IPCC Workshop on IPCC Inventory Software

Hands-on Demonstration/Exercise: Waste Sector

Baku, Azerbaijan, 5 September 2024

Baasansuren Jamsranjav and Fatma Betul Demirok

IPCC TFI-TSU

INTERGOVERNMENTAL PANEL ON climate change

WMO

UN environment programme

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 (CH_4)
   - Domestic Wastewater Treatment and Discharge (CH_4 and N_2O)

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

CH_4 emissions in year T from SWDS (Gg)

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

T : inventory year
X : waste category or type/material
R_T: recovered CH_4 in year T, Gg
OX_T : oxidation factor in year T, fraction

CH_4 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), sewered 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 CO_2, CH_4 and N_2O

- CO_2 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

CH_4 EMISSIONS

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

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

CH_4 Emissions : CH_4 emissions in inventory year, kg CH_4/yr
TOW : total organics in wastewater in inventory year, kg BOD/yr
S : organic component removed as sludge in inventory year, kg BOD/yr
Ui : fraction of population in income group i in inventory year
Ti,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
EFj : emission factor, kg CH_4/kg BOD
R : amount of CH_4 recovered in inventory year, kg CH_4/yr

Domestic Wastewater Treatment and Discharge

CH_4 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)

$$EF_j = B_o \bullet MCF_j$$

EFj : 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
MCFj : CH_4 correction factor (fraction)

Domestic Wastewater Treatment and Discharge

N_2O 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 N_2O emissions from wastewater effluent discharged into aquatic environment

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

$N_2O_{Emissions}$: 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 wastewater, kg N_2O-N/kg N
44/28 : conversion of kg N_2O-N into kg N_2O

Domestic Wastewater Treatment and Discharge

Indirect N_2O emissions from wastewater effluent discharged into aquatic environments

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

$N_{EFFLUENT}$: 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 N_2O emissions from advanced centralised wastewater treatment plants

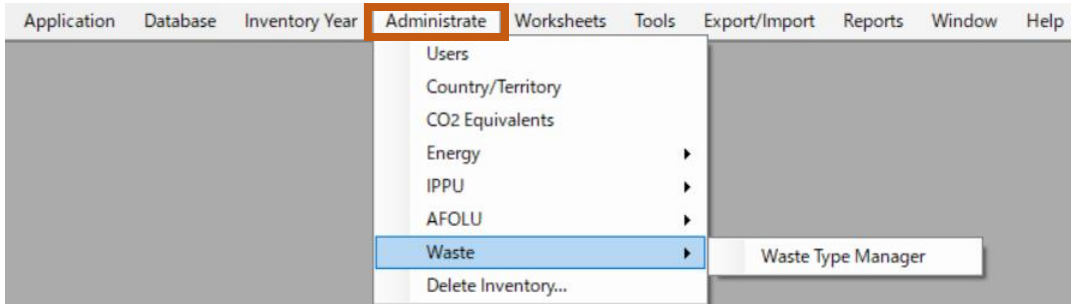
$$N_2O_{PLANTS} = P \bullet T_{PLANT} \bullet F_{IND-COM} \bullet EF_{PLANT}$$

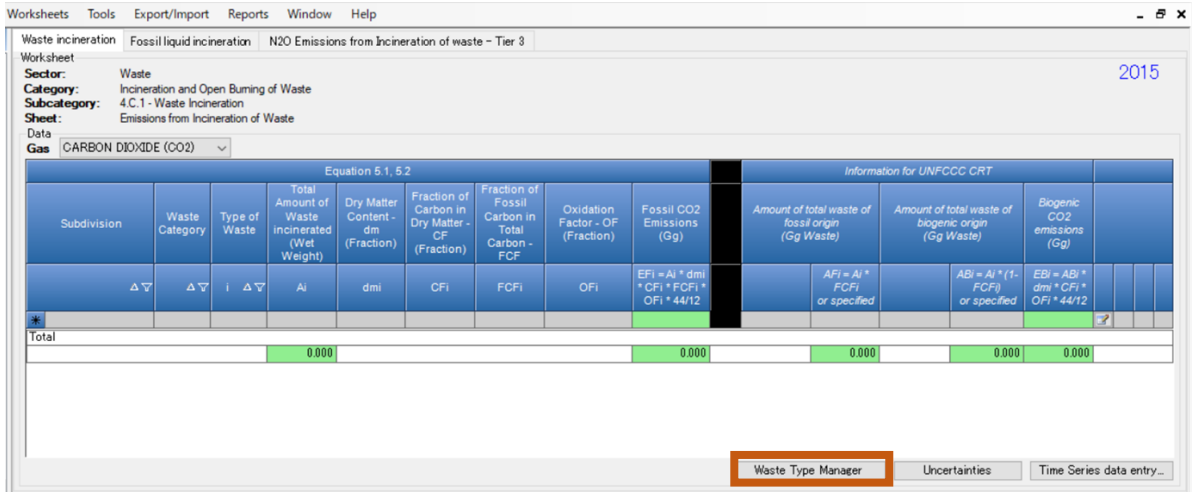
N_2O_{PLANTS} : total N_2O emissions from plants in inventory year, kg N_2O/yr
P : human population
T_{PLANT} : degree of utilization of modern, centralized WWT plants, %
$F_{IND-COM}$: fraction of industrial and commercial co-discharged protein (default = 1.25)
EF_{PLANT} : emission factor, 3.2 g N_2O/person/year

