



IPCC Workshop on IPCC Inventory Software

Hands-on Demonstration/Exercise: Waste Sector

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Overview

Hands-on demonstration/exercise on IPCC Inventory Software estimating greenhouse gas (GHG) emissions using

- Dummy data (Day2_Hands on exercise_Dummy data_Waste.xlsx)
- Default emissions factors (EFs) and parameters (incorporated in the Inventory Software)

Goals for Session

Get familiar with the IPCC Inventory Software environment

- Navigate the software interface and worksheets
- Enter activity data (AD) and select EFs
- Use the Waste Type Manager

Be able to estimate emissions using the IPCC Inventory Software

- Set up the Waste Type Manager
- Estimate GHG emissions from Solid Waste Disposal
- Estimate GHG emissions from Domestic Wastewater Treatment and Discharge

Hands-on Demonstration/Exercise

I. Using Data Manager

- Waste Type Manager

II. Estimating GHG emissions using IPCC Inventory Software

- Solid Waste Disposal (CH₄)
- Domestic Wastewater Treatment and Discharge (CH₄ and N₂O)

Data Manager

Organize and manage in one place relevant data used for multiple categories/worksheets

- Prepopulated with default data but can also enter user-specific data/information

Help ensure consistency of data used in estimation of emissions/removals across all relevant categories

- Data entered are transferred to relevant worksheets

Waste Type Manager is to be populated with data and information that will be used for estimation of GHG emissions from solid waste disposal and treatment

- Waste category, type, decomposability class and associated parameters: degradable organic carbon (DOC), fraction of DOC which decomposes (DOC_f), dry matter content (dm), total carbon in dry matter (CF), fossil carbon in total carbon (FCF)

Solid Waste Disposal

Disposal of municipal, industrial and other waste at solid waste disposal sites (SWDS) produces significant amounts of CH_4 and CO_2 (some small amounts of N_2O , NO_x , CO and NMVOCs)

- CO_2 emissions are of biogenic origin and not included in Waste sector

Methodology for estimating CH_4 emissions from SWDS is based on First Order Decay (FOD) method

- Degradable organic component in waste at landfills decays slowly throughout a few decades

The FOD method requires data on solid waste disposal for 50 years by default. When historical data are not available missing data can be estimated e.g., using surrogates

Solid Waste Disposal

CH₄ emissions in year T from SWDS (Gg)

$$CH_4 \text{ Emissions} = \left[\sum_x CH_4 \text{ generated}_{x,T} - R_T \right] \cdot (1 - OX_T)$$

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

- Key parameters: half-life, and either methane generation potential (L_o) or DOC content in waste and DOC_f

Domestic Wastewater Treatment and Discharge

Wastewater may be treated on site (uncollected), sewerred to a centralized plant (collected) or disposed untreated

- Treatment and discharge systems can differ between countries and can also differ for rural and urban users

Treatment and disposal of wastewater can be source of CO₂, CH₄ and N₂O

- CO₂ emissions are of biogenic origin and not included in Waste sector

Sludge produced in wastewater treatment is treated further and emissions from sludge sent to landfills, incinerated or used in agriculture are not included in this category.

Domestic Wastewater Treatment and Discharge

CH₄ EMISSIONS

Depend primarily on the amount of degradable organic material in wastewater, temperature and type of treatment system

$$CH_4 \text{ Emissions} = \left[\sum_{i,j} (U_i \bullet T_{i,j} \bullet EF_j) \right] (TOW - S) - R$$

CH₄ Emissions : CH₄ emissions in inventory year, kg CH₄/yr

TOW : total organics in wastewater in inventory year, kg BOD/yr

S : organic component removed as sludge in inventory year, kg BOD/yr

U_i : fraction of population in income group i in inventory year

T_{i,j} : degree of utilisation of treatment/discharge pathway or system, j, for each income group fraction i in inventory year

i : income group: rural, urban high income and urban low income

j : each treatment/discharge pathway or system

EF_j : emission factor, kg CH₄/kg BOD

R : amount of CH₄ recovered in inventory year, kg CH₄/yr

Domestic Wastewater Treatment and Discharge

CH₄ EMISSIONS

$$TOW = P \bullet BOD \bullet 0.001 \bullet I \bullet 365$$

TOW : total organics in wastewater in inventory year, kg BOD/yr

P : country population in inventory year, (person)

