



IPCC Inventory Software: Waste Sector

Remote Training on the IPCC Inventory Software for National Greenhouse Gas Inventories for the Latin America and Caribbean Region

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INTERGOVERNMENTAL PANEL ON climate change



Outline

- Waste sector
 - Solid Waste Disposal: First Order Decay (FOD) method
- IPCC Inventory Software (version 2.691)
 - Waste sector worksheets

Waste Sector

- Volume 5 of the *2006 IPCC Guidelines* provides methodological guidance for estimation of CO₂, CH₄ and N₂O emissions from Waste sector:
 - Solid waste disposal (4A)
 - Biological treatment of solid waste (4B)
 - Incineration and open burning of waste (4C)
 - Wastewater treatment and discharge (4D)
- Typically, CH₄ emissions from solid waste disposal sites (SWDSs) are the largest source in Waste sector
- Biogenic CO₂ emissions are not included in Waste sector
- All greenhouse gas (GHG) emissions from waste-to-energy should be estimated and reported under Energy sector

Solid Waste Disposal

- Decomposition of organic materials in waste under anaerobic environment produces significant amount of CH₄
- Waste disposal practices in SWDSs vary in the control, placement of waste and management of the site
 - Methane correction factor (MCF) accounts for the fact that unmanaged SWDSs produce less CH₄ from a given amount of waste than anaerobic managed SWDSs
- Methodology in the *2006 IPCC Guidelines* for estimating CH₄ emissions from SWDS is based on FOD method
 - Degradable organic component in waste at landfills decays slowly throughout a few decades during which significant amount of CH₄ and CO₂ are formed (some N₂O, NMVOCs, NO_x and CO)
 - CH₄ emissions are estimated as actual annual emissions
 - A simple spreadsheet model (IPCC Waste Model) to assist countries in using the FOD method <https://www.ipcc-nggip.iges.or.jp/public/2006gl/vol5.html>

Solid Waste Disposal: FOD Method

- Three tiers to estimate CH₄ emissions
 - Tier 1: Mainly default activity data (AD) and default parameters
 - Tier 2: Some default parameters but requires good quality country-specific AD on current and historical waste disposal at SWDS
 - Tier 3: Good quality country-specific AD and the use of either the FOD method with (1) nationally developed key parameters, or (2) measurement derived country-specific parameters.
- Key parameters: half-life, and either CH₄ generation potential (L₀) or degradable organic carbon (DOC) content in waste and the fraction of DOC which decomposes (DOC_f)
- Requires data for historical disposals of waste
 - Amount of municipal solid waste (MSW) can be estimated from population and per capita waste generation data (Tier 1)

Solid Waste Disposal: CH₄ Emissions

- CH₄ emissions in year *T* from SWDS (Gg)

