HS 3923.10 is PRODCOM code 22.22.13.00. The downloaded import, export, and domestic industrial production data for this example is shown in Table 1 below.

Table 1. Calculation of the amount of plastic products classified under HS code 3923.10 put on the market in Romania, for 2010-2018

	Import (kg)	**Export (kg)**	**Domestic industrial production (kg)**	**Consumption (kg)**
2010	12.130.944	3.830.219	3.944	8.304.669
2011	13.412.013	4.887.123	8.868	8.533.758
2012	11.429.978	3.744.558	4.301	7.689.721
2013	9.690.996	3.934.698	4.234	5.760.532
2014	10.167.984	3.651.131	3.527	6.520.380
2015	10.131.346	2.607.662	5.081	7.528.765
2016	13.159.306	3.410.695	5.222	9.753.833
2017	15.492.058	3.376.069	9.340	12.125.329
2018	17.922.324	5.694.501	8.290	12.236.113

4. The amount of plastic products classified under HS code 3923.10 put on the market is then used to calculate the amount of plastic waste generated according to equation 1. Assuming that the average lifespan is 0.5 years of plastic packaging products classified under HS code 3923.10, it is a fair approximation to take the year of sale to be the same as the year where the plastics waste is generated. In this example, f (the fraction of plastics in the product) is considered to be 1, *i.e.* completely made of plastics. Applying equation 2, yields the results shown in table 2.

[1] European Commission, Eurostat Ramon Server, Correspondence Table, https://ec.europa.eu/eurostat/ramon/relations/index.cfm?TargetUrl=LST_REL&StrLanguageCode=EN&IntCurrentPage=4.

Table 2. Plastic waste generated from plastic products classified under HS code 3923.1 put on the market in Romania, for 2010-2018

Year	Consumption (kg)	Plastic waste generated (kg)
2010	8.304.669	8.304.669
2011	8.533.758	8.533.758
2012	7.689.721	7.689.721
2013	5.760.532	5.760.532
2014	6.520.380	6.520.380
2015	7.528.765	7.528.765
2016	9.753.833	9.753.833
2017	12.125.329	12.125.329
2018	12.236.113	12.236.113

Estimating waste generated by type polymer

5. The approach described above provides an estimate of total plastic waste generated. It can be adapted to estimate the plastic waste generated by type of polymer. For that purpose, plastic waste is categorized according to the most commonly used types of plastic polymers, as follows:

(a) PE (polyethylene);

(b) PP (polypropylene);

(c) PS (polystyrene);

(d) PVC (polyvinylchloride);

(e) PET (polyethylene terephthalate);

(f) PUR (polyurethane).

6. In some cases, the HS heading includes a description of the type of plastic that makes up the product. For example, HS code 391721 is described as: “Rigid tubes, pipes and hoses, of polymers of ethylene”. In that case, the entire code can be linked to polyethylene (PE). However, in most cases, the type of plastic is not specified, such as in HS code 391731: “Rigid tubes, pipes and hoses, of plastics (excl. those of polymers of ethylene, propylene and vinyl chloride)”. In such cases, the compositional estimates for products in each of key sectors, from table 3 (adapted from Jambeck et al.[2]) can be applied.

Table 3. Average composition of plastic polymers for products used in key sectors

Sector	PE	PP	PS	PVC	PET	PUR	Other
Transportation	13%	38%	0%	4%	0%	24%	21%
Packaging	51%	18%	5%	2%	23%	0%	0%
Building and Construction	23%	6%	12%	43%	0%	13%	3%
EEE	18%	23%	15%	10%	0%	10%	25%
Consumer and Institutional	38%	32%	15%	5%	0%	8%	2%
Industrial Machinery	38%	25%	0%	0%	0%	38%	0%
Other	20%	32%	5%	11%	0%	19%	13%

7. In the example above, it is assumed that the entire product is made of plastic but the type of plastic polymer is unknown and the estimates in table 3 can be applied. Assuming f (the mass fraction of plastics in the product) to be equal to 1, and using the values for the packaging sector from table 3 for plastic type (c_i), the amount of plastic products put on the market is as follows:

[2] Jambeck, J.R., Andrady, A., Geyer, R., Narayan, R., Perryman, M., Siegler, T., Wilcox, C., Lavender Law, K., 2015, Plastic waste inputs from land into the ocean, Science, 347, pp. 768-771.

