Plan d'assurance et de contrôle qualité (AQ/CQ) de l'inventaire des gaz à effet de serre (GES) 1990–2022 : Déchets

Initiative pour la transparence de l’action climatique – ICAT

Plan d’assurance et de contrôle qualité (QA/QC) de l’inventaire des gaz à effet de serre (GES) 1990–2022 : Déchets

Livrable 2.d

Auteur : Traute Köther, Consultante Indépendant, Novembre 2025

PRÉPARÉ DANS LE CADRE DE

L’Initiative pour la transparence de l’action climatique (ICAT), soutenue par l’Autriche, le Canada, l’Allemagne, l’Italie, et la Children’s Investment Fund Foundation.

Supported by: Federal Foreign Office on the basis of a decision by the German Bundestag

IKI International Climate Initiative

CIFF Children’s Investment Fund Foundation

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PEOPLE'S DEMOCRATIC REPUBLIC OF ALGERIA

MINISTRY OF THE ENVIRONMENT AND QUALITY OF LIFE

QA/QC Plan
to the
GHG inventory 1990-2022
Waste

November 2025

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1 Waste (CRT sector 5)

1.1 Overview of the sector and background information

This chapter includes information on, and description of methodologies used for estimating GHG emissions, as well as references to activity data and emission factors reported under IPCC Sector *5 – Waste* for the period 1990 to 2022.

Emissions from the Waste sector are a source of GHGs in Algeria. In the year 2022, about 4.2% of national total GHGs emissions and 21.2% of national total CH4 emissions from Algeria originated from the Waste sector.

1.1.1 Country-specific issues

According to 2006 IPCC Guidelines it is *good practice* to account for all types of solid waste when estimating waste-related emissions in the greenhouse gas inventory. The availability and quality of data on solid waste generation as well as subsequent treatment vary significantly from country to country. In Algeria statistics on waste generation and treatment have been improved substantially during the last 10 years, but there is still gap in comprehensive waste data covering all waste types and treatment techniques. Therefore, an overall analysis was made of the collection process, disposal routes and various treatments techniques.

The following steps were done

Step 1 Definition of solid waste;

Step 2 Waste collection and waste disposal routes: Identification of waste treatments and allocation the waste to the waste treatments;

Step 3 - Compilation of activity data on waste generation per year starting from 1950;

Step 4 Estimation of GHG emission from the different waste treatments techniques.

1.1.2 Definition of solid waste

Folder	\ 06_Inventory\2024_submission\05_Waste
File	Waste.pptx
NID CHAPTER	Solid Waste Disposal (CRT category 5.A)

Solid waste is generated from households, offices, shops, markets, restaurants, public institutions, industrial installations, water works and sewage facilities, construction and demolition sites, and agricultural activities.

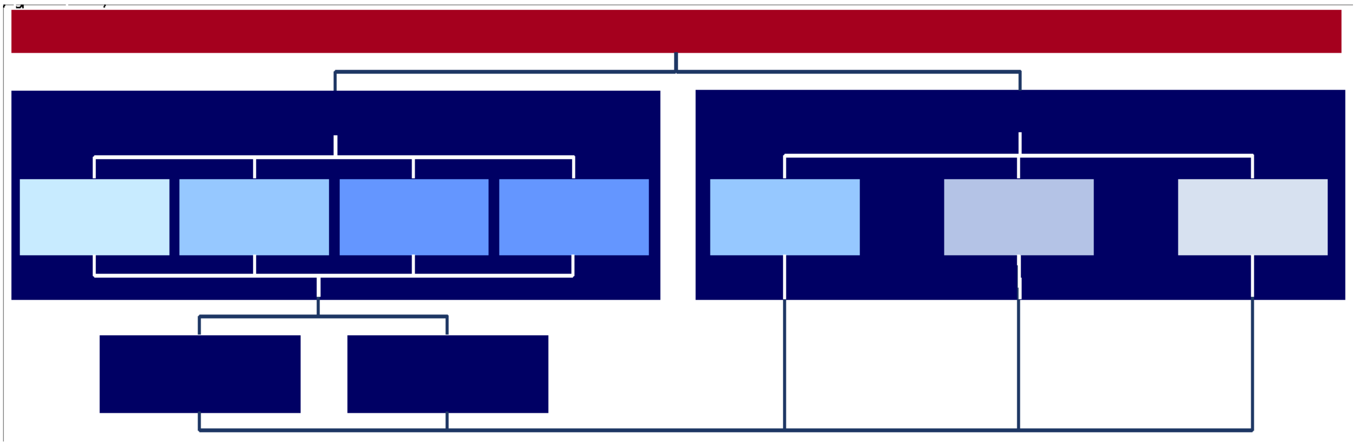

Figure 1-1 Definition of Waste

Solid waste fractions can be divided in the following fractions:

- Municipal Solid Waste (MSW) is generally defined as waste collected by municipalities or other local authorities. In Algeria, MSW includes
  - ⇒ household waste;
  - ⇒ garden (yard) and park waste; and
  - ⇒ commercial/institutional waste
  - ⇒ construction and demolition waste
- Sludge which comes from domestic and industrial wastewater treatment plants.
  - ⇒ In Algeria, Sludge is managed,
  - ⇒ On-site storage
  - ⇒ dumped, ….
- Industrial waste from different industrial sectors.
  - ⇒ In Algeria, industrial waste is managed and storage
- Clinical waste includes materials like plastic syringes, animal tissues, bandages, cloths, etc.
  - ⇒ In Algeria, clinical waste is incinerated.
- Hazardous waste which mainly consists out of waste oil, waste solvents, ash, cinder and other wastes with hazardous nature, such as flammability, explosiveness, causticity, and toxicity.

⇒ In Algeria, hazardous wastes is managed storage

- Agricultural waste, which is manure management and burning of agricultural residues, is considered in the agriculture sector.

1.1.2.1 Waste collection and waste disposal routes: waste treatments and related allocation

Waste collection and waste disposal routes: Identification of waste treatments and allocation of the waste to the related waste treatments

The collection process and the different disposal routes and treatments techniques are illustrative presented in the following figure. Solid waste management practices include collection, recycling, solid waste disposal on land, biological and other treatments as well as incineration without and with energy recovery and open burning of waste. Composting and the use of waste in agriculture needs also to be considered.

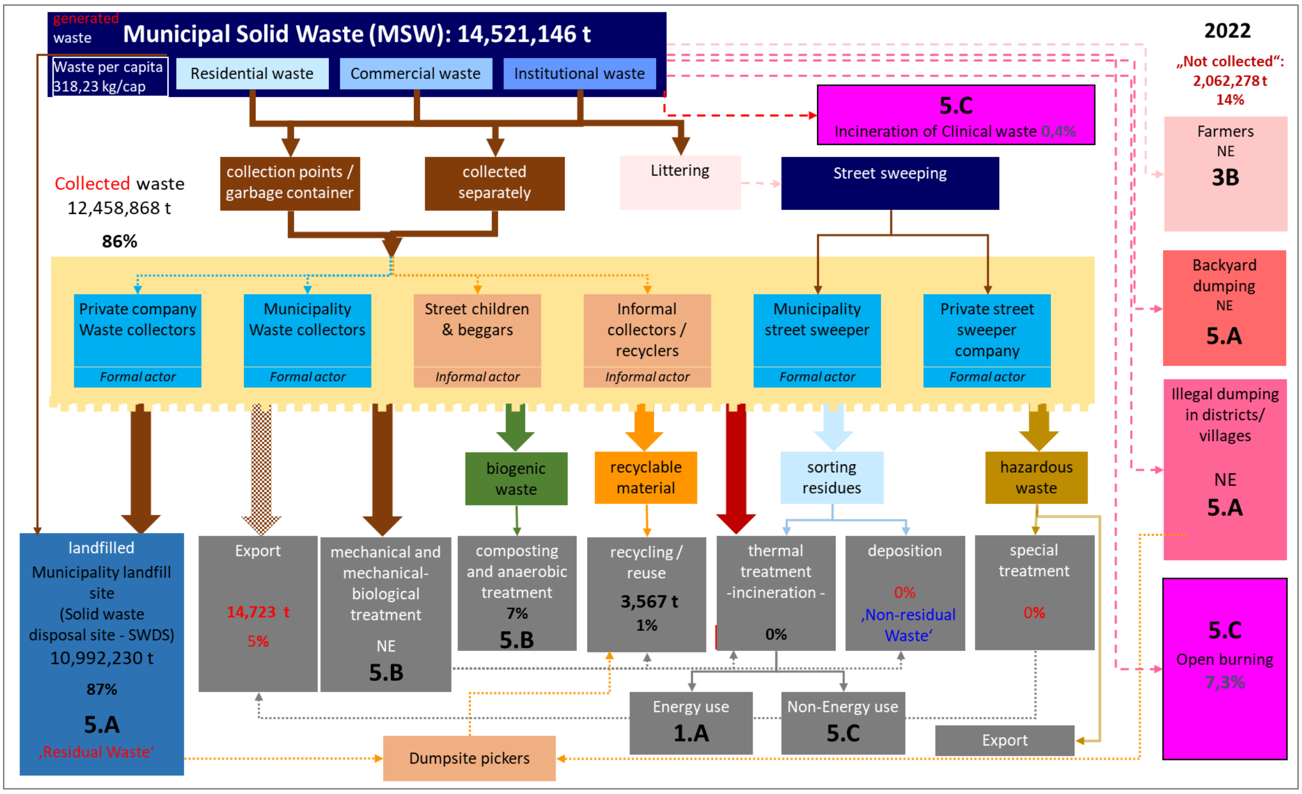

Figure 1-2 Waste collection and waste disposal route

1.1.2.2 Compilation of activity data on Municipal Solid Waste (MSW) generation (1950 -2022)

Waste generation is the product of the per capita waste generation rate - *tons / capita/year* or *kg / capita / day* - for each component and population. Historical data on waste generation are necessary to estimate GHG emissions from the different waste treatments techniques (see chapter **Error! Reference source not found.**) which also reflects changes in waste management practices (e.g., site covering, compacting, CH_4 recovery etc.). For estimating CH_4 emission from **solid waste disposal** requires data on

- waste generation of MSW for the last 72 years, starting in 1950;
- waste generation of sludge for the last 72 years, starting in 1950;

- waste generation of industrial waste for the last 72 years, starting in 1950;
- recycling rate, starting in 1950.

For all other waste treatment techniques, data required, 1990 is the starting year:

- IPCC category 5.C Open burning and/or incineration – reporting under
- IPCC category 5.B Composting and anaerobic treatment, mechanical and/or mechanical-biological treatment

1.2 Solid Waste Disposal (IPCC category 5.A)

Methodological issues

The following section describes GHG emissions resulting from solid waste disposal on land. According to the 2019 Refinements of the 2006 IPCC Guidelines, the solid waste disposal sites (SWDS) can be divided into five groups.

Table 1-1 Solid Waste Disposal Site (SWDS) Classification

IPCC Code	Description	In Algeria used
5.A.1 Managed Waste Disposal Sites	5.A.1.a. ***Anaerobic managed solid waste disposal sites*** must have controlled placement of waste (i.e., waste directed to specific deposition areas, a degree of control of scavenging and a degree of control of fires) and will include at least one of the following: (i) cover material; (ii) mechanical compacting; or (iii) levelling of the waste.	**X**
	5.A.1.b. ***Semi-aerobic managed solid waste disposal sites*** must have controlled placement of waste and will include all of the following structures for introducing air to waste layer: (i) permeable cover material; (ii) leachate drainage system; (iii) regulating pondage; and (iv) gas ventilation system.	
	5.A.1.c. **Active-aeration of managed landfills** includes the technology of in-situ low pressure aeration, air sparging, bioventing, passive ventilation with extraction (suction). These must have controlled placement of waste and will include leachate drainage system to avoid the blockage of air penetration, and (i) cover material; (ii) air injection or gas extraction system without drying of waste.	
5.A.2 Unmanaged Waste Disposal Sites	5.A.2.a ***Unmanaged solid waste disposal sites – deep and/or with high water table*** are all SWDS not meeting the criteria of managed SWDS and which have depths of greater than or equal to 5 meters and/or high-water table at near ground level. Latter situation corresponds to filling inland water, such as pond, river or wetland, by waste.	**X**
	5.A.2.b ***Unmanaged shallow solid waste disposal sites*** are all SWDS not meeting the criteria of managed SWDS and which have depths of less than 5 meters.	**X**
5.A.3 Uncategorized Waste Disposal Sites	***Uncategorized solid waste disposal sites*** are those SWDS where countries cannot categorize their landfills into above four categories of managed and unmanaged SWDS.	
Source: Table 3.1 (updated) SWDS classification and methane correction factors (MCF), 2019 Refinement to the 2006 IPCC Guidelines, Volume 5: Waste, Chapter 3: Solid Waste Disposal - 3.2.3 Choice of emission factors and parameters. Page 3.13		

The methodology used to estimate emissions from waste management activities requires country- specific knowledge on waste generation, composition and management practice. The main parameters that influence the estimation of the emissions from landfills, apart from the amount of the disposed waste, is the waste composition.