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

T : inventory year

x : waste category or type/material

R_T : recovered CH₄ in year T, Gg

OX_T : oxidation factor in year T, fraction

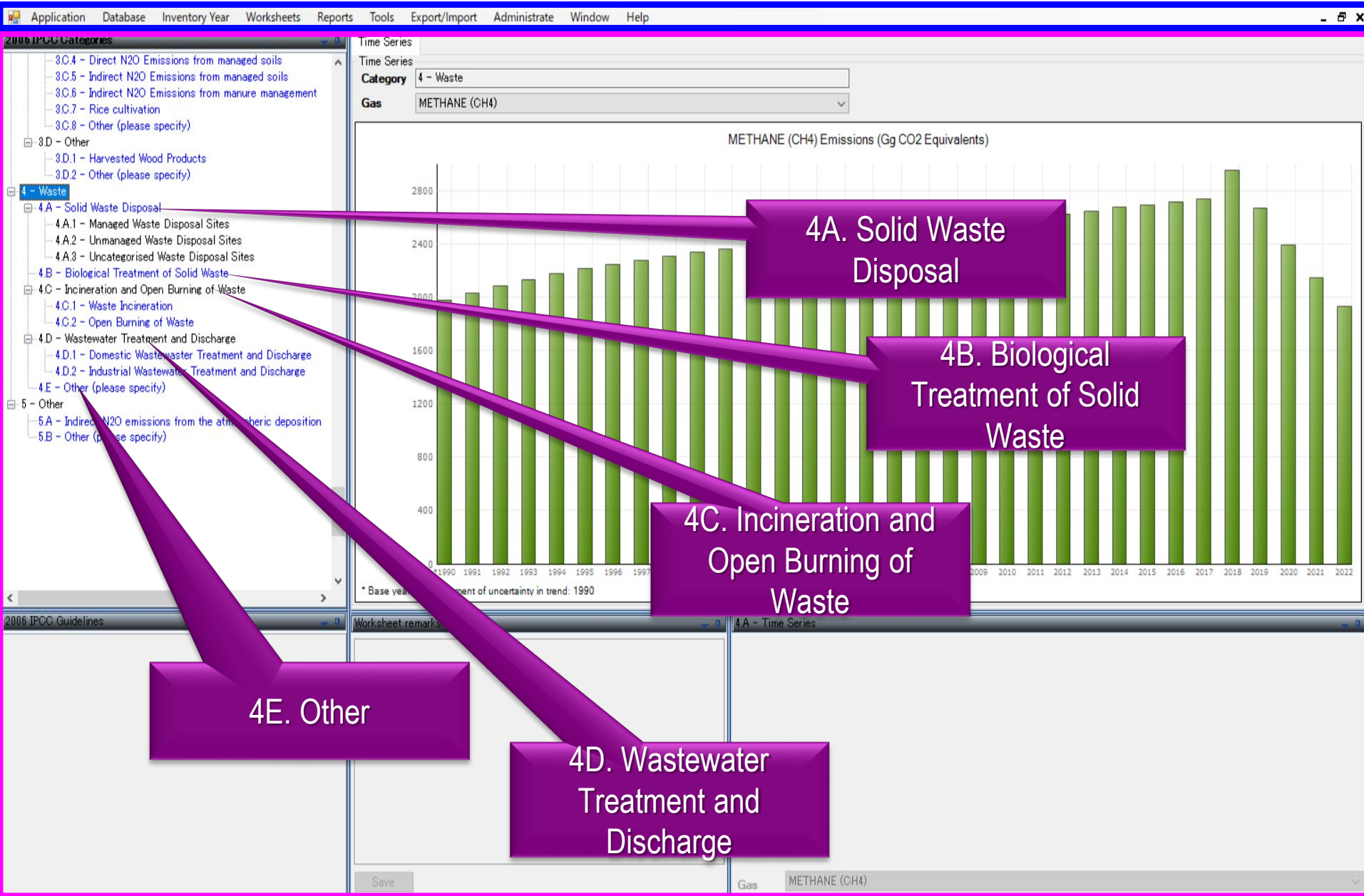
- CH₄ generated is estimated on the basis of the amount of Decomposable Degradable Organic Carbon (*DDOC_m*) which is the part of the organic carbon that will degrade under the anaerobic conditions in SWDS

IPCC Inventory Software

- Implements the methods in the *2006 IPCC Guidelines*
 - Default values of the *2006 IPCC Guidelines* are incorporated but gives users the flexibility to use their own country-specific data and information
 - Tier 1 and Tier 2 methods for Waste sector
 - In case default (Tier 1) worksheets are not suitable for higher tier calculations independent sets of the worksheets for each tier available
- The latest version of the software can be downloaded from IPCC TFI website

<https://www.ipcc-nggip.iges.or.jp/software/index.html>

IPCC Inventory Software: Waste Sector



Solid Waste Disposal

Application Database Inventory Year Worksheets Reports Tools Export/Import Administrate Window Help

2006 IPCC Categories

- 3.C.4 - Direct N₂O Emissions from managed soils
- 3.C.5 - Indirect N₂O Emissions from managed soils
- 3.C.6 - Indirect N₂O Emissions from manure management
- 3.C.7 - Rice cultivation
- 3.C.8 - Other (please specify)
- 3.D - Other
 - 3.D.1 - Harvested Wood Products
 - 3.D.2 - Other (please specify)
- 4 - Waste
 - 4.A - Solid Waste Disposal
 - 4.A.1 - Managed Waste Disposal Sites
 - 4.A.2 - Unmanaged Waste Disposal Sites
 - 4.A.3 - Uncategorised Waste Disposal Sites
 - 4.B - Biological Treatment of Solid Waste
 - 4.C - Incineration and Open Burning
 - 4.D - Waste Water Treatment and Discharge
 - 4.D.1 - Domestic Wastewater Treatment and Discharge
 - 4.D.2 - Industrial Wastewater Treatment and Discharge
 - 4.E - Other (please specify)
- 5 - Other
 - 5.A - Indirect N₂O emissions from the atmospheric deposition
 - 5.B - Other (please specify)