Table 4. Amount of plastic products classified under HS code 3923.10 put on the market in Romania, for 2010-2018, broken down by polymer type

Year	Consumption (kg)	PE	PP	PS	PVC	PET
2010	8.304.669	4.235.381	1.494.840	415.233	166.093	1.910.074
2011	8.533.758	4.352.217	1.536.076	426.688	170.675	1.962.764
2012	7.689.721	3.921.758	1.384.150	384.486	153.794	1.768.636
2013	5.760.532	2.937.871	1.036.896	288.027	115.211	1.324.922
2014	6.520.380	3.325.394	1.173.668	326.019	130.408	1.499.687
2015	7.528.765	3.839.670	1.355.178	376.438	150.575	1.731.616
2016	9.753.833	4.974.455	1.755.690	487.692	195.077	2.243.382
2017	12.125.329	6.183.918	2.182.559	606.266	242.507	2.788.826
2018	12.236.113	6.240.418	2.202.500	611.806	244.722	2.814.306

8. In the example, the average lifespan is 0.5 years for packaging waste. Thus, it is a fair approximation to take the year of sale, equal to the plastic waste generated. Using the data from table 4, the estimate of plastic waste generated is as follows:

Table 5. Plastic waste generated from plastic products classified under HS code 3923.1 put on the market in Romania, for 2010-2018, broken down by polymer type

Year	Plastic waste generated (kg)	PE	PP	PS	PVC	PET
2010	8.304.669	4.235.381	1.494.840	415.233	166.093	1.910.074
2011	8.533.758	4.352.217	1.536.076	426.688	170.675	1.962.764
2012	7.689.721	3.921.758	1.384.150	384.486	153.794	1.768.636
2013	5.760.532	2.937.871	1.036.896	288.027	115.211	1.324.922
2014	6.520.380	3.325.394	1.173.668	326.019	130.408	1.499.687
2015	7.528.765	3.839.670	1.355.178	376.438	150.575	1.731.616
2016	9.753.833	4.974.455	1.755.690	487.692	195.077	2.243.382
2017	12.125.329	6.183.918	2.182.559	606.266	242.507	2.788.826
2018	12.236.113	6.240.418	2.202.500	611.806	244.722	2.814.306

Key elements of the toolkit for applying the product lifetime methodology

9. To assist Parties in applying the product lifetime methodology, a toolkit has been developed and made available on the website of the Basel Convention.[2] It aims to facilitate data collection and calculation of results by users. Many countries lack the information base for undertaking a detailed inventory based on statistics. The toolkit therefore uses a practical approach that allow an examination of sectors that are likely to generate largest proportion of waste. The key element of the toolkit, as illustrated in figure 1, are:

(a) A spreadsheet tool (and supporting user manual) for collecting information on the trade in products containing plastic classified under 225 Harmonized System codes and the corresponding production data and for calculating amounts of plastic products put on the market for key sectors;

(b) A spreadsheet tool (and supporting user manual) for calculating plastic waste generated on the basis of amounts of plastic products put on the market. Estimates of key parameters are embedded in the tool to facilitate calculation of results;

(c) Linkage between trade and consumption data through 59 Plastic Keys which is a classification that groups products containing plastic into homogeneous groups according to material composition and lifespans. A related methodology for estimating e-waste generation has been successfully applied in developed and developing countries.[3,4]