1.2.1.1 *Main Activity* Solid Waste Disposal (CRT category 5.A)

Folder	\ 06_Inventory\2024_submission\05_Waste
File	5A_Total_Waste.xlsx 5A_Urban_Waste_Model.xlsx 5A_Rural_Waste_Model.xlsx
NID CHAPTER	Solid Waste Disposal (CRT category 5.A)

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Update GHG emissions and AD in tables & graphs</td></tr>
<tr><td>from sheet</td><td>Table5.A_AD_T_Total</td><td>Table5.A_CH4_T_Total</td></tr>
<tr><td></td><td>AD</td><td>emissions</td></tr>
<tr><td>Table</td><td>C-AH</td><td>B-AC</td></tr>
<tr><td>Graph</td><td></td><td>B-Ak</td></tr>
<tr><td colspan="3">Check for updated reasons for trend in chapter
● Trend -> Waste
● Executive Summary</td></tr>
</table>

1.2.1.1.1 Category description .

GHG emissions/ removals	CO_2		CH_4		N_2O	
	Estimated	KCA	Estimated	KCA	Estimated	KCA
5.A. Solid waste disposal	NA	-	✔	LA 1990, 2020 & 2022	NA	-
5.A.1. Managed waste disposal sites	NA	-	✔	-	NA	-
5.A.1.a. Anaerobic	NA	-	✔	-	NA	-
5.A.1.b. Semi-aerobic	NA	-	NO	-	NA	-
5.A.1.c. Active aeration	NA	-	NO	-	NA	-
5.A.2 Unmanaged Waste Disposal Sites	NA	-	✔	-	NA	-
5.A.3 Uncategorized Waste Disposal Sites	NA	-	NO	-	NA	-
A '✔' indicates: emissions from this sub-category have been estimated. Notation keys: IE - included elsewhere, NO – not occurrent, NE - not estimated, NA - not applicable, C – confidential						
LA – Level Assessment (in year) without LULUCF; TA – Trend Assessment without LULUCF						

1.2.1.1.2 Methodological issues

Folder	\ 06_Inventory\2024_submission\05_Waste
File	5A_Total_Waste.xlsx
Sheet	ChoiceMethology

CH_4 Emissions from solid waste disposal on land have been calculated using the First Order Decay (FOD) method, the IPCC Tier 1 method given in the 2006 IPCC Guidelines. The choice of a *good practice* method depends on national circumstances.

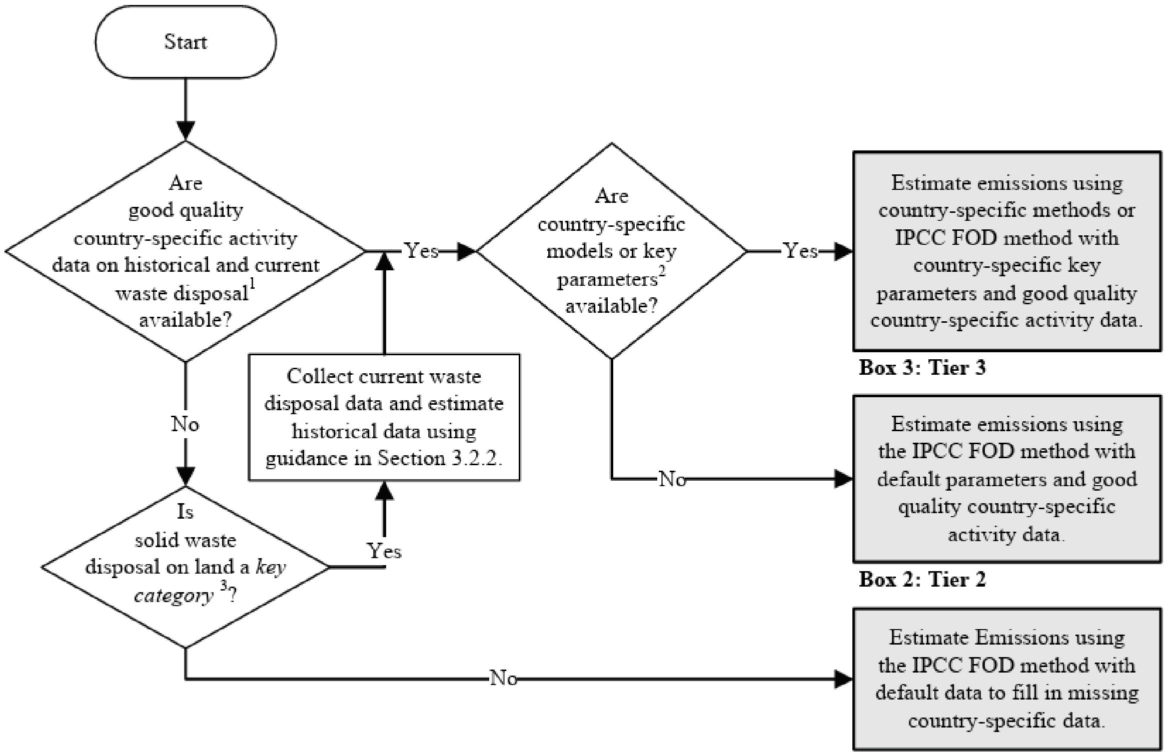
Tier 1 The estimations of the Tier 1 methods are based on the IPCC FOD method using mainly default activity data and default parameters.

Tier 2 Tier 2 methods use the IPCC FOD method and some default parameters but require good quality country-specific activity data on current and historical waste disposal at SWDS. Historical waste disposal data for 10 years or more should be based on country-specific statistics, surveys or other similar sources. Data are needed on amounts disposed at the SWDS.

Influencing factors of CH_4 Emissions generation and relevant data required:

- Waste amounts deposited / waste generated (starting year 1950)
- Waste treatment (collection, deposition/landfilling, composting, incineration/burning, recycling)
- Management practices at landfill sites – Methane correction factor (MCF)
- Conditions at landfill sites + Composition of waste deposited
- Organic carbon in landfill sites – degradable organic carbon (DOC)
- Methane generation rate constant (k)
- Landfill gas recovery, Oxidation
- National waste management policy

Figure 1-3 Decision tree for estimating CH_4 emission from Solid Waste Disposal Sites CRT category 5.A



1.2.1.1.3 Choice of methods

For estimating the CH_4 emissions the 2019 Refinement to the 2006 IPCC Guidelines Tier 1 approach[1] has been applied:

EQUATION 3.1 CH_4 emission from SWDS *(2019 Refinements to 2006 IPCC GL, Vol. 5, Chap.3)*

$$CH_4 emissions = \left[\sum_x CH_4\ generated_{x,T} - R_T\right] \times \left(1 - OX_T\right)$$

[1] Source: 2019 Refinement to the 2006 IPCC Guidelines, Volume 5: Waste, Chapter 3: Solid Waste Disposal - 3.2.1.1 FIRST ORDER DECAY (FOD)

Where:

CH_4 Emissions	= CH_4 emitted in year T (Gg)
T	= inventory year
x	= waste category (*municipal solid waste, sludge, industrial waste*) or type /material (*Food, paper, wood, textiles, etc.*)
R_T	= recovered CH_4 in year T (Gg)
OX_T	= oxidation factor in year T (fraction)

Methane generation: The **CH_4 generation potential** of the waste that is disposed in a certain year will decrease gradually throughout the following decades. In this process, the release of CH_4 from this specific amount of waste **decreases gradually**. The FOD model is built on an exponential factor that describes the fraction of degradable material which each year is degraded into CH_4.

The quantity of CH_4 emitted during decomposition process is directly proportional to the fraction of degradable organic carbon (DOC), which is defined as the carbon content of different types of organic biodegradable wastes such as paper and textiles, garden and park waste, food waste, wood and straw waste. The equations for estimating the CH_4 generation are given below. As the mathematics are the same for estimating the CH_4 emissions from all waste categories/waste types/materials, no indexing referring to the different categories/waste materials/types is used in the equations below.

Equation 3.2: Decomposable DOC from waste disposal data
(2019 Refinements to 2006 IPCC GL, Vol. 5, Chap.3)

$$DDOCm = W \times DOC \times DOC_f \times MCF$$

Where

DDOCm	= mass of decomposable DOC deposited (Gg)
W	= mass of waste deposited (Gg)
DOC	= degradable organic carbon in the year of deposition, fraction (Gg C/Gg waste)
DOC_f	= fraction of DOC that can decompose (fraction)
MCF	= CH_4 correction factor for aerobic decomposition in the year of deposition (fraction)

Although CH_4 generation potential (Lo)[2] is not used explicitly in the 2006 IPCC Guidelines, it equals the product of DDOCm, the CH_4 concentration in the gas (F) and the molecular weight ratio of CH_4 and C.

Equation 3.2: Transformation from DDOCm to L_O the year
(2019 Refinements to 2006 IPCC GL, Vol. 5, Chap.3)

$$L_o = DDOCm \times F \times \frac{16}{12}$$

Where:

Lo	= CH_4 generation potential (Gg CH_4)
DDOCm	= mass of decomposable DOC (Gg)
F	= fraction of CH_4 in generated landfill gas (volume fraction)
16/12	= molecular weight ratio CH_4/C (ratio)

Equation 3.4: DDOCm accumulated in the SWDS at the end of year T
(2019 Refinements to 2006 IPCC GL, Vol. 5, Chap.3)

$$DDOCma_T = DDOCmd_T + \left(DDOCmd_T \times e^{-k}\right)$$

Equation 3.5: DDOCm decomposed in the SWDS at the end of year T
(2019 Refinements to 2006 IPCC GL, Vol. 5, Chap.3)

$$DDOCm\ decomp_T = DDOCma_{T-1} \times \left(1 - e^{-k}\right)$$

Where:

T	= inventory year
DDOCmaT	= DDOCm accumulated in the SWDS at the end of year T (Gg)
DDOCmaT-1	= DDOCm accumulated in the SWDS at the end of year (T^{-1}) (Gg)
DDOCmdT	= DDOCm deposited into the SWDS in year T (Gg)
DDOCm decompT	= DDOCm decomposed in the SWDS in year T (Gg)
k	= reaction constant,
k	= $\ln(2)/t_{1/2}$ (y^{-1})
$t_{1/2}$	= half-life time (y)²

1.2.1.1.4 Choice of activity data

Folder	\ 06_Inventory\2024_submission\05_Waste
File	5A_Total_Waste.xlsx
based on	Waste-Activity-data_DZ.xlsx
	Reporting-Waste-Information.xlsx
	SolidWasteDisposal.xlsx
	5A_Rural_Waste_Model.xlsx
	5A_Urban_Waste_Model.xlsx
	ONS.xlsx

1.2.1.1.4.1 Choice of emission factors

Folder	\ 06_Inventory\2024_submission\05_Waste
File	5A_Total_Waste.xlsx
Sheet	IPCC-Default

1.2.1.2 Degradable organic carbon (DOC)

In the following table the applied degradable organic carbon (DOC) for various waste components is presented.