BOD : country-specific per capita BOD in inventory year, g/person/day

0.001 : conversion from grams BOD to kg BOD

I : correction factor for additional industrial BOD discharged into sewers (for collected the default is 1.25, for uncollected the default is 1.00)

$$EF_j = B_o \bullet MCF_j$$

EF_j : emission factor, kg CH₄/kg BOD

j : each treatment/discharge pathway or system

B_o : maximum CH₄ producing capacity, kg CH₄/kg BOD

MCF_j : CH₄ correction factor (fraction)

Domestic Wastewater Treatment and Discharge

N₂O EMISSIONS

Degradation of nitrogen components (e.g., urea, nitrate and protein) in the wastewater

- Direct emissions from treatment plants
- Indirect emissions from wastewater after disposal of effluent into waterways, lakes or the sea.

Domestic Wastewater Treatment and Discharge

Indirect N₂O emissions from wastewater effluent discharged into aquatic environment

$$N_2O \text{ Emissions} = N_{EFFLUENT} \bullet EF_{EFFLUENT} \bullet 44 / 28$$

N₂O_{Emissions} : N₂O emissions in inventory year, kg N₂O/yr

N_{EFFLUENT} : nitrogen in the effluent discharged to aquatic environments, kg N/yr

EF_{EFFLUENT} : emission factor for N₂O emissions from discharged wastewater, kg N₂O-N/kg N

44/28 : conversion of kg N₂O-N into kg N₂O

Domestic Wastewater Treatment and Discharge

Indirect N₂O emissions from wastewater effluent discharged into aquatic environments

$$N_{EFFLUENT} = (P \bullet PROTEIN \bullet F_{NPR} \bullet F_{NON-CON} \bullet F_{IND-COM}) - N_{SLUDGE}$$

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

Domestic Wastewater Treatment and Discharge

Direct N₂O emissions from advanced centralised wastewater treatment plants

$$N_2O_{PLANTS} = P \bullet T_{PLANT} \bullet F_{IND-COM} \bullet EF_{PLANT}$$

N₂O_{PLANTS} : total N₂O emissions from plants in inventory year, kg N₂O/yr

P : human population

T_{PLANT} : degree of utilization of modern, centralized WWT plants, %

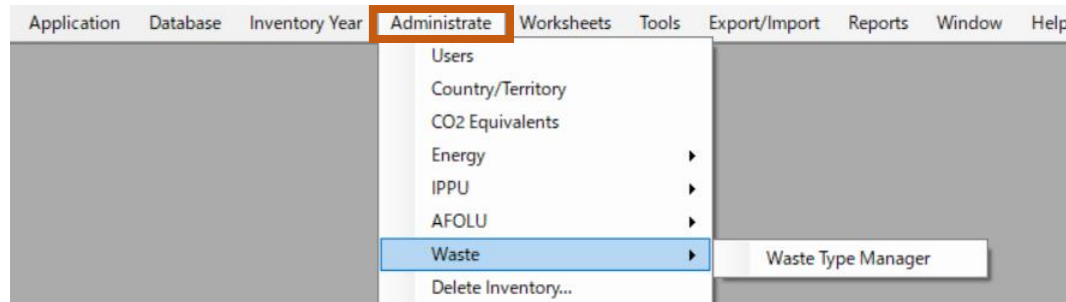
F_{IND-COM} : fraction of industrial and commercial co-discharged protein (default = 1.25)

EF_{PLANT} : emission factor, 3.2 g N₂O/person/year

Using Data Manager

Access the Waste Type Manager

- Administrate menu of the IPCC Inventory Software
- Waste sector worksheets



Worksheets Tools Export/Import Reports Window Help

Waste incineration Fossil liquid incineration N2O Emissions from Incineration of waste - Tier 3

Worksheet

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

Data

Gas: CARBON DIOXIDE (CO2)