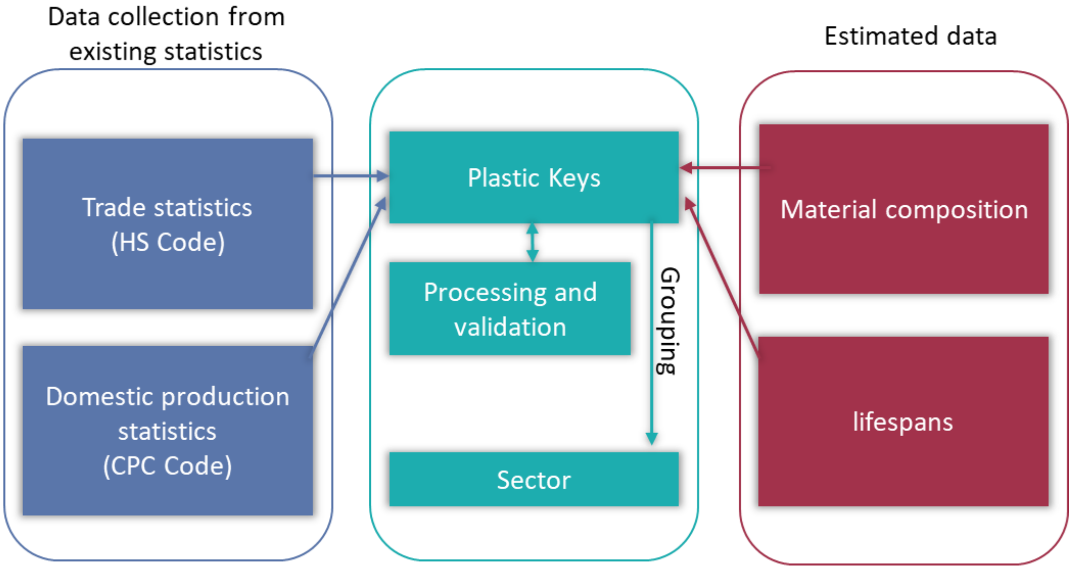

Figure 1. Key elements of the product lifetime toolkit

10. For the purpose of the toolkit, post-consumer plastic waste is classified into one of the following mutually exclusive categories, corresponding to sectors that use plastics:

(a) Packaging;

(b) Transportation;

(c) Building and Construction;

(d) Electronic and Electrical Equipment;

(e) Consumer and Institutional;

(f) Industrial Machinery;

(g) Textiles;

(h) Other.

11. The product lifetime methodology is best applied for the sectors packaging, consumer and institutional products, textiles and others, in which products have lifespans shorter than 10 years. Successfully applying the methodology for very durable products, such as in the built environment where lifespans of several decades are usual, is challenging as it requires long datasets of consumption, which are often absent. Accurate information on lifespans is also more difficult to obtain for such products.

[3] Forti V., Baldé C.P., Kuehr R. (2018). E-waste Statistics: Guidelines on Classifications, Reporting and Indicators, second edition. United Nations University, ViE – SCYCLE, Bonn, Germany; available at https://www.itu.int/en/ITU-D/Climate-Change/Documents/2018/EWaste_Guidelines_final.pdf.

[4] Implementation of the WEEE Directive (europa.eu).

Annex 3 to the guidance

Material flow analysis methodology

1. The material flow analysis (MFA) framework that is used as a basis for mapping the flows of plastic waste is illustrated in the material flow (MF) diagram in figure 1 below.