Table 1-2 Degradable organic carbon (DOC)

Degradable organic carbon (DOC) (weight fraction, wet basis)	Food	Garden	Paper	Wood	Textile	Disposable nappies	Plastics, other inert	Source
IPCC Default	0.15	0.2	0.4	0.43	0.24	0.24	0.15	Based on TABLE 2.4, Chapter 2, and EQUATION 3.7, Chapter 3, Vol. 5, 2006 IPCC Guidelines

EQUATION 3.7 Estimates DOC using default carbon content values (2006 IPCC GL, Vol. 5, Chap.3)

$$DOC = \sum_i DOC_i \times W_i$$

Where:

DOC = fraction of degradable organic carbon in bulk waste, Gg C/Gg waste

DOCi = fraction of degradable organic carbon in waste type i

Wi = fraction of waste type i by waste category

Table 1-3 Default dry matter content, DOC content, total carbon content and fossil carbon fraction of different MSW components

MSW component	Dry matter content in % of wet weight [1]	DOC content in % of wet waste		DOC content in % of dry waste		Total carbon content in % of dry weight		Fossil carbon fraction in % of total carbon	
	Default	Default	Range	Default	Range [2]	Default	Range	Default	Range
Paper/cardboard	90	40	*36 - 45*	44	*40 - 50*	46	*42 - 50*	1	*0 - 5*
Textiles [3]	80	24	*20 - 40*	30	*25 - 50*	50	*25 - 50*	20	*0 - 50*
Food waste	40	15	*8 - 20*	38	*20 - 50*	38	*20 - 50*	-	-
Wood	85 4	43	*39 - 46*	50	*46 - 54*	50	*46 - 54*	-	-
Garden and Park waste	40	20	*18 - 22*	49	*45 - 55*	49	*45 - 55*	0	*0*
Nappies	40	24	*18 - 32*	60	*44 - 80*	70	*54 - 90*	10	*10*
Rubber and Leather	84	(39) [5]	*(39) [5]*	(47) [5]	*(47) [5]*	67	*67*	20	*20*
Plastics	100	-	-	-	-	75	*67 - 85*	100	*95 - 100*
Metal [6]	100	-	-	-	-	NA	*NA*	NA	*NA*
Glass [6]	100	-	-	-	-	NA	*NA*	NA	*NA*
Other, inert waste	90	-	-	-	-	3	*0 - 5*	100	*50 - 100*

1.2.1.3 Methane Correction Factor (MCF)

The Methane Correction Factor (MCF) reflects the way in which MSW is managed and the effect of management practices on CH_4 generation. MCF accounts for the fact that unmanaged SWDS produce less CH_4 from a given amount of waste than anaerobic managed SWDS. The methodology requires countries to provide data or estimates of the quantity of waste that is disposed of to each of categories of solid waste disposal sites. 2006 IPCC Guidelines provides default values for MCF (2006 IPCC, Vol. 5: Waste Table 3.1, p.6.8).

Table 1-4 SWDS classification and methane correction factors (MCF)

Type of Site	Methane Correction Factor (MCF) Default Values	Source
(1) Managed – anaerobic	1.0	TABLE 3.1, Vol. 5, Chapter 3, 2019 Refinements to 2006 IPCC Guidelines
(2) Managed well – semi-aerobic	0.5	
(3) Managed poor – semi aerobic	0.7	
(4) Managed well – active-aeration	0.4	
(5) Managed poorly – active-aeration	0.7	
(6) Unmanaged – deep (>5 m waste) and /or high-water table	0.8	
(7) Unmanaged – shallow (<5 m waste)	0.4	
(8) Uncategorised SWDS	0.6	

Table 1-5 Recommended default methane generation rate (k) values under Tier 1 [2]

Type of Waste		Climate Zone*							
		Boreal and Temperate (MAT ≤ 20°C)				Tropical[1] (MAT > 20°C)			
		Dry (MAP/PET < 1)		Wet (MAP/PET > 1)		Dry (MAP < 1000 mm)		Moist and Wet (MAP ≥ 1000 mm)	
		Default	Range[2]	Default	Range[2]	Default	Range[2]	Default	Range[2]
Slowly degrading waste	Paper/textiles waste	**0.04**	0.03[3,5] – 0.05[3,4]	0.06	0.05 – 0.07[3,5]	0.045	0.04 – 0.06	0.07	0.06 – 0.085
	Wood/ straw waste	**0.02**	0.01[3,4] – 0.03[6,7]	0.03	0.02 – 0.04	0.025	0.02 – 0.04	0.035	0.03 – 0.05
Moderately degrading waste	Other (non – food) organic putrescible/ Garden and park waste	**0.05**	0.04 – 0.06	0.1	0.06 – 0.1[8]	0.065	0.05 – 0.08	0.17	0.15 – 0.2
Rapidly degrading waste	Food waste/Sewage sludge	**0.06**	0.05 – 0.08	0.185[4]	0.1[3,4] – 0.2[9]	0.085	0.07 – 0.1	0.4	0.17 – 0.7[10]
Bulk Waste		**0.05**	0.04 – 0.06	0.09	0.08[8] – 0.1	0.065	0.05 – 0.08	0.17	0.15[11] – 0.2

Table 1-6 Recommended default half-life (t1/2) values (YR) under Tier 1[3]

Type of Waste		Climate Zone*							
		Boreal and Temperate (MAT ≤ 20°C)				Tropical[1] (MAT > 20°C)			
		Dry (MAP/PET < 1)		Wet (MAP/PET > 1)		Dry (MAP < 1000 mm)		Moist and Wet (MAP ≥ 1000 mm)	
		Default	Range[2]	Default	Range[2]	Default	Range[2]	Default	Range[2]
Slowly degrading waste	Paper/textiles waste	**17**	14[3,5] –23[3,4]	12	10 – 14[3,5]	15	12 – 17	10	8 – 12
	Wood/ straw waste	**35**	23[3,4] –69[6,7]	23	17 – 35	28	17 – 35	20	14 – 23
Moderately degrading waste	Other (non – food) organic putrescible/ Garden & park waste	**14**	12 – 17	7	6 – 9[8]	11	9 – 14	4	3 – 5
Rapidly degrading waste	Food waste/Sewage sludge	**12**	9 – 14	44	3[3,4] – 6[9]	8	6 – 10	2	1[10] – 4
Bulk Waste		**14**	12 – 17	7	6 – 9[8]	11	9 – 14	4	3 – 5[11]

1.2.1.4 Uncertainty assessment and time-series consistency

Folder	\ 06_Inventory\2024_submission\05_Waste
File	5A_Total_Waste.xlsx
Sheet	Uncertainty
ToDo	Check for updated information in file Are QC checks performed according to QA/QC checklist?
	Cross-check and/or update in file 19R_V1_IPCC_Tool_Uncertainty_Analysis_DZA-v2_230124_graph
	Cross-check and/or update in chapter

[2] Table 3.3, Vol. 5, Chapter 3, 2006 IPCC Guidelines

[3] Table 3.4, Vol. 5, Chapter 3, 2006 IPCC Guidelines

	1.6 General uncertainty assessment, including data pertaining to the overall uncertainty of inventory totals 11.2 Annex II: Uncertainty assessment

The uncertainties for activity data and emission factors used for IPCC category 5.A *Solid Waste Disposal* are presented in the following table.

Table 1-7 Uncertainty for IPCC sub-category 5.A Solid Waste Disposal.

Uncertainty	CH_4	Source
Activity data (AD)	87%	TABLE 3.5 (UPDATED) 2019 Refinement to the 2006 IPCC GL, Vol. 5, Chap. 3.7
Emission factor (EF)	52%	
Combined Uncertainty (U)	101%	$U_{total} = \sqrt{U_{AD}^2 + U_{EF}^2}$

1.2.1.4.1 Category-specific QA/QC and verification

Folder	\ 06_Inventory\2024_submission\05_Waste
File	5A_Total_Waste.xlsx
Sheet	QC CHECKLIST

The following source-specific QA/QC activities were performed out:

- Checked of calculations by spreadsheets
  - documented sources,
  - use of units,
  - strictly defined interfaces between spreadsheets/calculation modules,
  - unique structure of sheets which do the same,
  - record keeping, use of write protection,
  - unique use of formulas, special cases are documented/highlighted,
  - quick-control checks for data consistency through all steps of calculation.
- time series consistency
- plausibility checks of dips and jumps.

1.2.1.4.2 Category-specific planned improvements including tracking of those identified in the review process

Folder	\ 06_Inventory\2024_submission\05_Waste
File	5A_Total_Waste.xlsx
Sheet	PlannedImp_5_Waste

Considering the potential contribution of identified improvements in the total GHG emissions and the corresponding resources needed to make these improvements effective, developments presented in following table will be explored.

Table 1-8 Planned improvements for IPCC sub-category 5.A Solid Waste Disposal

GHG source & sink category	Planned improvement	Type of improvement		Priority
5	Further investigation on waste flow: collection, disposal, recycling, incineration with energy and without energy recovery, open burning, composting, etc. ● By Wilaya and/or by Climate region ○ Rural population ○ Urban population ▪ Agglomerate / big cities ▪ “Other” urban ● Evaluation of existing studies	AD	Accuracy Transparency Comparability Completeness Consistency	high
5	Further investigation on waste generation (rate) ● By Wilaya and/or by Climate region (see Table 1-6 & Table 1-5) ○ Rural population ○ Urban population ▪ Agglomerate / big cities ▪ “Other” urban ● Evaluation of existing studies	AD		high
5	Further investigation on amount and waste management practices regarding clinic waste, sludge, hazardous waste, etc.	AD		medium
5	Further investigation on industrial waste generation and industrial waste management practices	AD		medium
5.A	In-depth analysis of existing data on waste collection and disposal from municipalities for application of higher TIER methodology (TIER 2): good quality country-specific activity data on current and historical waste disposal at SWDS (data for the last 30 years (or more))	AD		high
5.A	Further investigation on waste management practices (managed, unmanaged, unspecified) (see Table 1-4)	AD		high

1.3 Biological treatment of solid waste (IPCC category 5.B)

1.3.1.1.1 Category description

GHG emissions/ removals	CO_2	CH_4		N_2O	
Estimated					
5.B.1. Composting	NA	✔		✔	
5.B.2. Anaerobic digestion at biogas facilities	NA	NO	NE From 2010-2022	NO	NE From 2010-2022
Key Category	-	-		-	

A ‘✔’ indicates: emissions from this sub-category have been estimated.

Notation keys: IE - included elsewhere, NO – not occurrent, NE - not estimated, NA - not applicable, C – confidential

LA – Level Assessment (in year) without LULUCF; TA – Trend Assessment without LULUCF

The following section describes GHG emissions resulting from biological treatment of solid waste, which originates from three different processes:

- Composting,
- anaerobic digestion of organic waste, and
- mechanical-biological (MB) treatment.

Composting and anaerobic digestion of organic waste, such as food waste, garden and park waste and sludge, is common in many countries. Advantages of the biological treatment include:

- reduced volume in the waste material,
- stabilization of the waste,
- destruction of pathogens in the waste material, and
- production of biogas for energy use.

The end products of the biological treatment can, depending on its quality, be recycled as fertilizer and soil amendment, or be disposed in Solid waste disposal sites (SWDS).

Anaerobic treatment is usually linked with methane (CH_4) recovery and combustion for energy, and thus the greenhouse gas emissions from the process should be reported in the Energy Sector.