Parameters Methane Correction Factor Activity Data Amount Deposited Methane Calculations Methane Recovery Results Long Term stored C in SWDS Harvested Wood Products

Country/Territory Japan

Region Asia - Eastern

Approach Bulk waste data only

Activity Data National data

Starting year 1970

Fraction of DOC dissimilated 0.500

Delay Time (months)

Fraction of methane (F) in developed gas 0.5

Conversion factor, C to CH₄ 1.8

Oxidation Factor (OX)

Parameters for carbon storage

% paper in industrial waste

% wood in industrial waste

DOC (Degradable organic carbon) [weight fraction, wet basis]

Garden (HWP) 0.200

Paper (HWP) 0.400

Wood and straw (HWP) 0.430

Bulk MSW 0.180

Sewage sludge 0.050

Industrial Waste 0.150

Methane generation rate constant (k) [1 / years]

Bulk MSW 0.090

Sewage sludge 0.185

Industrial Waste 0.090

Climate Zone Boreal and temperate wet

* The bulk waste option is suitable for use without data or with limited data on waste composition, but with good information on bulk waste disposed at SWDS. Default values are estimated as a function of climate zone.

** In case of "Population / GDP" use "Data" sheet to estimate amount of waste deposited to SWDS based on Population and GDP. In case of "National statistics" enter directly into "Amount deposited" sheet.

Worksheet remarks

4.A - Time Series

Save

Gas METHANE (CH₄)

Select region

Select climate zone

Two options: Bulk waste and Waste composition

IPCC default values will be adjusted (e.g., CH₄ generation rate constant)

Solid Waste Disposal

Application Database Inventory Year Worksheets Reports Tools Export/Import Administrate Window Help

2006 IPCC Categories

- 3.C.4 - Direct N₂O Emissions from managed soils
- 3.C.5 - Indirect N₂O Emissions from managed soils
- 3.C.6 - Indirect N₂O Emissions from manure management
- 3.C.7 - Rice cultivation
- 3.C.8 - Other (please specify)
- 3.D - Other
 - 3.D.1 - Harvested Wood Products
 - 3.D.2 - Other (please specify)
- 4 - Waste
 - 4.A - Solid Waste Disposal
 - 4.A.1 - Managed Waste Disposal Sites
 - 4.A.2 - Unmanaged Waste Disposal Sites
 - 4.A.3 - Uncategorised Waste Disposal Sites
 - 4.B - Biological Treatment of Solid Waste
 - 4.C - Incineration and Open Burning of Waste
 - 4.C.1 - Waste Incineration
 - 4.C.2 - Open Burning of Waste
 - 4.D - Wastewater Treatment and Discharge
 - 4.D.1 - Domestic Wastewater Treatment and Discharge
 - 4.D.2 - Industrial Wastewater Treatment and Discharge
 - 4.E - Other (please specify)
- 5 - Other
 - 5.A - Indirect N₂O emissions from the atmospheric
 - 5.B - Other (please specify)

Parameters Methane Correction Factor Activity Data Amount Deposited Methane Calculations Methane Recovery Results Long Term stored C in SWDS Harvested Wood Products

Worksheet

Sector: Waste
 Category: Methane emissions from Solid Waste Disposal Sites
 Subcategory: 4.A - Solid Waste Disposal
 Sheet: Industrial and MSW Activity Data

Data

Waste Composition Type: Municipal Solid Waste

Year	Total MSW [Gg]	% to SWDS [%]	Total to SWDS [Gg]
IPCC Regional Defaults			
		25	0
1970	2000	25	500
1971	2000	25	500
1972	2000	25	500
1973	2000	25	500
1974	2000	25	500
1975	2000	25	500
1976	2000	25	500
1977	2000	25	500
1978	2000	25	500
1979	2000	25	500
1980	2000	25	500
1981	2000	25	500
1982	2000	25	500
1983	2000	25	500
1984	2000	25	500
1985	2000	25	500

This worksheet allows Ctrl+C/Ctrl+V to copy/paste data. The cells can be overwritten when pasting.