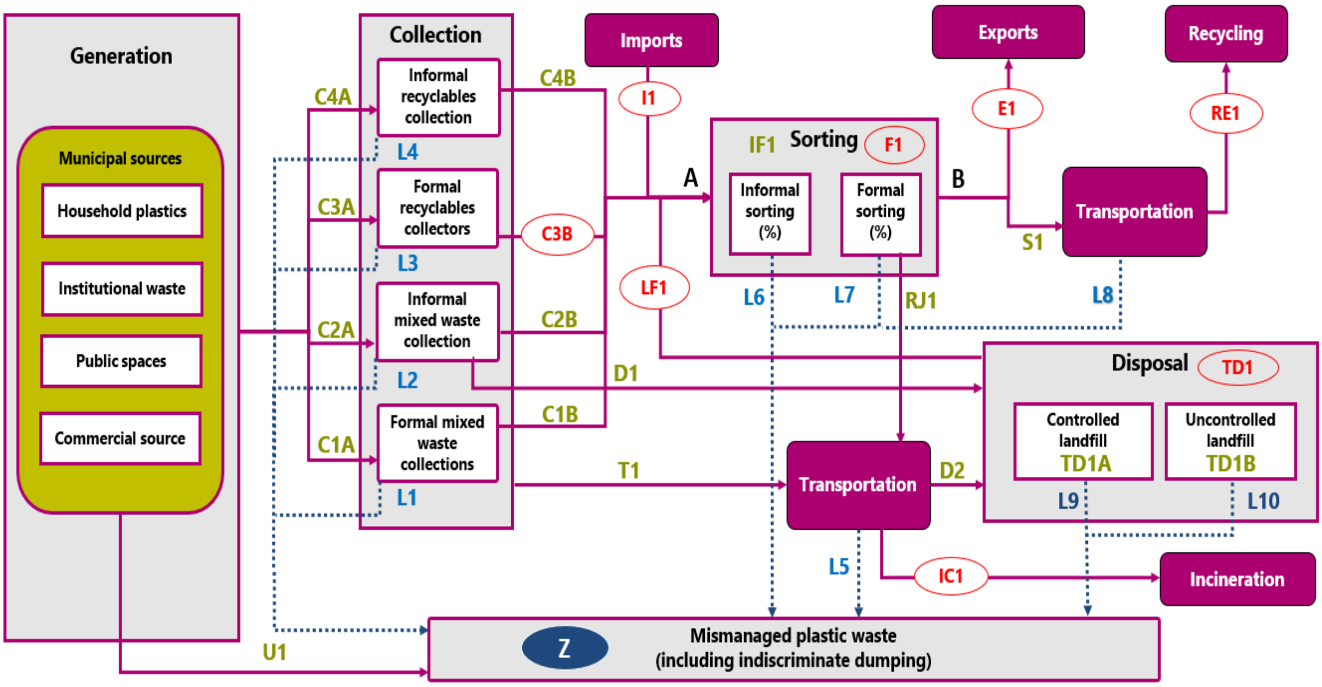

Figure 1. Material flow diagram. Grey boxes represent the different stages of the plastic waste management system such as collection, sorting, disposal etc; purple arrows represent flows of plastic waste between the various stages; blue arrows represent leakage of plastic waste at each stage. Adapted from the Waste Flow Diagram[1]

2. The methodology requires various key data points to be completed so that the MFA can be constructed. These key points are highlighted in red on the MF diagram. Other data points (labelled in green) are calculated using a combination of these key values and other supporting data points (the full data collection and calculation process is available in the manual for using the MFA methodology-see below). The leakage rates at each point of the MFA are then estimated based on a qualitative assessment (see below for more information). The flows also include the import and export of plastic which are estimated based on customs date.

3. The MF diagram is comprised of the following components (the definitions below are for use in the context of the MFA framework):

(a) **Generation:** This is the quantity of plastic waste generated at the municipal level. This is plastic waste generated by sources that typically form part of the municipal waste management system: residents, businesses, institutions and public spaces (e.g. streets and parks);

(b) **Collection.** This describes the different ways in which plastic wastes are collected from their points of generation. It is divided into formal collection and informal collection flows. It also differentiates between: i) plastic waste that is collected separately as part of source segregated collection systems, and ii) waste plastic collected as part of mixed waste. The informal collection system can be particularly complex, comprising a wide range of actors such as door-to-door collectors who buy recyclable materials from residents, informal recyclers collecting materials from containers in the street and also informal workers collecting plastic waste from landfills (see flow LF1);

(c) **Sorting.** This is where plastic waste is sorted notably for mechanical recycling. Mixed waste without the recyclable plastic fractions may be sent for further energy recovery or to other disposal facilities. Sorting typically involves removing unwanted materials and items and separating

[1] GIZ, University of Leeds, Eawag-Sandec, Wasteaware (2020). Toolkit: Waste Flow Diagram (WFD): A rapid assessment tool for mapping waste flows and quantifying plastic leakage.

plastics into different polymers and grades so that they can be sold for reprocessing into new materials. In many contexts, sorting is undertaken by formal and informal actors and often represents a complex ecosystem of different actors conducting different types of interlinked sorting operations at a variety of scales. As well as sorting of source segregated plastic, some mixed wastes may also be sorted to remove the valuable plastic component. For the purposes of this model, it is assumed that removal of plastics for recycling at the sorting stage is undertaken by the formal sector (i.e., at formal material recovery facilities). Removal of plastics by the informal sector is considered accounted for in flow LF1 as part of the informal mixed waste collection flow;