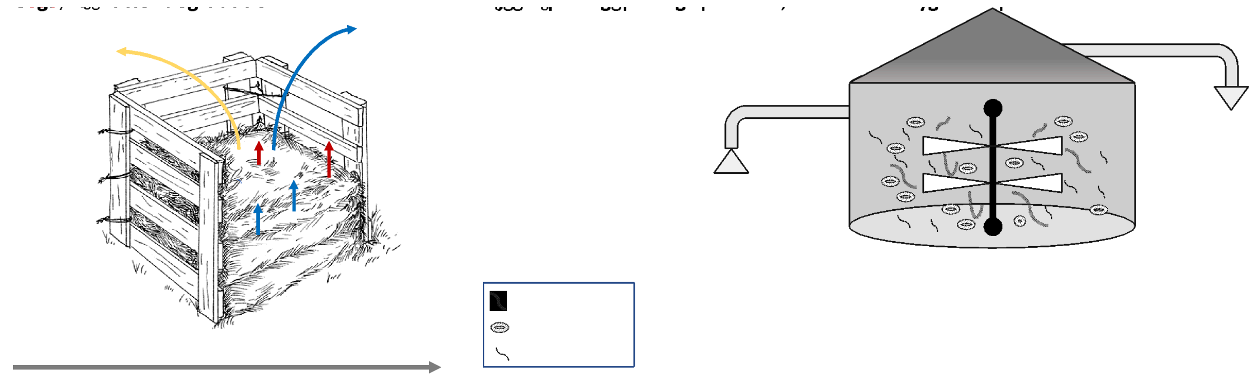


Figure 1-4 Scheme of composting and anaerobic digestion

1.3.1.1.2 Methodological issues

Folder	\ 06_Inventory\2024_submission\05_Waste
File	5B_Composting.xlsx
Sheet	ChoiceMethology

1.3.1.1.3 Choice of methods

For estimating the CH_4 and NO_2 emissions, the 2006 IPCC Guidelines Tier 1 approach[4] has been applied. CH_4 and NO_2 emissions from composting and anaerobic digestion of organic waste are result of the degradable organic carbon (DOC), composting is an aerobic process and a large fraction of the degradable organic carbon (DOC) in the waste material is converted into carbon dioxide (CO_2). CH_4 is formed in anaerobic sections of the compost, but it is oxidized to a large extent in the aerobic sections of the compost. The estimated CH_4 released into the atmosphere ranges from less than 1 % to a few per cent of the initial carbon content in the material, Composting can also produce emissions of N_2O. The range of the estimated emissions varies from less than 0.5% to 5% of the initial nitrogen content of the material (Petersen et al., 1998; Hellebrand 1998;

Vesterinen, 1996; Beck-Friis, 2001; Detzel et *al.*, 2003). Poorly working composts are likely to produce more both of CH_4 and N_2O (e.g., Vesterinen, 1996).

For estimating the CH_4 and N_2O emissions of biological treatment the default method given in Equations 4.1 and 4.2, has been applied, according to the 2006 IPCC Guidelines Tier 1 approach.

EQUATION 4.1 CH_4 Emissions from biological treatment (2006 IPCC GL, Vol. 5, Chap.4)

$$CH_4\ emissions = \sum_i (M_i \times EF_i) \times 10^{-3} - R$$

Where:

CH_4 emissions	= CH_4 emissions in inventory year (Gg)
M_i	= mass of organic waste treated by biological treatment type i (Gg)
EFj	= CH_4 emission factor (g CH_4/kg of waste treated)
i	= composting or anaerobic digestion
R	= total amount of CH_4 recovered in inventory year (Gg CH_4)

For estimating the N_2O emissions, the 2006 IPCC Guidelines Tier 1 approach has been applied.

EQUATION 4.2 N_2O Emissions from biological treatment (2006 IPCC GL, Vol. 5, Chap.4)

$$N_2O\ emissions = \sum_i (M_i \times EF_i) \times 10^{-3}$$

Where:

N_2O emissions	= N_2O emissions in inventory year (Gg)
M_i	= fraction of waste type/material of component j in the MSW (as wet weight open burned)
EF_i	= aggregate CH_4 emission factor (g N_2O/Gg of waste)
i	= category or type of waste open-burned, specified as follows:

1.3.1.1.4 Choice of activity data

Folder	\ 06_Inventory\2024_submission\05_Waste
File	5B_Composting.xlsx
based on	Waste-Activity-data_DZ.xlsx
	ONS.xlsx

[4] Source: 2006 IPCC Guidelines, Volume 5: Waste, Chapter 4: Chapter 4: Biological Treatment of Solid Waste - 4.1.1 Choice of method

1.3.1.1.4.1 Choice of emission factors

Folder	\ 06_Inventory\2024_submission\05_Waste
File	5B_Composting
Sheet	5B_Composting_GHG

Table 1-9 GHG Emission factor TIER 1 for IPCC sub-category 5.b Biological treatment of waste

Type of biological treatment	**CH_4 Emission Factors (g CH_4/kg waste treated)**		**N_2O Emission Factors (g N_2O/kg waste treated)**		**Remarks**	**Source**
	EF on a wet weight basis	**type**	**EF on a wet weight basis**	**type**		
Composting	4	D	0.24	D	Assumptions on the waste treated: 25-50% DOC in dry matter, 2% N in dry matter, Moisture content 52%.	TABLE 4.1; Chap. 4, Vol. 5, 2006 IPCC GL, p 4.6

Note:							
D	Default	CS	Country specific	PS	Plant specific	IEF	Implied emission factor

1.3.1.2 Uncertainty assessment and time-series consistency

Folder	\ 06_Inventory\2024_submission\05_Waste
File	5B_Composting.xlsx
Sheet	Uncertainty
ToDo	Check for updated information in file Are QC checks performed according to QA/QC checklist?
	Cross-check and/or update in file 19R_V1_IPCC_Tool_Uncertainty_Analysis_DZA-v2_230124_graph
	Cross-check and/or update in chapter 1.6 General uncertainty assessment, including data pertaining to the overall uncertainty of inventory totals 11.2 Annex II: Uncertainty assessment

The uncertainties for activity data and emission factors used for IPCC category 5.B *Biological treatment* are presented in the following table.

Uncertainty	**CH_4**	**N_2O**	**Reference** 2006 IPCC GL, Vol. 5, Chap. 3.7
Activity data (AD)	87%	87%	Based on Table 3.5
Emission factor (EF)	50%	50%	Based on Table 3.4 & 3.5
Combined Uncertainty (U)	132%	173%	$U_{total} = \sqrt{U_{AD}^2 + U_{EF}^2}$

1.3.1.2.1 Category-specific QA/QC and verification

Folder	\ 06_Inventory\2024_submission\05_Waste
File	5B_Composting
Sheet	QC CHECKLIST

The following source-specific QA/QC activities were performed out:

- Checked of calculations by spreadsheets
  - documented sources,
  - use of units,
  - strictly defined interfaces between spreadsheets/calculation modules,
  - unique structure of sheets which do the same,
  - record keeping, use of write protection,
  - unique use of formulas, special cases are documented/highlighted,
  - quick-control checks for data consistency through all steps of calculation.
- cross checks with other relevant sectors are performed to avoid double counting or omissions;
- time series consistency (plausibility checks of dips and jumps).

1.3.1.2.2 Category-specific planned improvements including tracking of those identified in the review process

Folder	\ 06_Inventory\2024_submission\05_Waste
File	5B_Composting.xlsx
Sheet	PlannedImp_5_Waste

Considering the potential contribution of identified improvements in the total GHG emissions and the corresponding resources needed to make these improvements effective, developments presented in following table will be explored.

Table 1-10 Planned improvements for IPCC sub-category 5.B Biological treatment of solid waste.

GHG source & sink category	Planned improvement	Type of improvement		Priority
5.B	Investigation on composting activities especially in the rural area and the use of compost in agriculture by Wilaya / climate region	AD	Accuracy	High
5.B	Investigation on composting activities of sludge by Wilaya / climate region	EF		Medium
5	Further investigation on waste flow: collection, disposal, recycling, Anaerobic digestion at biogas facilities and incineration with energy and without energy recovery, open burning, composting, etc. ● By Wilaya and/or by Climate region ○ Rural population ○ Urban population ▪ Agglomerate / big cities ▪ "Other" urban ● Evaluation of existing studies	AD	Accuracy Transparency Comparability Completeness Consistency	high
5	Further investigation on waste generation (rate) ● By Wilaya and/or by Climate region (see Table 1-6	AD		high

GHG source & sink category	Planned improvement	Type of improvement		Priority
	& Table 1-5) ○ Rural population ○ Urban population ▪ Agglomerate / big cities ▪ “Other” urban ● Evaluation of existing studies			

1.4 Incineration and Open Burning of Waste (IPCC category 5.C)

The following section describes GHG emissions resulting from waste incineration and open burning of waste, which originates from:

⇒ 5.C.1 Waste Incineration

⇒ 5.C.2 Open Burning of Waste

According to the 2006 IPCC Guidelines waste incineration and open burning of waste produces emissions of CO_2, CH_4 and N_2O.

1.4.1.1 Main Activity Incineration and Open Burning of Waste (IPCC category 5.C)

<table>
<tr><td>Folder</td><td colspan="3">\ 06_Inventory\2024_submission\05_Waste</td></tr>
<tr><td>File</td><td colspan="3">5C_OpenBurnIncin_Tool.xlsx
5C_OpenBurn-Inciner-Tool.xlsx</td></tr>
<tr><td>NID CHAPTER</td><td colspan="3">Incineration and Open Burning of Waste (CRT category 5.C)</td></tr>
<tr><td rowspan="5">ToDo</td><td colspan="3">Check for updated reasons for trend in sectoral chapter
Update GHG emissions and AD in tables & graphs
from sheet WasteData 4C2_Open-Burning_GHG</td></tr>
<tr><td></td><td>AD</td><td>emissions</td></tr>
<tr><td>Table</td><td>C-DA</td><td>A-BP</td></tr>
<tr><td>Graph</td><td>DD-DQ</td><td>BP-BV</td></tr>
<tr><td colspan="3">Check for updated reasons for trend in chapter
● Trend -> Waste
● Executive Summary</td></tr>
</table>

1.4.1.1.1 Category description .

GHG emissions/ removals	CO_2	CH_4	N_2O
Estimated			
5.C.1 Waste incineration (Biogenic / Non-biogenic)			
5.C.1.a.i. Municipal Solid waste	NE	NE	NE
5.C.1.a.ii. Other			
5.C.1.a.ii.1. Industrial Waste	NE	NE	NE
5.C.1.a.ii.2. Sewage Sludge	NE	NE	NE
5.C.1.a.ii.3. Clinical Waste	✔	✔	✔
5.C.1.a.ii.4. Hazardous Waste	NE	NE	NE
5.C.1.a.ii.5. Other	NE	NE	NE
5.C.2 Open Burning of Waste (Biogenic / Non-biogenic)			
5.C.2.a.i. Municipal Solid waste	✔	✔	✔
5.C.2.a.ii. Other			
5.C.2.a.ii.1. Industrial Waste	NE	NE	NE
5.C.2.a.ii.2. Sewage Sludge	NE	NE	NE
5.C.2.a.ii.3. Clinical Waste	NE	NE	NE

GHG emissions/ removals	CO_2	CH_4	N_2O
5.C.2.a.ii.4. Hazardous Waste	NE	NE	NE
5.C.2.a.ii.5. Other	NE	NE	NE
Key Category			-
5.C.1 Waste incineration	-	-	-
5.C.2 Open Burning of Waste	- LA 2022	-	-
A '✔' indicates: emissions from this sub-category have been estimated. Notation keys: IE - included elsewhere, NO – not occurrent, NE - not estimated, NA - not applicable, C – confidential			
LA – Level Assessment (in year) without LULUCF; TA – Trend Assessment without LULUCF			

1.4.1.1.2 Methodological issues

Folder	\ 06_Inventory\2024_submission\05_Waste
File	5C_OpenBurn-Inciner-Tool.xlsx
Sheet	ChoiceMethology

Figure 1-5 Decision tree for estimating CO2 emission from CRT category 5.C Incineration and open burning of waste