Worksheet remarks

4.A - Time Series

METHANE (CH₄) Emissions (Gg CO₂ Equivalents)

* Base year for assessment of uncertainty in trend: 1990

Gas METHANE (CH₄)

Save

2006 IPCC Guidelines

Time Delay
 The default assumption is that the reaction starts on the first of January in the year after deposition, which is equivalent to an average delay time of six months before decay to methane commences ("Delay time" = 6). It is good practice to assume an average delay of from two to six months. If a value greater than six months is chosen, evidence to support this must be provided. To make the model work for delay times from 7 to 18 months, the number 13 in "exp2" in all the methane calculating sheets is changed to 25, and DDOcmd in columns F and G is readdressed one cell down.

MCF and distribution of waste by SWDS

Amount of waste

2018

Solid Waste Disposal

Application Database Inventory Year Worksheets Reports Tools Export/Import Administrate Window Help

2006 IPCC Categories

- 3C.4 - Direct N2O Emissions from managed soils
- 3C.5 - Indirect N2O Emissions from managed soils
- 3C.6 - Indirect N2O Emissions from manure management
- 3C.7 - Rice cultivation
- 3C.8 - Other (please specify)
- 3D - Other
 - 3D.1 - Harvested Wood Products
 - 3D.2 - Other (please specify)
- 4 - Waste
 - 4A - Solid Waste Disposal
 - 4A.1 - Managed Waste Disposal Sites
 - 4A.2 - Unmanaged Waste Disposal Sites
 - 4A.3 - Uncategorised Waste Disposal Sites
 - 4B - Biological Treatment of Solid Waste
 - 4C - Incineration and Open Burning of Waste
 - 4C.1 - Waste Incineration
 - 4C.2 - Open Burning of Waste
 - 4D - Wastewater Treatment and Discharge
 - 4D.1 - Domestic Wastewater Treatment and Discharge
 - 4D.2 - Industrial Wastewater Treatment and Discharge
 - 4E - Other (please specify)
 - 5 - Other
 - 5A - Indirect N2O emissions from the atmospheric deposition
 - 5B - Other (please specify)

Parameters Methane Correction Factor Activity Data Amount Deposited **Methane Calculations** Methane Recovery Results Long Term stored C in SWDS Harvested Wood Products

Worksheet

Sector: Waste
 Category: Methane emissions from Solid Waste Disposal Sites
 Subcategory: 4.A - Solid Waste Disposal
 Sheet: Methane Calculations

2018

Data

Waste Type: Total MSW

DOC: 0.18 DOCF: 0.5 k: 0.09 Half-life time (h=ln(2)/k): 7.70163533E

exp1=exp(-k) 0.91393118E Mor when the reaction is set to start (M) 13 exp2=exp(-k*((13-M)/12)) 1 CH4 Fraction 0.5

Year	Amount deposited	MCF	Decomposable D (DDOCm) deposited	DDOCm not reacted, Deposition year	DDOCm decomposed, Deposition year	DDOCm accumulated in SWDS end of year	DDOCm decomposed	CH4 generated
	W	MCF	D = W * DOC * D / MCF	B = D * exp2	C = D * (1-exp2)	H = B + (H(y-1) * exp1)	E = C + H(y-1) * (1-exp1)	Q = E * 16/12 * F
	Gg	fraction	Gg	Gg	Gg	Gg	Gg	Gg
1970	500	0.8	36	36	0	36	0	0
1971	500	0.8	36	36	0	68.90152	3.09848	2.06565
1972	500	0.8	36	36	0	98.97125	5.93027	3.95351
1973	500	0.8	36	36	0	126.45291	8.51834	5.67889
1974	500	0.8	36	36	0	151.56926	10.88365	7.25577
1975	500	0.8	36	36	0	174.52387	13.04539	8.69692
1976	500	0.8	36	36	0	195.50281	15.02106	10.01404
1977	500	0.8	36	36	0	214.67612	16.8267	11.2178
1978	500	0.8	36	36	0	232.1992	18.47692	12.31795
1979	500	0.8	36	36	0	248.21409	19.98511	13.32341
1980	500	0.8	36	36	0	262.85059	21.36349	14.24233
1981	500	0.8	36	36	0	276.22736	22.62324	15.08216
1982	500	0.8	36	36	0	288.45279	23.77456	15.84971
1983	500	0.8	36	36	0	299.626	24.82679	16.55119
1984	500	0.8	36	36	0	309.83755	25.78846	17.1923