(d) **Landfill disposal.** This is the disposal of waste plastics at designated landfill disposal sites. These disposal sites are divided into two types following the approach by the WaCT: controlled disposal sites and uncontrolled disposal sites (UN-Habitat, 2019);

(e) **Recycling:** These are materials that have been sorted and are sent for recycling;

(f) **Incineration.** This element represents the quantity of plastics disposed to formally operated incineration plants. It does not differentiate between incineration with or without energy recovery;

(g) **Imports and exports**. This captures the flows into and out of the waste management system in the form of imported and exported plastic waste;

(h) **Transportation.** This captures the transport of mixed waste to disposal sites and the transport of sorted waste plastics to recycling facilities. This step is included so as to allow consideration of the potential leakage from relatively long-distance formal transport of plastic wastes (see below);

(i) **Mismanaged plastic waste.** This is the aggregate quantity of waste that escapes into the environment and is a sum of all the estimated leakages from different elements of the system and uncollected plastic waste.

4. Development of the inventory is undertaken in four steps:

Step 1 - Baseline data collection
Step 2 - Leakage factors estimation
Step 3 - Calculation
Step 4 - Creating a national summary

Step 1 - Baseline data collection

5. The first step is to define the archetypes for which baseline data will be collected. It is recommended that any existing classification or administrative divisions used by government bodies such as national statistical or census organisations be considered, while defining archetypes. Areas within these classifications are likely to share similarities in waste generation patterns and management practices. For example, the archetypes defined for a pilot study in Ghana were derived from the administrative divisions defined by the Ghana Statistical Survey and were based on population. The resultant archetypes had the following features:

Mega – All Metropolitan Assemblies which comprised urban centres with populations over 250,000.

Medium – All Municipal Assemblies comprising single-town councils with populations of 95,000 or more.

Small – All District Assemblies comprising smaller towns and rural areas with low population density and minimal access to waste collection and management services.

6. The next step is to collect necessary data points for each archetype. This requires a relatively intense effort of reviewing existing studies and information sources for appropriate data and, if resources allow, collection of primary data via site visits, surveys and interviews with key stakeholders. Ideally, data should be sourced from representative and reliable studies and information. It is also recommended that data used belongs to the same time period (year, study period etc.). In the absence of primary data, records from official sources from neighbouring or similar contexts may be used where available. Official records for rural areas and regions with low economic activity may often be unavailable. In such cases, literature sources may provide representative data from similar geographies.

7. Depending on the availability of each data point, it may be necessary to derive these from other studies or use proxy values. For example, if no data is available on waste composition, it would be appropriate to use some proxy data on composition from a similar context. Where appropriate data cannot be found then it will be necessary to estimate the values using expert judgement.

8. The required data points are summarized in table 1 below. The data points are compiled separately for each archetype.

Table 1. Baseline data to be collected for the MFA methodology

Data point	**MFA ref.**	**Data point**	**Unit**	**Comments**	**Data collection method (in order of preference where there is more than one method available)**
1	-	Population	No.	Total population of archetype.	From official sources such as recent census data or other national statistical sources
2	-	Rate of MSW generation	Kg/person/day	Rate of generation of municipal solid waste per person per day.	1. Primary data collection (see Step 2 of WaCT) 2. Recent waste characterisation studies 3. Triangulation of values from representative regions obtained through a literature review
3	-	Proportion of plastic waste in MSW	%	Proportion of MSW that comprises plastic waste.	
4	TD1	Quantity of plastic waste disposed at designated disposal sites[2]	Tonnes/day	Quantity of plastic waste and received at designated landfill sites (controlled and uncontrolled).	1. Primary data collection (see Step 5 of WaCT). Estimated as the proportion or quantity of plastic in the waste received at the respective sites. 2. Triangulation of values from representative regions obtained through a literature review.
5	-	Proportion of total plastic waste disposed to designated disposal sites which ends up in controlled landfills.	%		
6	-	Proportion of total plastic waste disposed to designated disposal sites which ends up in uncontrolled landfills.	%		
7	-	Proportion of total plastic waste received at designated disposal sites that comes from formal mixed waste collection services.	%		
8	-	Proportion of total plastic waste received at landfills that comes from informal mixed waste collection services.	%		

[2] Designated Disposal – Sites recognised and used by public and private authorities for waste disposal.