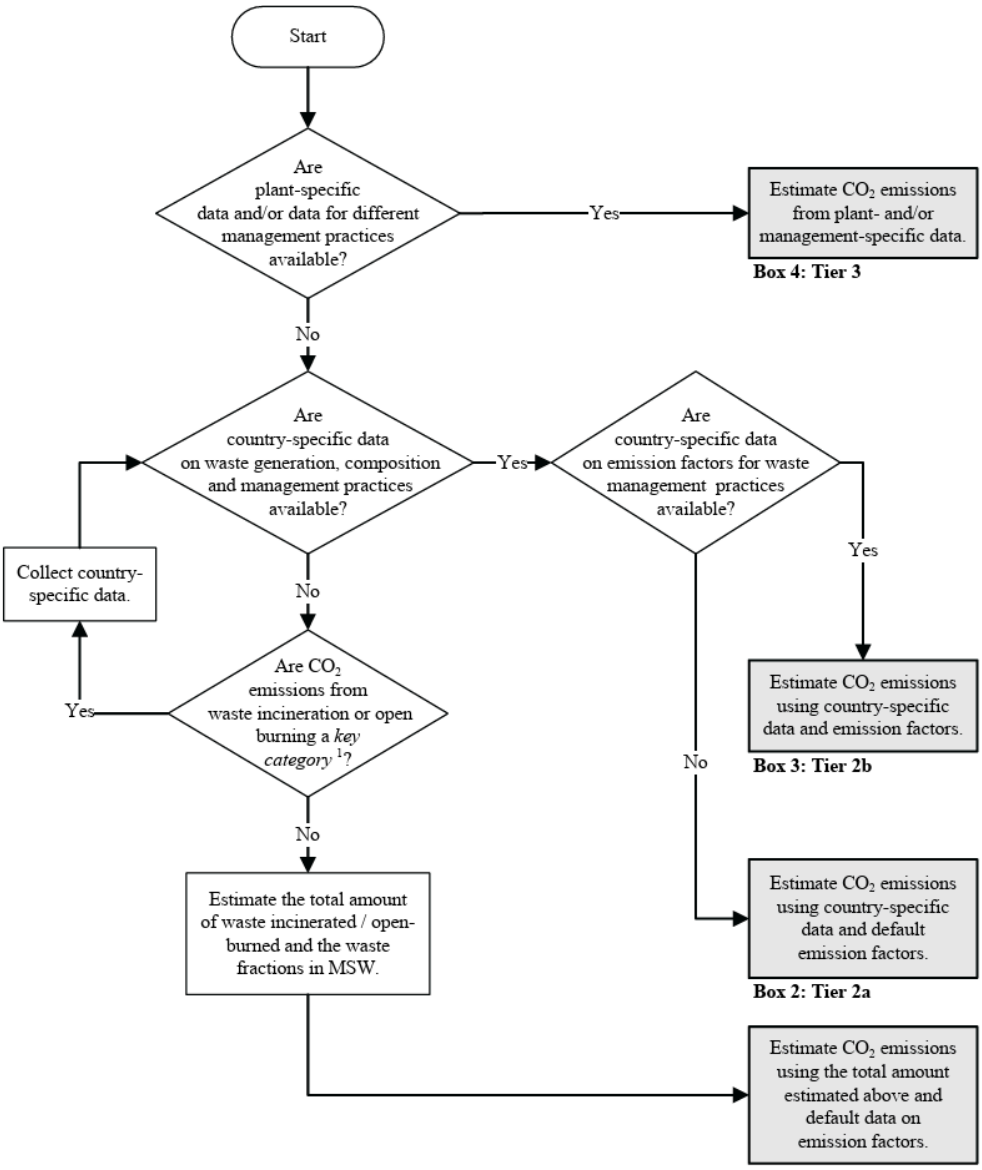
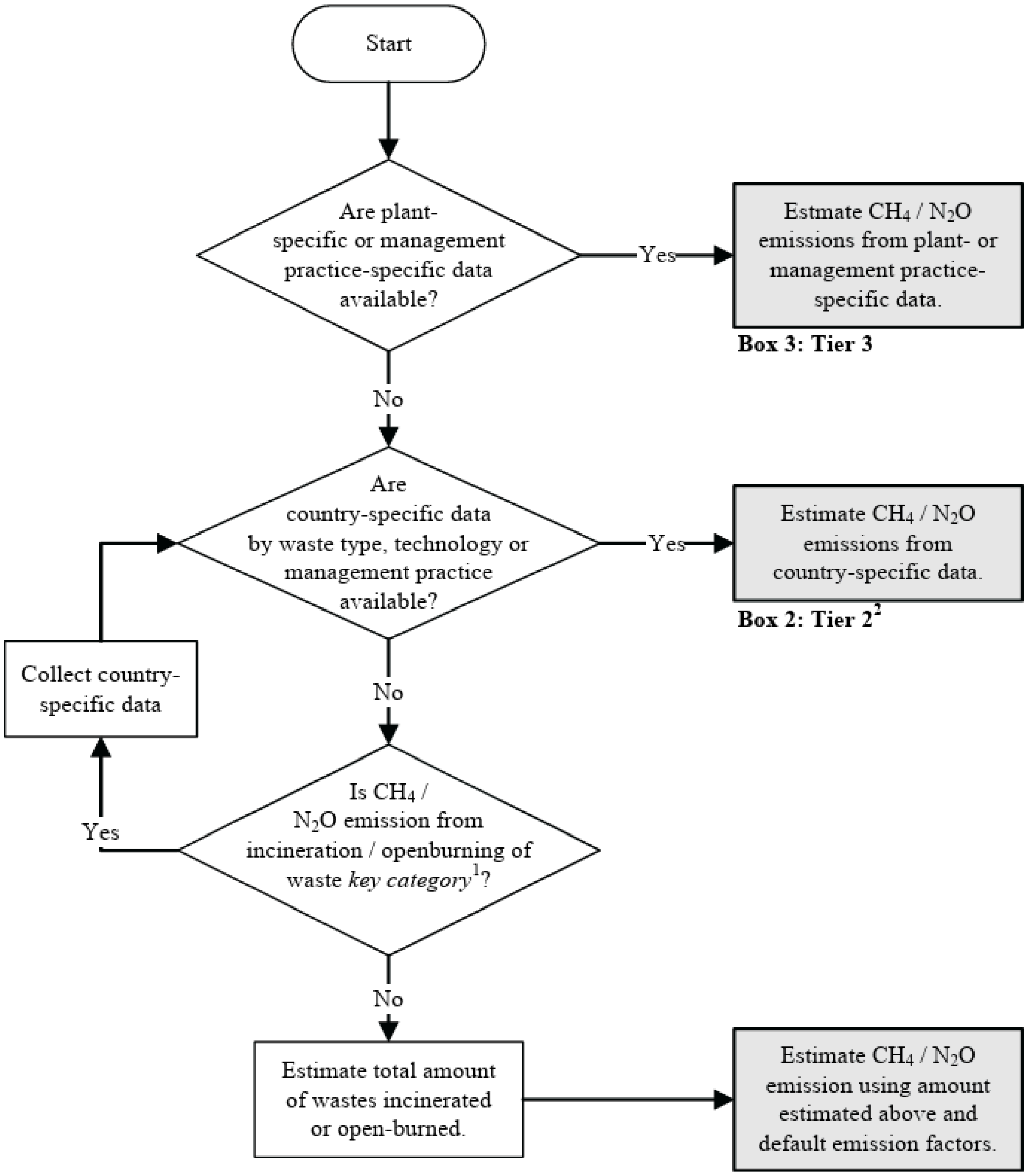


Figure 1-6 Decision tree for estimating CH4 and N2O emission from CRT category 5.C Incineration and open burning of waste



1.4.1.1.3 Choice of methods

For estimating the CO_2 emissions, the 2006 IPCC Guidelines Tier 1 approach[5] has been applied.

EQUATION 5.1 CO_2 Emission estimate based on the total amount of waste combusted (2006 IPCC Guidelines, Volume 5: Waste, Chap. 5)

$$CO_2\ emissions = M \sum_i (SW_i \times dm_i \times CF_i \times FCF_i \times OF_i) \times \frac{44}{12}$$

[5] Source: 2006 IPCC Guidelines, Volume 5: Waste, Chapter 5: Incineration and Open Burning of Waste - 5.2.2 Choice of method for estimating CO_2 emissions

Where:

CH_4 emissions = CH_4 emissions in inventory year (Gg)
WF_i = fraction of waste type of component j in the MSW (as wet weight open burned)
dm_i = dry matter content in the waste (wet weight) open-burned (fraction)
CF_i = fraction of carbon in the dry matter (total carbon content) (fraction)
FCF_i = fraction of fossil carbon in the total carbon, (fraction)
OF_i = oxidation factor (fraction)
44/12 = conversion factor from C to CO_2
i = type of waste open-burned specified as follows:

MSW ⇒ estimated

ISW: industrial solid waste ⇒ not estimated

HW: hazardous waste ⇒ not estimated

CW: clinical waste ⇒ estimated

SS: sewage sludge ⇒ not estimated

For Municipal Solid waste (MSW), it is *good practice* to calculate the CO_2 emissions on the basis of waste types/material (such as paper, wood, plastics) in the waste open-burned.

EQUATION 5.2 CO_2 Emission estimate based on the total amount of waste combusted (2006 IPCC GL, Vol. 5: Waste, Chap. 5)

$$CO_2\ emissions = MSW \times \sum_j (WF_j \times dm_j \times CF_j \times FCF_j \times OF_j) \times \frac{44}{12}$$

Where:

CO_2 Emissions = CO_2 emissions in inventory year (Gg)
MSW = total amount of municipal solid waste as wet weight open-burned (Gg)
WF_j = fraction of waste type/material of component j in the MSW (as wet weight open burned)
dm_j = dry matter content in the waste (wet weight) open-burned (fraction)
CFj = fraction of carbon in the dry matter (total carbon content) (fraction)
FCF_j = fraction of fossil carbon in the total carbon, (fraction)
OF_j = oxidation factor (fraction)
44/12 = conversion factor from C to CO_2

with: $\sum_j WF_j = 1$

j = component of the MSW open-burned such as paper/cardboard, textiles, food waste, wood, garden & park waste, disposable nappies, rubber and leather, plastics, metal, glass, other inert waste.

For estimating the CH_4 emissions the 2006 IPCC Guidelines Tier 1 approach[6] has been applied. CH_4 emissions from incineration and open burning of waste are a result of incomplete combustion. Important factors affecting the emissions are temperature, residence time, and air ratio (i.e., air volume in relation to the waste amount). The CH_4 emissions are particularly relevant for open burning, where a large fraction of carbon in the waste is not oxidized. The conditions can vary much, as waste is a very heterogeneous and a low-quality fuel with variations in its calorific value.

EQUATION 5.4 CH_4 Emission estimate based on the total amount of waste combusted (2006 IPCC GL, Vol. 5: Waste, Chap. 5)

$$CH_4\ emissions = \sum_i (IW_i \times EF_i) \times 10^{-6}$$

Where:

CH_4 emissions	= CH_4 emissions in inventory year (Gg)
MSW	= total amount of municipal solid waste as wet weight open-burned (Gg)
IW_i	= amount of solid waste of type *i* incinerated or open-burned, Gg/yr
EFj	= aggregate CH_4 emission factor (kg CH_4/Gg of waste)
10^{-6}	= conversion factor from kilogram to gigagram
i	= category or type of waste incineration and waste open-burned, specified as follows:

MSW: municipal solid waste ⇒ estimated

ISW: industrial solid waste ⇒ not estimated

HW: hazardous waste ⇒ not estimated

CW: clinical waste ⇒ estimated

SS: sewage sludge ⇒ not estimated

For estimating the Nitrous oxide (N_2O) emissions the 2006 IPCC Guidelines Tier 1 approach[7] has been applied. N_2O is emitted in combustion processes at relatively low combustion temperatures between 500 and 950 °C.