Equation 5.1.5.2

Information for UNFCCC CRT

Subdivision	Waste Category	Type of Waste	Total Amount of Waste Incinerated (Wet Weight)	Dry Matter Content - dm (Fraction)	Fraction of Carbon in Dry Matter - CF (Fraction)	Fraction of Fossil Carbon in Total Carbon - FCF	Oxidation Factor - OF (Fraction)	Fossil CO2 Emissions (Gg)	Amount of total waste of fossil origin (Gg Waste)	Amount of total waste of biogenic origin (Gg Waste)	Biogenic CO2 emissions (Gg)
Δ ▾	Δ ▾	i Δ ▾	AI	dmi	CFI	FCFI	OFI	EFI = AI * dmi * CFI * FCFI * OFI * 44/12	AFI = AI * FCFI or specified	ABI = AI * (1 - FCFI) or specified	EBI = ABI * OFI * 44/12
Total			0.000					0.000	0.000	0.000	0.000

Waste Type Manager Uncertainties Time Series data entry...

Using Data Manager

Working with Waste Type Manager

- Update existing data and add missing data of parameters
- Add user-specific waste category/type and associated data (see dummy data)

Waste Type Manager

Type of weight of waste ☒ Wet Weight ☐ Dry Weight ☐ Show user-defined waste types only

Waste Category	Waste Type / Industry Type		Degradable organic carbon		Degradable organic carbon which decomposes in SWDS	Dry Matter Content	Total Carbon in Dry Matter	Fossil Carbon in Total Carbon	
	Class of decomposability	Type	DOC (Fraction of wet weight)	DOC (Fraction of dry weight)	DOCf (Fraction)	dm (Fraction)	CF (Fraction)	FCF (Fraction)	
Industrial Waste	Bulk waste	Bulk Industrial Waste	0.150		0.500		0.500	0.900	
	Highly decomposable waste	Food, beverages and tobacco	0.150	0.380	0.700	0.400	0.380		
	Inert	Petroleum products, Solvents, Plastics			0.000	1.000	0.800	1.000	
		Rubber		0.390	0.460	0.000	0.840	0.670	0.200
	Less decomposable waste	Construction and demolition		0.040	0.040	0.500	1.000	0.240	0.200
		Wood and wood products		0.430	0.510	0.500	0.850	0.510	
	Moderately decomposable waste	Pulp and paper		0.400	0.440	0.500	0.900	0.460	0.010
Municipal Waste	Bulk waste	Textile	0.240	0.300	0.500	0.800	0.500	0.200	
		Bulk Municipal Waste		0.180		0.500			
	Highly decomposable waste	Food waste	0.150	0.380	0.700	0.400	0.380		
	Inert	Garden and park		0.200	0.490	0.700	0.400	0.490	0.000
		Glass				0.000			
	Less decomposable waste	Metal			0.000				
		Plastic			0.000	1.000	0.750	1.000	
	Moderately decomposable waste	Rubber and leather		0.390	0.460	0.000	0.840	0.670	0.200
		Wood		0.430	0.500	0.500	0.850	0.500	
	Other waste	Disposable nappies		0.240	0.600	0.500	0.400	0.700	0.100
		Paper and cardboard		0.400	0.440	0.500	0.900	0.460	0.010
		Textile		0.240	0.300	0.500	0.800	0.500	0.200
Sludge	Bulk waste	Clinical waste	0.150	0.230	0.500	0.650	0.600	0.400	
	Hazardous waste				0.500				
Sludge	Highly decomposable waste	Industrial sewage sludge	0.090	0.350	0.500				
		Municipal sewage sludge	0.090	0.350	0.500				

Category, Class and Name of default waste types cannot be changed and default waste types cannot be deleted.
Selected Type of Weight of Waste is automatically applied in all the relevant worksheets across all the Inventory Years.

SaveUndoClose

Type in blank cells/
overwrite existing values

Use last row to add user-
specific waste
category/type ...

Estimating Emissions: Worksheets

SOLID WASTE DISPOSAL

Parameters worksheet (after populating Waste Type Manager)

- Select region and climate zone: IPCC defaults on other worksheets will be adjusted to selected regions/climate zone
- Initial settings for FOD method (start year, delay time, etc.)
- **Waste Type Parameters for Selected Subdivision:** Select waste category/types and update associated parameters to be used for calculation of CH₄ emissions for a subdivision, if any. Can have different waste categories/types and different values of associated parameters in each subdivision set in national GHG inventory.