Worksheet remarks

4.A - Time Series

METHANE (CH4) Emissions (Gg CO2 Equivalents)

* Base year for assessment of uncertainty in trend: 1990

Gas METHANE (CH4)

After entering parameters and AD

Amount of CH₄ generated

Solid Waste Disposal

Application Database Inventory Year Worksheets Reports Tools Export/Import Administrate Window Help

2006 IPCC Categories

- 3.C.4 - Direct N2O Emissions from managed soils
- 3.C.5 - Indirect N2O Emissions from managed soils
- 3.C.6 - Indirect N2O Emissions from manure management
- 3.C.7 - Rice cultivation
- 3.C.8 - Other (please specify)
- 3.D - Other
 - 3.D.1 - Harvested Wood Products
 - 3.D.2 - Other (please specify)
- 4 - Waste
 - 4.A - Solid Waste Disposal
 - 4.A.1 - Managed Waste Disposal Sites
 - 4.A.2 - Unmanaged Waste Disposal Sites
 - 4.A.3 - Uncategorised Waste Disposal Sites
 - 4.B - Biological Treatment of Solid Waste
 - 4.C - Incineration and Open Burning of Waste
 - 4.C.1 - Waste Incineration
 - 4.C.2 - Open Burning of Waste
 - 4.D - Wastewater Treatment and Discharge
 - 4.D.1 - Domestic Wastewater Treatment and Discharge
 - 4.D.2 - Industrial Wastewater Treatment and Discharge
 - 4.E - Other (please specify)
- 5 - Other
 - 5.A - Indirect N2O emissions from the atmospheric deposition
 - 5.B - Other (please specify)

Parameters Methane Correction Factor Activity Data Amount Deposited Methane Calculations Methane Recovery Results Long Term stored C in SWDS Harvested Wood Products

Worksheet

Sector: Waste
 Category: Methane emissions from Solid Waste Disposal Sites
 Subcategory: 4.A - Solid Waste Disposal
 Sheet: Results

Data

Year	Methane generated				Methane recovery	Methane Emissions
	MSW	Sludge	Industrial	Total		
	F (Gg)	G (Gg)	H (Gg)	I (Gg)	J (Gg)	M = (I-J) * (1-OX) (Gg)
1970	0	0	0	0	0	0
1971	2.06565	6.75583	2.7542	11.57568	0	11.57568
1972	3.95351	12.37063	5.27135	21.59549	0	21.59549
1973	5.67889	17.03711	7.5718	30.28786	0	30.28786
1974	7.25577	20.91544	9.67	37.84557	0	37.84557
1975	8.69692	24.13874	11	44.43157	0	44.43157
1976	10.01404	26.81764	11	50.18374	0	50.18374
1977	11.2178	29.04409	11	55.21894	0	55.21894
1978	12.31795	30.89449	11	59.63637	0	59.63637
1979	13.32341	32.43237	11	63.52032	0	63.52032
1980	14.24233	33.71051	11	66.94261	0	66.94261
1981	15.08216	34.77278	11	69.96449	0	69.96449
1982	15.84971	35.65564	11	72.63829	0	72.63829
1983	16.55119	36.38938	11	75.00883	0	75.00883
1984	17.1923	36.9992	11	77.11457	0	77.11457
1985	17.77823	37.5060	11	78.98857	0	78.98857
1986	18.31373	37.92	11	80.65929	0	80.65929
1987	19.83597	38.2	11	84.56125	0	84.56125
1988	21.22719	38.2	11	88.08888	0	88.08888

Worksheet remarks

4.A - Time Series

METHANE (CH4) Emissions (Gg CO2 Equivalents)

* Base year for assessment of uncertainty in trend: 1990

Save

Gas METHANE (CH4)