Data point	MFA ref.	Data point	Unit	Comments	Data collection method (in order of preference where there is more than one method available)
9	IC1	Quantity of plastic waste received at incineration facilities	Tonnes/day	Includes incineration both with and without energy recovery.	
10	RE1	Quantity of plastic waste received at recycling facilities	Tonnes/day	The quantity of waste received by recycling facilities (after sorting). Includes both mechanical and chemical recycling.	1. Obtained through interviews and waste characterisation studies (see Step 4 of WaCT) at recovery facilities receiving sorted waste. Estimated as the proportion or quantity of plastic in the waste received at the respective sites 2. From literature sources
11	I1	Quantity of plastic waste imported	Tonnes/year	Based on assessment of transboundary movement data.	Official sources such as customs
12	E1	Quantity of plastic waste exported	Tonnes/year	Based on assessment of transboundary movement data.	
13	RJ1	Proportion of plastic waste that is rejected during formal sorting processes	%	It is assumed that this material is sent for disposal.	1. Obtained through interviews and waste characterisation studies (see Step 2 of WaCT) at sorting facilities receiving sorted waste. Estimated as the proportion or quantity of plastic in the waste received at the respective sites 2. From literature sources
14	-	Proportion of plastic waste that is rejected during informal sorting processes.	%	It is assumed that this material is not sent for formal disposal. This data point is used to calculate the leakage rate from informal sorting activities.	Derived from data point 13.

Data point	MFA ref.	Data point	Unit	Comments	Data collection method (in order of preference where there is more than one method available)
15	F1	Quantity of plastic waste sorted for recycling by formal sorting facilities	Tonnes/day	Quantity of plastic waste sorted by formal sorting facilities (before leakage and rejects).	Obtained through surveys of the sorting system to identify number of facilities and capacities. Key players can be interviewed to obtain estimates of daily throughput of plastic waste.
16	C3B	Quantity of plastic waste collected by formal services	Tonnes/day	Quantities of source segregate plastic waste collected by formal collection services for sorting.	Obtain through official records of transfer stations or sorting facilities receiving waste from formal services or through interviews of key stakeholders in the service
17		Quantity of mixed waste received at formal sorting facilities	Tonnes/day	From formal and informal mixed waste collections	
18	-	Proportion of mixed waste received at formal sorting facilities that comes from formal sources	%	Proportional split of formal and informal mixed waste collections received at formal sorting facilities	
	-	Proportion of mixed waste received at formal sorting facilities that comes from informal sources	%		Derived from data point 18
19	-	Proportion of plastic in mixed waste received at formal sorting facilities that comes from formal mixed waste collections	%	Plastic fraction of mixed waste received by formal sorting facilities from formal and informal sources.	Obtained through surveys of the sorting system to identify number of facilities and capacities. Key players can be interviewed to obtain estimates of daily throughput of plastic waste.
20	-	Proportion of plastic in mixed waste received at formal sorting facilities that comes from informal mixed waste collections	%		
21	LF1	Quantities of plastic waste collected by informal services through waste picking at landfills	Tonnes/day		Obtained through waste characterisation studies and interviews of the informal sectors are key disposal sites

Step 2 - Leakage factors estimation

9. Once the baseline data points have been populated, the next step is to estimate the extent of plastic waste leakage from the waste management system. This leakage can be due to a range of factors including the rejection of non-recyclable plastics during sorting or poor handling practices during waste collection that causes plastics to escape during storage, transportation or from disposal

sites. A leakage factor describing the percentage of plastic waste leakage is estimated for each stage of potential leakage, according to the calculations shown in table 2, using an approach developed within the WFD methodology.