EQUATION 5.5 N_2O emission estimate based on the total amount of waste combusted (2006 IPCC GL, Vol. 5: Waste, Chap. 5)

$$N_2O\ emissions = \sum_i (IW_i \times EF_i) \times 10^{-6}$$

Where:

N_2O emissions	= N_2O emissions in inventory year (Gg)
IW_i	= amount of solid waste of type *i* incinerated or open-burned, Gg/yr
EF_i	= aggregate N_2O emission factor (kg N_2O/Gg of waste)
10^{-6}	= conversion factor from kilogram to giga gram
i	= category or type of waste incineration and waste open-burned, specified as follows:

MSW: municipal solid waste ⇒ estimated

ISW: industrial solid waste ⇒ not estimated

[6] 2006 IPCC Guidelines, Volume 5: Waste, Chapter 5: Incineration and Open Burning of Waste - 5.2.2 Choice of method for estimating CH_4 emissions

[7] 2006 IPCC Guidelines, Volume 5: Waste, Chapter 5: Incineration and Open Burning of Waste - 5.2.2 Choice of method for estimating N_2O emissions

HW: hazardous waste	⇒ not estimated
CW: clinical waste	⇒ estimated
SS: sewage sludge	⇒ not estimated

1.4.1.1.4 Choice of activity data

Folder	\ 06_Inventory\2024_submission\05_Waste
File	5C_OpenBurn-Inciner-Tool.xlsx
based on	Waste-Activity-data_DZ.xlsx
	OpenBurn-Inciner-Tool.xlsx
	Hospital-Waste.xlsx
	ONS.xlsx

1.4.1.1.5 Choice of emission factors

Folder	\ 06_Inventory\2024_submission\05_Waste
File	5C_OpenBurn-Inciner-Tool.xlsx
Sheet	4C1_Incineration_GHG 4C2_Open-Burning_GHG

Table 1-11 Default dry matter content, DOC content, total carbon content and fossil carbon fraction of different MSW components

MSW component	Dry matter content in % of wet weight [1] dm	Total carbon content in % of dry weight CF		Fossil carbon fraction in % of total carbon FCF	
	Default	Default	Range	Default	Range
Paper/cardboard	90	46	42 - 50	1	0 - 5
Textiles [3]	80	50	25 - 50	20	0 - 50
Food waste	40	38	20 - 50	-	-
Wood	85 4	50	46 - 54	-	-
Garden and Park waste	40	49	45 - 55	0	0
Nappies	40	70	54 - 90	10	10
Rubber and Leather	84	67	67	20	20
Plastics	100	75	67 - 85	100	95 - 100
Metal [6]	100	NA	NA	NA	NA
Glass [6]	100	NA	NA	NA	NA
Other, inert waste	90	3	0 - 5	100	50 - 100

Remark: for footnotes see 2006 IPCC Guidelines

Source: Table 2.4 (excerpt), Vol. 5, Chapter 2, 2006 IPCC Guidelines

1.4.1.1.6 Uncertainty assessment and time-series consistency

Folder	\ 06_Inventory\2024_submission\05_Waste
File	5C_OpenBurn-Inciner-Tool.xlsx
Sheet	Uncertainty
ToDo	Check for updated information in file Are QC checks performed according to QA/QC checklist?
	Cross-check and/or update in file 19R_V1_IPCC_Tool_Uncertainty_Analysis_DZA-v2_230124_graph
	Cross-check and/or update in chapter 1.6 General uncertainty assessment, including data pertaining to the overall uncertainty of inventory totals 11.2 Annex II: Uncertainty assessment

The uncertainties for activity data and emission factors used for IPCC category *5.C. Incineration and open burning of waste* are presented in the following table.

Table 1-12 Uncertainty for IPCC sub-category 5.C.1. Incineration of waste.

Uncertainty	CO_2	CH_4	N_2O	Reference
Activity data (AD)	27%	27%	27%	2006 IPCC GL, Vol. 5, Chap. 5.7 (5.7.2 Activity data uncertainties)
Emission factor (EF)	40%	100%	100%	2006 IPCC Guidelines Vol. 5, Chap. 5 (5.7.1 Emission factor uncertainties)
Combined Uncertainty (U)	48%	104%	104%	$U_{total} = \sqrt{U_{AD}^2 + U_{EF}^2}$

Table 1-13 Uncertainty for IPCC sub-category 5.C.2 Incineration and open burning of waste.

Uncertainty	CO_2	CH_4	N_2O	Reference
Activity data (AD)	87%	87%	87%	2006 IPCC GL, Vol. 5, Chap. 5.7 Based on Table 3.5
Emission factor (EF)	25%	100%	100%	2006 IPCC Guidelines Vol. 5, Chap. 5 (5.7.1)
Combined Uncertainty (U)	90%	132%	132%	$U_{total} = \sqrt{U_{AD}^2 + U_{EF}^2}$

1.4.1.1.7 Category-specific QA/QC and verification

Folder	\ 06_Inventory\2024_submission\05_Waste
File	5C_OpenBurn-Inciner-Tool.xlsx
Sheet	QC CHECKLIST

The following source-specific QA/QC activities were performed:

- Checked of calculations by spreadsheets
    - documented sources,
    - use of units,
    - strictly defined interfaces between spreadsheets/calculation modules,
    - unique structure of sheets which do the same,
    - record keeping, use of write protection,

  - unique use of formulas, special cases are documented/highlighted,
  - quick-control checks for data consistency through all steps of calculation.
- cross checks with other relevant sectors are performed to avoid double counting or omissions
- time series consistency
- plausibility checks of dips and jumps.

1.4.1.1.8 Category-specific planned improvements including tracking of those identified in the review process

Folder	\ 06_Inventory\2024_submission\05_Waste
File	5C_OpenBurn-Inciner-Tool.xlsx
Sheet	PlannedImprove

Considering the potential contribution of identified improvements in the total GHG emissions and the corresponding resources needed to make these improvements effective, developments presented in following table will be explored.

GHG source & sink category	Planned improvement	Type of improvement		Priority
5.C	Investigation on composting activities especially in the rural area the open burning is practiced by Wilaya / climate region	AD	Accuracy	High
5.C	Investigation on incineration (with and without energy recovery) and open burning activities of ● Industrial solid wastes ● Hazardous waste ● Clinical waste ● Sewage sludge ● Other by Wilaya / climate region	EF		Medium
5.C	Further investigation on waste flow: collection, disposal, recycling, Anaerobic digestion at biogas facilities and incineration with energy and without energy recovery, open burning, composting, etc. ● By Wilaya and/or by Climate region ○ Rural population ○ Urban population ▪ Agglomerate / big cities ▪ “Other” urban ● Evaluation of existing studies	AD	Accuracy Transparency Comparability Completeness Consistency	high

GHG source & sink category	Planned improvement	Type of improvement		Priority
5.C	Further investigation on waste generation (rate) ● By Wilaya and/or by Climate region (see Table 1-6 & Table 1-5) ○ Rural population ○ Urban population ▪ Agglomerate / big cities ▪ “Other” urban ● Evaluation of existing studies	AD		High

1.5 Wastewater Treatment and Discharge (IPCC category 5.D)

1.5.1 Category description

GHG emissions/ removals	CO_2	CH_4	N_2O
Estimated			
5.D.1. Domestic wastewater	NA	✔	✔
Recovery	NA	NE	NE
5.D.2. Industrial wastewater	NA	NE	NE
Recovery	NA	NE	NE
5.D.3. Other	NA	NE	NE
Recovery	NA	NE	NE
Key Category	-	LA 1990 & 2022	-
A '✔' indicates: emissions from this sub-category have been estimated. Notation keys: IE - included elsewhere, NO – not occurrent, NE - not estimated, NA - not applicable, C – confidential			
LA – Level Assessment (in year) without LULUCF; TA – Trend Assessment without LULUCF			

This chapter includes the CH_4 and N_2O emissions estimations from *domestic and Industrial wastewater* Treatment and Discharge*.* The IPCC category 5.D *wastewater* Treatment and Discharge is for CH_4 a Key Category

The following section describes GHG emissions resulting from Wastewater Treatment and Discharge. According to 2006 IPCC Guidelines wastewater can be a source of methane (CH_4) when treated or disposed anaerobically. It can also be a source of nitrous oxide (N_2O) emissions. Carbon dioxide (CO_2) emissions from wastewater are not considered because these are of biogenic origin and should not be included in national total emissions.

Nitrous Oxide (N_2O)

There are two sources of N_2O emissions:

- Indirect N_2O emissions from discharge of effluent into waterways, lakes and sea.
- Direct N_2O emissions from treatment plants which are low compared to indirect emissions

Nitrous oxide (N_2O) is associated with the degradation of nitrogen components in the wastewater, e.g., urea, nitrate and protein. Domestic wastewater includes human sewage mixed with other household wastewater, which can include effluent from shower drains, sink drains, washing machines, etc.

Methane (CH_4)

Wastewater as well as its sludge components can produce CH_4 if it degrades anaerobically. The extent of CH_4 production depends primarily on the quantity of degradable organic material in the wastewater, the temperature, and the type of treatment system. With increases in temperature, the rate of CH_4 production increases. This is especially important in uncontrolled systems and in warm climates.

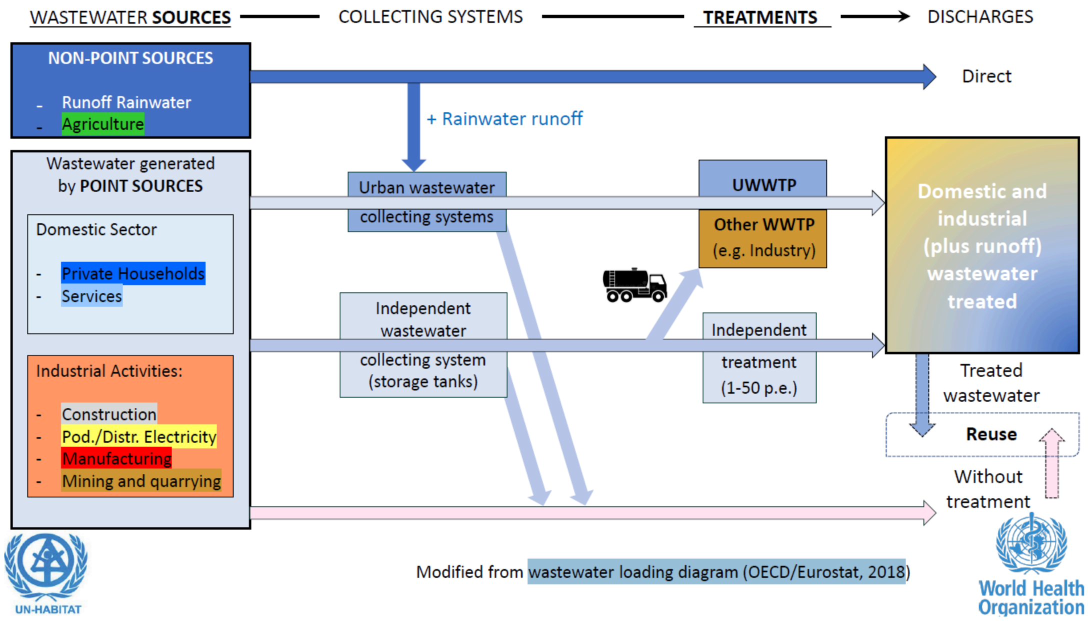


Figure 1-7 Wastewater flow

Wastewater is defined as

- domestic effluent consisting of blackwater (excreta, urine and faecal sludge) and grey-water (kitchen and bathing wastewater), or
- water from commercial establishments and institutions, including hospitals, or
- industrial effluent, storm water and other urban run-off.

Sanitation services have, mainly understandably, been given less priority than water supply since people tend to grant more urgency to the provision of water. Access to improved sanitation can have different interpretations from one country to another. Septic tanks, latrines, river and lake discharge and sewer are om many developing countries the main domestic treatment and discharge facilities. In 2022, among the five treatment and discharge systems were the commonest.