Annual CH₄ emissions

Biological Treatment of Solid Waste

Application Database Inventory Year Worksheets Reports Tools Export/Import Administrate Window Help

2018

2006 IPCC Categories

- 3C.7 - Rice cultivation
- 3C.8 - Other (please specify)
- 3D - Other
 - 3D.1 - Harvested Wood Products
 - 3D.2 - Other (please specify)
- 4 - Waste
 - 4A - Solid Waste Disposal
 - 4A.1 - Managed Waste Disposal Sites
 - 4A.2 - Unmanaged Waste Disposal Sites
 - 4A.3 - Uncategorised Waste Disposal Sites
 - 4B - Biological Treatment of Solid Waste
 - 4C - Incineration and Open Burning of Waste
 - 4C.1 - Waste Incineration
 - 4C.2 - Open Burning of Waste
 - 4D - Wastewater Treatment and Discharge
 - 4D.1 - Domestic Wastewater Treatment and Discharge
 - 4D.2 - Industrial Wastewater Treatment and Discharge
 - 4E - Other (please specify)
 - 5 - Other
 - 5A - Indirect N₂O emissions from the atmospheric depositions
 - 5B - Other (please specify)

Biological Treatment of Solid Waste

Worksheet

Sector: Waste

Category: Biological Treatment of Solid Waste

Subcategory: 4.B - Biological Treatment of Solid Waste

Sheet: 1 of 1 Estimation of emissions from Biological Treatment of Solid Waste

Data

Gas: METHANE (CH₄)

Waste basis: Dry

Biological Treatment System	Waste Category	Type of Waste	A Total Annual amount treated by biological treatment facilities [Gg]	B Emission Factor [g CH ₄ / kg waste treated]	C Gross Annual Methane Generation [Gg]	D Recovered / Flared Methane per Year [Gg]	E Net Annual Methane Emissions [Gg]
					C = (A * B) / 1000		E = (C - D)
Anaerobic digestion at sewage treatment plant	Sewage Sludge	Sewage Sludge	30	2	0.06	0	0.06
Composting	Municipal Solid Waste	Food waste	45	10	0.45		0.45
Total							0.51

Uncertainties

Time Series data entry...

Worksheet remarks

4B - Time Series

METHANE (CH₄) Emissions (Gg CO₂ Equivalents)

* Base year for assessment of uncertainty in trend: 1990

Gas: METHANE (CH₄)

Select gas

Select dry or wet basis

Enter uncertainties of AD and EF

Chart with emission time series. Select gas from drop-down list

Parameters of worksheets can be edited across existing inventory years

Incineration and Open Burning of Waste

Application Database Inventory Year Worksheets Reports Tools Export/Import Administrate Window Help

2018

2006 IPCC Categories

- 3C.7 - Rice cultivation
- 3C.8 - Other (please specify)
- 3D - Other
 - 3D.1 - Harvested Wood Products
 - 3D.2 - Other (please specify)
- 4 - Waste
 - 4A - Solid Waste Disposal
 - 4A.1 - Managed Waste Disposal Sites
 - 4A.2 - Unmanaged Waste Disposal Sites
 - 4A.3 - Uncategorised Waste Disposal Sites
 - 4B - Biological Treatment of Solid Waste
 - 4C - Incineration and Open Burning of Waste
 - 4C.1 - Waste Incineration
 - 4C.2 - Open Burning of Waste
 - 4D - Wastewater Treatment and Discharge
 - 4D.1 - Domestic Wastewater Treatment and Discharge
 - 4D.2 - Industrial Wastewater Treatment and Discharge
 - 4E - Other (please specify)
- 5 - Other
 - 5A - Indirect N₂O emissions from the atmospheric deposit
 - 5B - Other (please specify)

Worksheet

Sector: Waste
 Category: Incineration and Open Burning of Waste
 Subcategory: 4.C.1 - Waste Incineration
 Sheet: 1 of 1 Estimation of Emissions from Incineration of Waste

Gas: CARBON DIOXIDE (CO₂)
 CARBON DIOXIDE (CO₂)
 METHANE (CH₄)
 NITROUS OXIDE (N₂O)