Estimating Emissions: Worksheets

SOLID WASTE DISPOSAL

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

2006 IPCC Categories

1 - Energy

2 - Industrial Processes and Product Use

3 - Agriculture, Forestry, and Other Land Use

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 atmosphere

5.B - Indirect CO2 emissions from the atmosphere

5.C - Other

Parameters

SWDS Types - Utilization

Activity Data

Amount Deposited

Long Term stored C in SWDS

Harvested Wood Products

Country/TerritoryWorld

RegionWorld - World

SubdivisionRegion_A

Climate ZoneBoreal and temperate wet

FOD main parameters and Waste Types for selected Subdivision

Starting year1970

Delay Time (months)6

Fraction of methane (F) in developed gas0.500

Conversion Factor, C to CH41.333333

Parameters for HWP (Bulk MSW)

% garden in municipal waste0.00 %

% paper in municipal waste19.00 %

% wood in municipal waste4.00 %

Parameters for HWP (Bulk Industrial Waste)

% paper in industrial waste15.00 %

% wood in industrial waste10.00 %

Waste Type Parameters for selected Subdivision...

Save

Waste Type Manager

Select (☒) waste category/ type and update associated parameters

Waste Type Parameters

Waste Category	Class of decomposability	Waste Type / Industry Type	Use in calculations	Degradable organic carbon (DOC) (Fraction of wet weight)	Degradable organic carbon which decomposes in SWDS (DOCf (Fraction))	Methane generation rate constant (k)
Industrial Waste	Bulk waste	Bulk Industrial Waste	<input checked="" type="checkbox"/>	0.15	0.150	0.09
	Highly decomposable waste	Food, beverages and tobacco	<input type="checkbox"/>			
	Less decomposable waste	Construction and demolition	<input type="checkbox"/>			
	Moderately decomposable waste	Wood and wood products	<input type="checkbox"/>			
		Pulp and paper	<input type="checkbox"/>			
Municipal Waste	Bulk waste	Bulk Municipal Waste	<input checked="" type="checkbox"/>	0.3	0.6	0.09
	Highly decomposable waste	Food waste	<input type="checkbox"/>			
	Less decomposable waste	Garden and park	<input type="checkbox"/>			
	Moderately decomposable waste	Wood	<input type="checkbox"/>			
		Disposable nappies	<input type="checkbox"/>			
Other waste	Bulk waste	Clinical waste	<input type="checkbox"/>			
		Hazardous waste	<input type="checkbox"/>			
		Industrial sewage sludge	<input type="checkbox"/>			
Sludge	Highly decomposable waste	Municipal sewage sludge	<input type="checkbox"/>			

CancelOK

Estimating Emissions: Worksheets

SOLID WASTE DISPOSAL

Implements copy and paste functions e.g., pasting time series data copied from Microsoft Excel

1. Select the starting cell for which data paste should start
2. Define a paste region by highlighting cells and paste the data (Ctrl+V)

Time series data pasted

The left screenshot shows the '2006 IPCC Categories' tree on the left, with '4.A - Solid Waste Disposal' selected. The 'Parameters' panel on the right shows 'Waste' as the sector and 'Methane emissions from Solid Waste Disposal Sites' as the category. The 'Subdivision' is set to 'Region_A'. The 'Waste Category' is 'Municipal Waste'. The 'Total Waste' column is highlighted in green. A red arrow points to the starting cell (1) in the 'Year' column, and another red arrow points to the paste region (2) in the 'Total Waste' column.



The right screenshot shows the same interface, but with the 'Total Waste' column now containing time series data. A red arrow points to the data in the 'Total Waste' column, indicating that the data has been pasted.