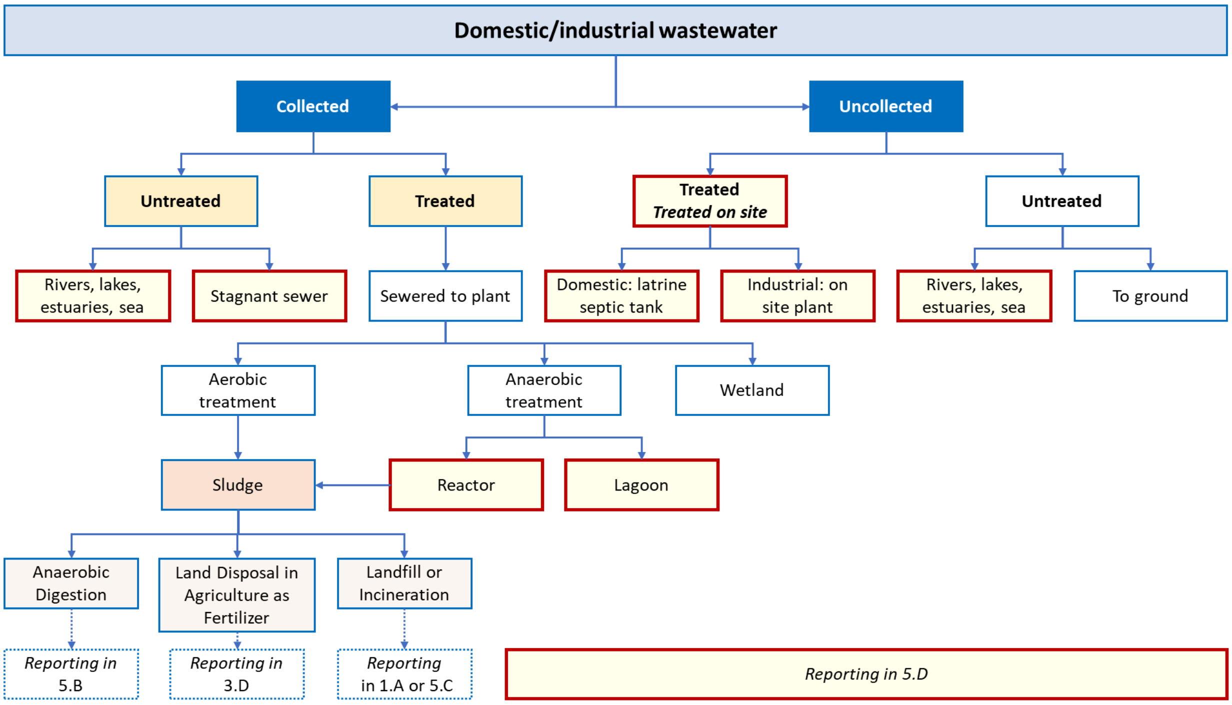


Figure 1-8 Wastewater treatment systems and discharge pathways[8]

Further differentiation was done according to the split provided in the 2006 IPCC Guidelines[9].

Type of treatment and discharge pathway or system	Comments
Untreated system	
Open defecation	
River and lake discharge	Rivers with high organics loadings can turn anaerobic.
Stagnant sewer	calculated in order to have always 100%
Treated system	
Flowing sewer (open or closed)	Fast moving, clean. (Insignificant amounts of CH_4 from pump stations, etc)
Centralized, aerobic treatment plant	Must be well managed. Some CH_4 can be emitted from settling basins and other pockets.
Centralized, aerobic treatment plant	Not well managed. Overloaded.
Anaerobic digester for sludge	CH_4 recovery is not considered here.
Anaerobic reactor	CH_4 recovery is not considered here.
Anaerobic shallow lagoon	Depth less than 2 meters use expert judgment.
Anaerobic deep lagoon	Depth more than 2 meters
Septic system	Half of BOD settles in anaerobic tank.

[8] According to 2006 IPCC Guidelines, Volume 5: Waste, Chapter 6: Wastewater Treatment and Discharge - Figure 6.1

[9] Table 6.3, Chap. 6.2.2.2, Volume 5, 2006 IPCC Guidelines

Type of treatment and discharge pathway or system	Comments
Latrine (family)	Dry climate, ground water table lower than latrine, small family (3-5 persons)
Latrine (many user)	Dry climate, ground water table lower than latrine, communal (many users)
Latrine	Wet climate/flush water use, ground water table higher than latrine
Latrine	Regular sediment removal for fertilizer

1.5.2 Methodological issues

Folder	\ 06_Inventory\2024_submission\05_Waste
File	5D_WasteWater-Tool.xlsx
Sheet	ChoiceMethology

Figure 1-9 Decision tree for estimating CH4 emission from CRT category 5.D domestic wastewater

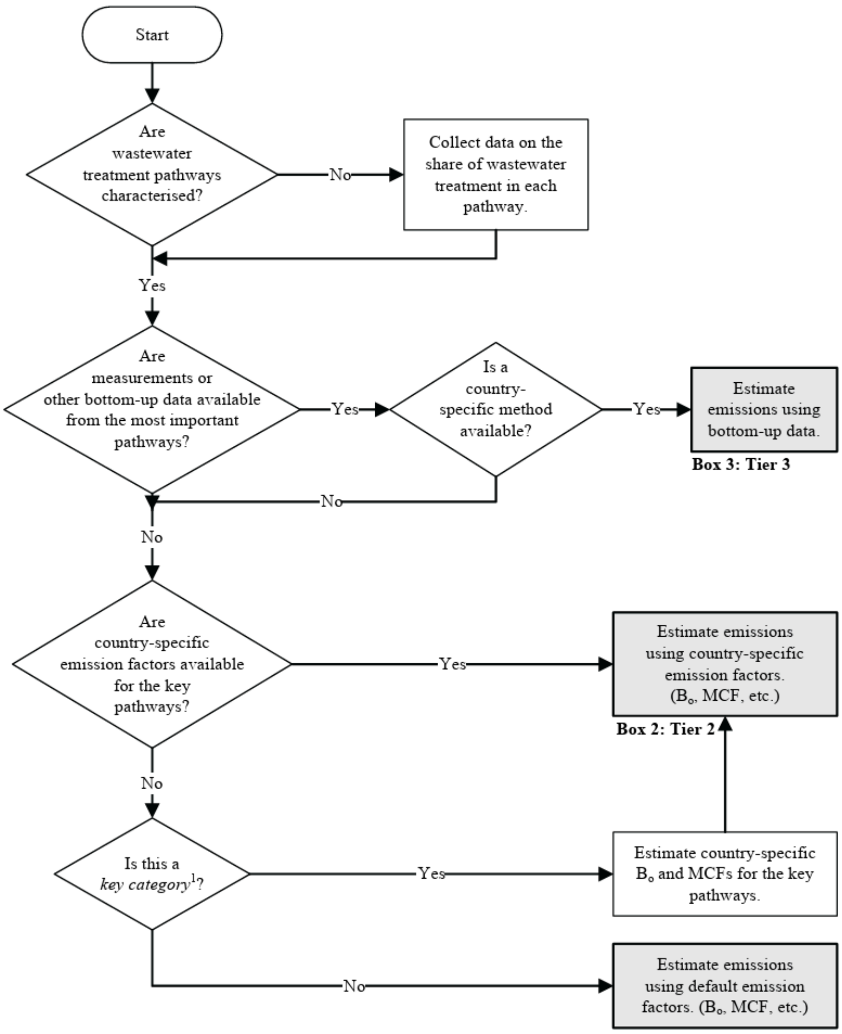
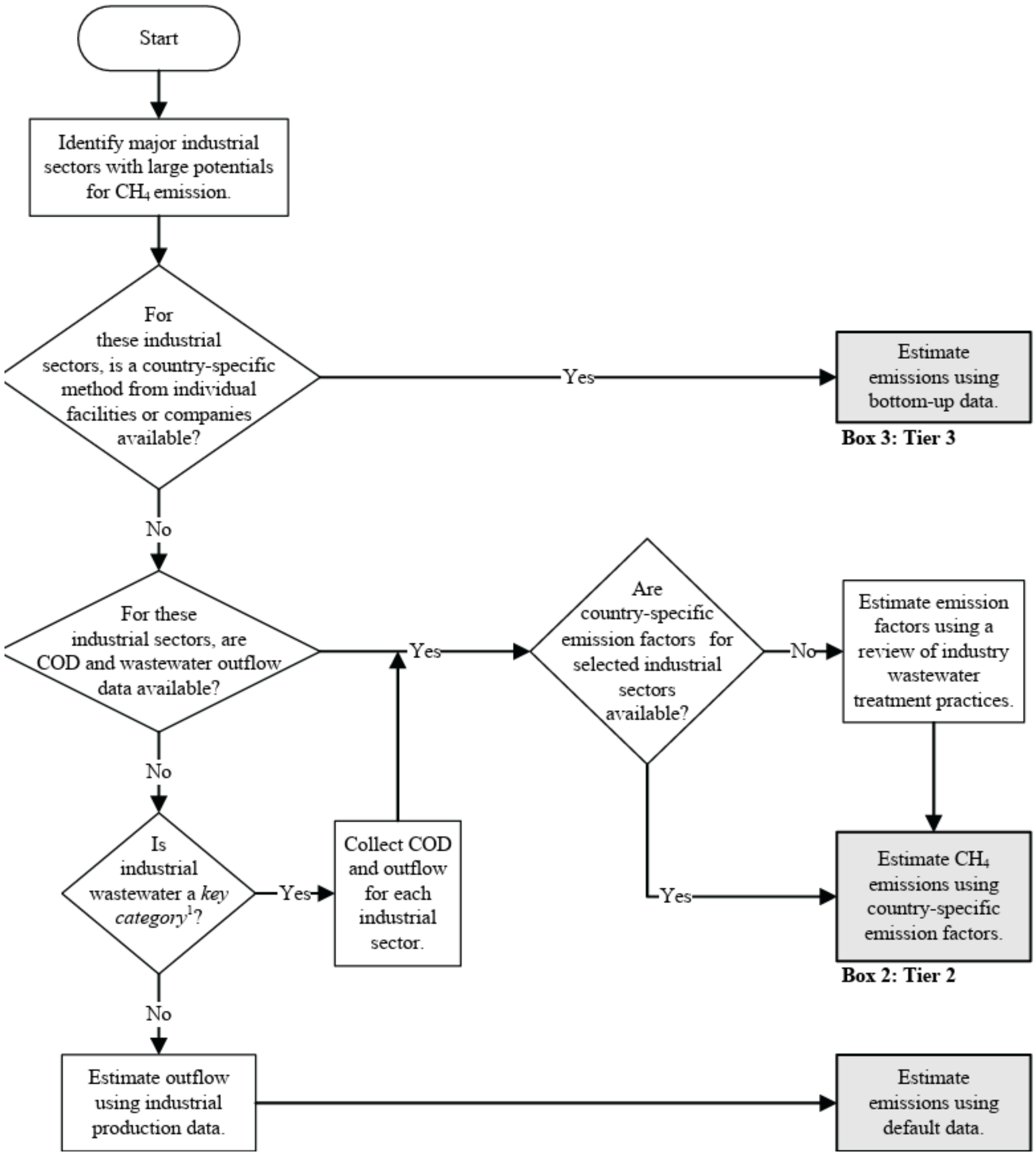


Figure 1-10 Decision tree for estimating CH4 emission from CRT category 5.D wastewater treatment



1.5.2.1 Choice of methods

The steps for *good practice* in inventory preparation for CH_4 from domestic wastewater are as follows:

Step 1: Use Equation 6.3 to estimate total organically degradable carbon in wastewater (TOW).

Step 2: Select the pathway and systems (See Figure 1-8 Wastewater treatment systems and discharge pathways (Figure 6.1 in 2006 IPCC GL, Vol. 5, Chapter 6) according to country activity data. Use Equation 6.2 to obtain the emission factor for each domestic wastewater treatment/discharge pathway or system.

Step 3: Use Equation 6.1 to estimate emissions, adjust for possible sludge removal and/or CH_4 recovery and sum the results for each pathway/system.

CH_4 emissions from domestic wastewater for each treatment/discharge pathway or system, j

Equation 6.1, 2019 Refinement to the 2006 IPCC GL, Vol. 5, Chapter 6, page 6.17

$$CH_4\,emissions = \left[\left(TOW_j - S_j\right) * EF_j - R_j\right]$$

where

CH_4 Emissions	= CH_4 emissions from treatment/discharge pathway or system, j, in year, kg CH_4/yr
TOW	= organics in wastewater of treatment/discharge pathway or system, j, in year, kg BOD/yr
S_j	= organic component removed from wastewater (in the form of sludge) from treatment/discharge pathway or system, j, in inventory year, kg BOD/y
Ui	= fraction of population in income group i in inventory year, See Table 6.5.
j	= each treatment/discharge pathway or system
EF_j	= emission factor, kg CH_4 / kg BOD
R_j	= amount of CH_4 recovered in inventory year, kg CH_4/yr

Due to lack of data, currently it is assumed that sludge was removed. Therefore, the emission from sludge are included in 5.D.