Type of MSW: MSW aggregated

Waste Category	Type of Waste	Total Amount of Waste incinerated (Wet Weight) [Gg Waste]	Dry Matter Content - dm [Fraction]	Fraction of Carbon in Dry Matter - CF [Fraction]	Fraction of Fossil Carbon in Total Carbon - FCF [Fraction]	Oxidation Factor - OF [Fraction]	Fossil Emissions [Gg]
Municipal Solid Waste	Total MSW	4500	0.78	0.34		1	350.064
Industrial Waste	Industrial Waste						0
Sewage Sludge	Sewage Sludge						0
Hazardous waste	Hazardous waste						0
Clinical waste	Clinical waste						0
Other	Other						0
Total							350.064

Equation: $F = A * B * C * D * E * \frac{44}{12}$

Two options: Total amount of MSW incinerated or MSW components

Uncertainties Time Series data entry...

Worksheet remarks

4C.1 - Time Series

CARBON DIOXIDE (CO₂) Emissions (Gg CO₂ Equivalents)

* Base year for assessment of uncertainty in trend: 1990

Gas: CARBON DIOXIDE (CO₂)

Wastewater Treatment and Discharge

Application Database Inventory Year Worksheets Reports Tools Export/Import Administrate Window Help

2006 IPCC Categories

- 3C.7 - Rice cultivation
- 3C.8 - Other (please specify)
- 3D - Other
 - 3D.1 - Harvested Wood Products
 - 3D.2 - Other (please specify)
- Waste
- 4A - Solid Waste Disposal
 - 4A.1 - Managed Waste Disposal Sites
 - 4A.2 - Unmanaged Waste Disposal Sites
 - 4A.3 - Uncategorised Waste Disposal Sites
- 4B - Biological Treatment of Solid Waste
- 4C - Incineration and Open Burning of Waste
 - 4C.1 - Waste Incineration
 - 4C.2 - Open Burning of Waste
- 4D - Wastewater Treatment and Discharge
 - 4D.1 - Domestic Wastewater Treatment and Discharge
 - 4D.2 - Industrial Wastewater Treatment and Discharge
- 4E - Other (please specify)
- 5A - Indirect N₂O emissions from the atmosphere
- 5B - Other (please specify)

Tier Tier 1

Regions and TOVs Emission Factors Methane Emissions N Effluent Indirect N₂O

Worksheet: Waste
Sector: Waste
Category: Domestic Wastewater Treatment and Discharge
Subcategory: 4.D.1 - Domestic Wastewater Treatment and Discharge
Sheet: 2 of 3 Estimation of CH₄ emission factor for Domestic Wastewater

2018

Type of treatment or discharge	Maximum methane producing capacity - B0 [kg CH ₄ /kg BOD]	Methane correction factor for each treatment system - MCF _f	Emission Factor - EF _f [kg CH ₄ /kg BOD]
			$C = A \times B$
Sea, river and lake discharge	0.6	0.1	0.06
		0.5	0.3
		0	0

System	Treatment Type	Comments	Default Value	Range
Untreated	Sea, river and lake discharge	Rivers with high organics loadings can turn anaerobic.	0.1	0 - 0.2
	Stagnant sewer	Open and warm	0.5	0.4 - 0.8
	Flowing sewer (open or closed)	Fast moving, clean. (Insignificant amounts of CH ₄ from pump stations, etc)	0	0
Treated	Centralized, aerobic treatment plant	Must be well managed. Some CH ₄ can be emitted from settling basins and other pockets.	0	0 - 0.1
	Centralized, aerobic treatment plant	Not well managed. Overloaded.	0.3	0.2 - 0.4
	Anaerobic digester for sludge	CH ₄ recovery is not considered here.	0.8	0.8 - 1
	Anaerobic reactor	CH ₄ recovery is not considered here.	0.8	0.8 - 1
	Anaerobic shallow lagoon	Depth less than 2 metres, use expert judgment.	0.2	0 - 0.3

Choose tier. Independent sets of the worksheets for each tier

Select type of treatment or discharge

2006 IPCC Guidelines

No higher tiers and decision tree for N₂O emissions are given in the 2006 IPCC Guidelines

METHANE (CH₄) Emissions (Gg CO₂ Equivalents)

* Base year for assessment of uncertainty in trend: 1990

Save Gas METHANE (CH₄)

Thank you

<https://www.ipcc-nggip.iges.or.jp/>