Table 2. Calculation of leakage factors (from WFD)

Stage	Leakage influencer	Description	Calculation
During collection	Collection containers	Likelihood of leakage based on how waste is stored at the point of collection	(L1 to L3) Leakage from collection services = Collection containers + Method of loading + Primary transportation + Handling
	Method of loading	Likelihood of leakage based on method of loading collected waste on to transportation	
	Primary transportation	Likelihood of leakage based on type and control of primary transportation used to collect waste	
	Handling	Likelihood of leakage due to multiple handling of waste	
During sorting	Storage	Likelihood of non-rejects being dumped or mismanaged during storage	First establish % rejects in sorting facilities. (see baseline data points 22) (L6 and L7) Leakage from formal sorting = (Reject rate/100 X Disposal of rejects) + (Non-rejects/100 X (Storage + Sorting))
	Sorting	Likelihood of non-rejects being dumped or mismanaged during storage	
During informal recycling collections or waste picking from landfills	Extraction of recyclables	Likelihood of leakage occurring during door to door collection or scavenging and waste picking stages	(L4) Leakage from informal value chain = Extraction of recyclables + Transportation
	Transportation	Likelihood of leakage during transportation from collection to aggregation or sale point	
During transportation	Vehicle capacity	Likelihood of leakage due to insufficient capacity in the vehicle compared to the load	(L5 and L8) Leakage from transportation = Vehicle capacity X Containment of waste X Cover for vehicles
	Containment of waste (at the point of loading)	Likelihood of leakage if waste is not contained during transportation	
	Cover for vehicle	Likelihood of leakage if the vehicle is not covered	
During disposal	Environment hazards		(L9 and L10) Leakage from disposal = Environmental hazards + (Weather exposure X Waste handling X Coverage X Burning X Fencing)
	Weather exposure		
	Waste handling		

[a] *These calculations are applied to formal and informal mixed waste collection as well as formal recycling collections (or source segregated collections).*
[b]*These calculations are applied to formal and informal sorting facilities.*

[c] *These calculations are applied when plastic waste is transported to disposal, recycling and energy recovery facilities*

Step 3 - Calculation

10. The baseline data and leakage factors from steps 1 and 2 enable the calculation of the flows shown in the MF diagram. The summary of flow calculations are presented in table 3.

Table 3. Summary of flow calculations

Flow ref	Description	Type	Calculation
Generation			
X	Total plastic waste generation	Key data point	= Population x Rate of MSW generation per capita X % Proportion of plastic waste in MSW
U1	**Uncollected waste**	**Calculated**	**= X - (C1A+C2A+C3A+C4A)**
Treatment			
RE1	Tonnes plastic received for recycling	Key data point	Data point 10
IC1	Tonnes plastic waste received for incineration	Key data point	Data point 9
S1	Tonnes of plastic waste sorted for recycling	Calculated	= RE1/(1-%leakage during transportation to recycling/100)
F1	Tonnes of plastic waste received for sorting at formal facilities (pre-sorting)	Key data point	Data point 15
IF1	Tonnes of plastic waste received for sorting at informal facilities (pre-sorting)	Calculated	= (B-F1+RJ1+L7)/(1-%leakage during informal sorting/100)
B	**Sum of all plastic waste sorting outputs**	**Calculated**	**= E1+S1**
Disposal			
TD1	Tonnes of plastics waste disposed in landfills	Key data point	Data point 4
TD1A	Plastic waste disposed in controlled landfills	Calculated	= TD1*Proportion of disposed plastic ending up in controlled landfills (data collection ref 5)
TD1B	Plastic waste disposed in uncontrolled landfills	Calculated	= TD1*Proportion of disposed plastic ending up in uncontrolled landfills (data collection ref 6)
D1	Plastic waste in informal mixed waste collections delivered to landfill	Calculated	= TD1*Proportion of total plastic waste received at landfills that comes from formal mixed waste collection services (data collection ref 7)
D2	Plastic waste in formal mixed waste collections delivered to landfills	Calculated	= TD1*Proportion of total plastic waste received at landfills that comes from formal mixed waste collection services (data collection ref 8)
T1	Plastic waste from formal mixed waste collections for transportation to disposal	Calculated	= (IC1+D2)/(1-%leakage during transportation to disposal/100) - RJ1
RJ1	Plastic waste rejects from sorting dispatched to landfills	Calculated	= F1*Reject rate at formal sorting facilities
Collection			
C1B	Tonnes of plastic waste received from formal mixed waste collections	Calculated	= Qty of mixed waste received in formal sorting facility x Proportion of formal mixed waste collection x Proportion of