Total CH_4 emissions from domestic wastewater treatment and discharge

Equation 6.1A, 2019 Refinement to the 2006 IPCC GL, Vol. 5, Chapter 6, page 6.17

$$CH_4\,emissions = \sum_j \left[CH_4\,emission\right] * \left[10^{-6}\right]$$

where

CH_4 Emissions	= CH_4 emissions in inventory year, kg CH_4/yr
CH_4 $Emissions_j$	= CH_4 emissions from treatment/discharge pathway or system, j, in year, kg CH_4/yr
j	= each treatment/discharge pathway or system
10^{-6}	= conversion of kg to Gg

The N_2O emissions are estimated according to TIER 1 methodology from 2006 IPCC GL:

Total N_2O emissions from wastewater effluent

Equation 6.7, 2006 IPCC GL, Vol. 5, Chapter 6, page 6.25

$$N_2O\,emissions = N_{effluent} * EF_{effluent} * \frac{44}{28}$$

Where

N_2O emissions	= N_2O emissions in inventory year, kg N_2O/yr
$N_{EFFLUENT}$	= nitrogen in the effluent discharged to aquatic environments, kg N/yr
$EF_{EFFLUENT}$	= emission factor for N_2O emissions from discharged to wastewater, kg N_2O-N/kg N
44/28	= The factor 44/28 is the conversion of kg N_2O-N into kg N_2O.

1.5.2.2 Choice of activity data

Folder	\ 06_Inventory\2024_submission\05_Waste
File	5D_WasteWater-Tool.xlsx
based on	Waste-Activity-data_DZ.xlsx
	Taux de raccordement national assainissement.xlsx
	Officiel données DEM ONA 2010-2022.xlsx

	ONS.xlsx
	JMP_2023_DZA_Algeria.xlsx

1.5.2.3 Choice of CH_4 emission factor

Folder	\ 06_Inventory\2024_submission\05_Waste
File	5D_WasteWater-Tool.xlsx
Sheet	EF_Parameter_DomesticWW EF_Parameter_IndustrialWW IndustrialWW

CH_4 Emission Factor for each Domestic Wastewater Treatment/Discharge Pathway or System

Equation 6.2, 2006 IPCC GL, Vol. 5, Chapter 6, page 6.12

$$EF_j = B_o * MCF_j$$

where

EF_j = emission factor, kg CH_4/kg BOD

j = each treatment/discharge pathway or system

Bo = maximum CH_4 producing capacity, kg CH_4/kg BOD

MCF_j = methane correction factor (fraction)

Table 1-14 Producing capacity (B_o) for domestic wastewater

Parameter	Value	Source
Bo Producing capacity for domestic wastewater	0.6 kg CH_4/kg BOD	IPCC default TABLE 6.2, 2006 IPCC GL, Vol. 5, Chapter 6, page 6.12

Table 1-15 Default MCF values and resultant EFs for domestic wastewater by type of treatment system and discharge pathway

Type of treatment and discharge pathway or system	Comments	MCF [1]	MCF [1] Range	EF[2] kg CH_4/kg BOD	EF[2] kg CH_4/kg COD
Discharge from treated or untreated system					
Discharge to aquatic environments (Tier 1)	Most aquatic environments including rivers are supersaturated in CH_4. Nutrient oversupply will increase CH_4 emissions. Environments where carbon accumulates in sediments have higher potential for methane generation.	0.11	(0.004 – 0.27)	0.068	0.028

Type of treatment and discharge pathway or system	Comments	MCF [1]	MCF [1] Range	EF[2] kg CH_4/kg BOD	EF[2] kg CH_4/kg COD
Discharge to aquatic environments other than reservoirs, lakes, and estuaries (Tier 2)	Most aquatic environments including rivers are supersaturated in CH_4. Nutrient oversupply will increase CH_4 emissions.	0.035	(0.004 – 0.06)	0.021	0.009
Discharge to reservoirs, lakes, and estuaries (Tier 2)	Environments where carbon accumulates in sediments have higher potential for methane generation.	0.19	(0.08 – 0.27)	0.114	0.048
Discharge to soil	Sludge and/or wastewater discharge to soil may be a source of CH_4 for fertilization	Emissions reported in Volume 4			
Stagnant sewer	Open and warm	0.5	(0.4 – 0.8)	0.3	0.125
Flowing sewer (open or closed)	Fast moving, clean. (Insignificant amounts of CH_4 from pump stations, etc.)	0		0	0
Wastewater treatment system					
Centralized, aerobic treatment plant	Some CH_4 can be emitted from settling basins and other anaerobic pockets. May also emit CH_4 generated in upstream sewer networks during turbulent and/or aerobic treatment processes. For treatment plants that are receiving wastewater beyond the design capacity, inventory compilers should judge the amount of organic material removed in sludge accordingly.	0.03	(0.003 – 0.09)	0.018	0.0075
Anaerobic reactor (e.g., upflow anaerobic sludge blanket digestion (UASB))	CH_4 recovery is not considered here.	0.8	(0.8 – 1.0)	0.48	0.2
Anaerobic shallow lagoon and facultative lagoons	Depth less than 2 meters, use expert judgment.	0.2	(0 – 0.3)	0.12	0.05
Anaerobic deep lagoon	Depth more than 2 meters	0.8	(0.8 – 1.0)	0.48	0.2
Constructed wetlands	See *2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories*: Wetlands (IPCC 2014)				
Septic tank	Septic tanks emit CH_4	0.5	(0.4 – 0.72)	0.3	0.125
Septic tank + land dispersal field	Septic tanks emit CH_4; negligible emissions come from land dispersal field	0.5	(0.4 – 0.72)	0.3	0.125
Latrine	Dry climate, ground water table lower than latrine, small family (3–5 persons)	0.1	(0.05 – 0.15)	0.06	0.025
Latrine	Dry climate, ground water table lower than latrine, communal (many users)	0.5	(0.4 – 0.6)	0.3	0.125
Latrine	Wet climate/flush water use, ground water table higher than latrine	0.7	(0.7 – 1.0)	0.42	0.175

Source: TABLE 6.3 (updated) Default MCF values and resultant EFs for domestic wastewater by type of treatment system and discharge pathway, 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 5: Waste, Chapter 6

The activity data for this source category is the total amount of organically degradable material in the wastewater (TOW). This parameter is a function of human population and BOD generation per person. It is expressed in terms of biochemical oxygen demand (kg BOD/year). The equation for TOW is:

Total Organically Degradable Material In Domestic Wastewater

Equation 6.3, 2019 Refinement to the 2006 IPCC GL, Vol. 5, Chapter 6, page 6.22

$$TOW = P * BOD * 0.001 * I * 365$$

Total organics in domestic wastewater by treatment/discharge pathway or system

Equation 6.3 A, 2019 Refinement 2006 IPCC GL, Vol. 5, Chapter 6, page 6.22

$$TOW_i = \sum_i \left[TOW * U_i * T_{ij} * I_j\right]$$

Where:

TOWj	= total organics in wastewater in inventory year, kg BOD/yr, for income group i and treatment/discharge pathway or system, j.
TOW	= total organics in wastewater in inventory year, kg BOD/yr.
U_i	= fraction of population in income group i in inventory year. See Table 6.5.
T_{ij}	= degree of utilization of treatment/discharge pathway or system, j, for each income group fraction.
I_j	= correction factor for additional industrial BOD discharged into treatment/discharge pathway or system j for collected the default is 1.25, for uncollected the default is 1.00.

The N_2O emissions are estimated according to TIER 1 methodology from 2006 IPCC GL:

N_2O Emission Factor for each Domestic Wastewater Treatment/Discharge Pathway or System

Equation 6.2, 2006 IPCC GL, Vol. 5, Chapter 6, page 6.12

$$N_{Effluent} = \left(P * Protein * F_{NRP} * F_{non-con}\right) - N_{sludge}$$

Where:

$N_{EFFLUENT}$	= total annual amount of nitrogen in the wastewater effluent, kg N/yr
P	= human population
Protein	= annual per capita protein consumption, kg/person/yr
F_{NPR}	= fraction of nitrogen in protein, default = 0.16, kg N/kg protein
$F_{NON-CON}$	= factor for non-consumed protein added to the wastewater
$F_{IND-COM}$	= factor for industrial and commercial co-discharged protein into the sewer system
N_{SLUDGE}	= nitrogen removed with sludge (default = zero), kg N/yr

1.5.3 Uncertainty assessment and time-series consistency

Folder	\ 06_Inventory\2024_submission\05_Waste
File	5D_WasteWater-Tool.xlsx

Sheet	Uncertainty
ToDo	Check for updated information in file Are QC checks performed according to QA/QC checklist?
	Cross-check and/or update in file 19R_V1_IPCC_Tool_Uncertainty_Analysis_DZA-v2_230124_graph
	Cross-check and/or update in chapter 1.6 General uncertainty assessment, including data pertaining to the overall uncertainty of inventory totals 11.2 Annex II: Uncertainty assessment

The uncertainties for activity data and emission factors used for IPCC category 5.D *Wastewater Treatment and Discharge* are presented in the following table. The following parameters are believed to be very uncertain:

- The degrees to which wastewater in developing countries is treated in latrines, septic tanks, or removed by sewer, for urban high, urban low income groups and rural population (Ti,j).
- The fraction of sewers that are 'open', as well as the degree to which open sewers in developing countries are anaerobic and will emit CH_4. This will depend on retention time and temperature, and on other factors including the presence of a facultative layer and possibly components that are toxic to anaerobic bacteria (e.g., certain industrial wastewater discharges).
- The amount of industrial TOW that is discharged into open or closed domestic sewers for each country is very difficult to quantify.

Table 1-16 Uncertainty for IPCC sub-category 5.D Wastewater Treatment and Discharge.

Uncertainty	CH_4	N_2O	**Reference** 2006 IPCC GL, Vol. 5, Chap. 6
Activity data (AD)	71%		Table 6.7
		71%	Table 6.11
Emission factor (EF)	129%		Table 6.7
		261%	Table 6.11
Combined Uncertainty (U)	142%	270%	$U_{total} = \sqrt{U_{AD}^2 + U_{EF}^2}$

1.5.4 Category-specific QA/QC and verification

Folder	\ 06_Inventory\2024_submission\05_Waste
File	5D_WasteWater-Tool.xlsx
Sheet	QC CHECKLIST

The following source-specific QA/QC activities were performed out:

- Checked of calculations by spreadsheets
  - documented sources,
  - use of units,

- strictly defined interfaces between spreadsheets/calculation modules,
- unique structure of sheets which do the same,
- record keeping, use of write protection,
- unique use of formulas, special cases are documented/highlighted,
- quick-control checks for data consistency through all steps of calculation.

- cross-checked from different sources: national statistic, WHO/UNICEF
- cross checks with other relevant sectors are performed to avoid double counting or omissions;
- time series consistency
- plausibility checks of dips and jumps.

1.5.5 Category-specific planned improvements including tracking of those identified in the review process

Folder	\ 06_Inventory\2024_submission\05_Waste
File	5D_WasteWater-Tool.xlsx
Sheet	PlannedImprovements

Considering the potential contribution of identified improvements in the total GHG emissions and the corresponding resources needed to make these improvements effective, developments presented in following table will be explored.

Table 1-17 Planned improvements for IPCC sub-category 5.D Wastewater Treatment and Discharge

GHG source & sink category	Planned improvement	Type of improvement		Priority
5.D	Investigation on wastewater flow: collection – treatment and discharge pathways and systems • Wilayas / climate zone • Urban population (high / low income) • Rural population	AD	Accuracy Transparency Comparability Completeness Consistency	High
5.D	Estimation of amount of wastewater treated • Wilayas / climate zone • Urban population (high / low income) • Rural population	AD		High
5.D	Use of metadata prepared for and submitted to WHO/UNICEF Joint Monitoring Programme for Water Supply, Sanitation and Hygiene (JMP)	AD		High
5.D	Investigation of flow and amount of industrial wastewater	AD		High
5.D	Sludge separation and annual amount of sludge removal that is • dumped • applied to soil (agriculture) • incinerated	AD		High
5.D	Investigation of protein consumption	AD		Medium
5.D	Implementation of 2019 refinements to 2006 IPCC Guidelines: • N_2O emissions from domestic wastewater treatment plants • N_2O emissions from domestic wastewater effluent			High

GHG source & sink category	Planned improvement	Type of improvement		Priority
	• TOW in wastewater prior to treatment or wastewater that is discharged without treatment • TOW in treated wastewater effluent are treated as treated TOW in wastewater.			