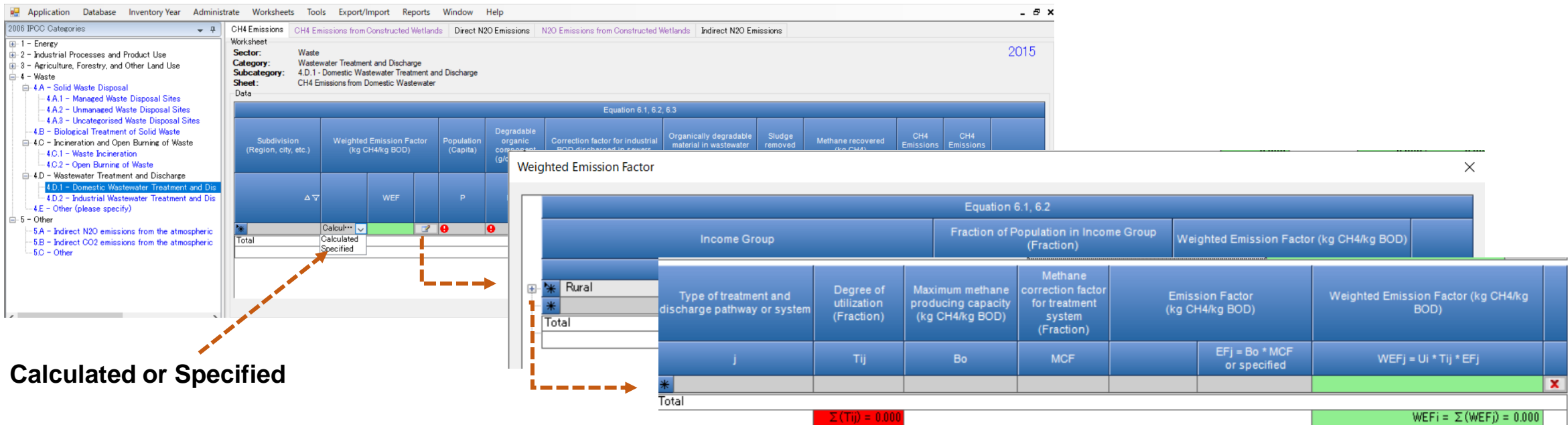
Year	Population (Capita)	Waste per capita (kg/cap/yr)	Total Waste (Gg)	% to SWDS (%)	Total to SWDS (Gg)	Bulk Mun.
	A	B	C = A * B * 10 ⁻⁶	D	E = C * (D/100)	%
1970	1294883					
1971	1328921					
1972	1365845					
1973	1400310					
1974	1445350					
1975	1485695					
1976	1531095					
1977	1572531					
1978	1616871					
1979	1658459					
1980	1697793					
1981	1759303					
1982	1801797					
1983	1825785					
1984	1883652					
1985	1937945					
1986	1969931					
1987	2021805					

Estimating Emissions: Worksheets

DOMESTIC WASTEWATER TREATMENT AND DISCHARGE

Worksheet specific features

- Two options available for AD and emission parameters: “Calculated” and “Specified” (select from drop-down list)
- Display a worksheet for “Calculated” option (click  button)
- Expand worksheets (click  button)



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

2006 IPCC Categories

- 1 - Energy
- 2 - Industrial Processes and Product Use
- 3 - Agriculture, Forestry, and Other Land Use
- 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
 - 5B - Indirect CO2 emissions from the atmospheric
 - 5C - Other

Worksheet: CH4 Emissions from Domestic Wastewater

Sector: Waste

Category: Wastewater Treatment and Discharge

Subcategory: 4.D.1 - Domestic Wastewater Treatment and Discharge

Sheet: CH4 Emissions from Domestic Wastewater

2015

Equation 6.1, 6.2, 6.3

Subdivision (Region, city, etc.)	Weighted Emission Factor (kg CH4/kg BOD)	Population (Capita)	Degradable organic component (g/g)	Correction factor for industrial BOD discharged to sewer	Organically degradable material in wastewater	Sludge removed	Methane recovered (kg CH4)	CH4 Emissions	CH4 Emissions
	WEF	P							
Total	Calculated								

Weighted Emission Factor

Equation 6.1, 6.2

Income Group	Fraction of Population in Income Group (Fraction)	Weighted Emission Factor (kg CH4/kg BOD)			
Rural					
Total					
j	Tij	Bo	MCF	EFj = Bo * MCF or specified	WEFj = Ui * Tij * EFj
Total					

$\Sigma(T_{ij}) = 0.000$

$WEF_i = \Sigma(WEF_j) = 0.000$

Calculated or Specified

Supporting Materials

More information on functionalities of the IPCC Inventory Software

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

Step by step guidance on estimation of GHG emissions from Waste sector using the IPCC Inventory Software

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

THANK YOU

FOR YOUR ATTENTION

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