Flow ref	Description	Type	Calculation
			plastic in formal mixed waste collection (data ref 17, 18 and 19)
C2B	Tonnes of plastic waste received from informal mixed waste collections for sorting	Calculated	= Qty of mixed waste received in formal sorting facility x Proportion of informal mixed waste collection x Proportion of plastic in informal mixed waste collection (data ref 17, 18 and 20)
C3B	Tonnes of plastic waste received from formal recycling collection for sorting (pre-sorting)	Key data point	Data point 16
C4B	Tonnes of plastic waste received from informal recycling collections for sorting	Calculated	= C4B=A-I1-C3B-C2B-C1B-LF1
C1A	Tonnes plastic waste collected by formal mixed waste collection	Calculated	= (C1B+T1)/(1-%leakage during formal mixed waste collection)
C2A	Tonnes plastic waste collected by informal mixed waste collection	Calculated	= (C2B+D1)/(1-%leakage during informal mixed waste collection)
C3A	Tonnes plastic waste collected by formal recycling collections	Calculated	= C3B/(1-%leakage during formal recycling collections)
C4A	Tonnes plastic waste collected by informal recycling collections	Calculated	= (C4B)/(1-%leakage during informal recycling collections)
LF1	Informal recyclables taken from landfill	Key data point	Data point 20
A	**Sum of all plastic waste received for sorting**	**Calculated**	**=IF1+F1+L6+L7+RJ1**
Imports and Exports			
I1	Plastic waste received through imports	Key data point	Data point 11
E1	Plastic waste sent for exports	Key data point	Data point 12
Leakages and Mismanaged waste			
L1	Leakage during formal mixed waste collections	Calculated	= C1A*%Leakage factor for formal mixed waste collection
L2	Leakage during informal mixed waste collections	Calculated	= C2A*%Leakage factor for informal mixed waste collection
L3	Leakage during formal recycling collections	Calculated	= C3A*%Leakage factor for formal recycling collections
L4	Leakage during informal recycling collections	Calculated	= C4A*%Leakage factor for informal recycling collections
L5	Leakage during long distance transportation of mixed waste to disposal	Calculated	= (RJ1+T1)*%Leakage factor for transportation to disposal
L6	Leakage during informal sorting	Calculated	= IF1*%leakage factor for informal sorting
L7	Leakage during formal sorting	Calculated	= F1*%leakage factor for formal sorting
L8	Leakage during long distance transportation of plastic waste to recycling	Calculated	= S1*%Leakage factor for transportation to recycling
L9	Leakage from controlled landfill sites	Calculated	= TD1A*%Leakage factor for controlled disposal
L10	Leakage from uncontrolled landfill sites	Calculated	= TD1B*%Leakage factor for uncontrolled disposal

Flow ref	Description	Type	Calculation
Z	**Mismanaged waste leaking into the environment**	**Calculated**	**= All Leakages + U1**

Step 4 – Creating a national summary

11. Once the MFA has been populated for each archetype, the key values from each MFA can be summed to provide an overall estimate of plastic waste flows at a national level. The key outputs of the analysis process can be found on the 'National summary' worksheet of the spreadsheet tool (see below). It presents the following key elements:

(a) Total plastic waste collected, broken down into plastic waste collected by the informal and formal collection systems;

(b) Total mismanaged plastic waste, broken down into uncollected plastic waste and leakage from the waste management system;

(c) Total plastic waste recycled;

(d) Total plastic waste incinerated;

(e) Total plastic waste disposed of in landfills.

Key elements of the toolkit for applying the MFA methodology

12. To assist Parties in applying the MFA methodology, a toolkit has been developed and made available on the website of the Basel Convention.[2] It aims to facilitate data collection and calculation of results by users. Many countries lack the information base for undertaking a detailed inventory to map all plastic waste flows. The toolkit therefore uses a practical approach that allow an examination of flows within the MFA framework presented in figure 1 above which reflects the flows likely to occur in some form in many developing countries. The toolkit consists of:

(a) A spreadsheet tool that facilitates data collection for the small, medium and mega archetypes and calculation of results to produce a national summary;

(b) A manual that provides detailed explanation on the MFA methodology with linkages to the spreadsheet tool.

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