Using Data Manager

Access the Waste Type Manager

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

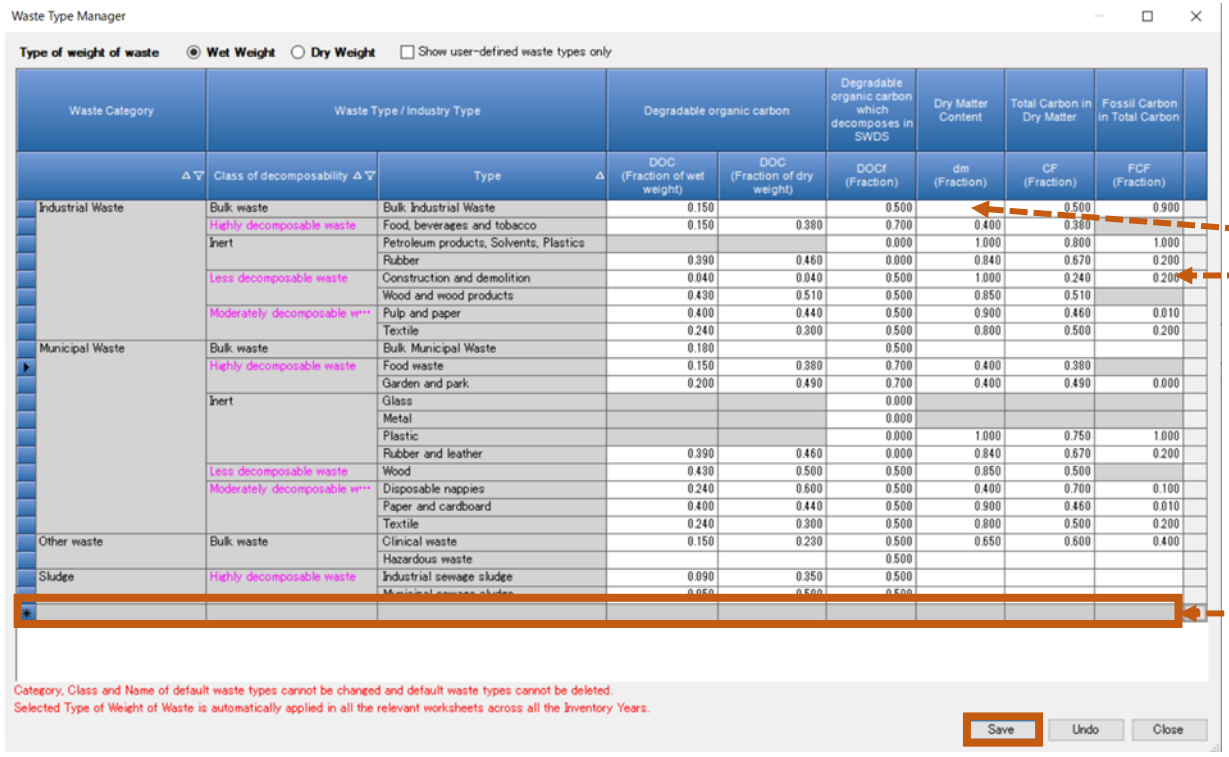




Using Data Manager

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)



Type in blank cells/ overwrite existing values

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

Estimating Emissions: Worksheets

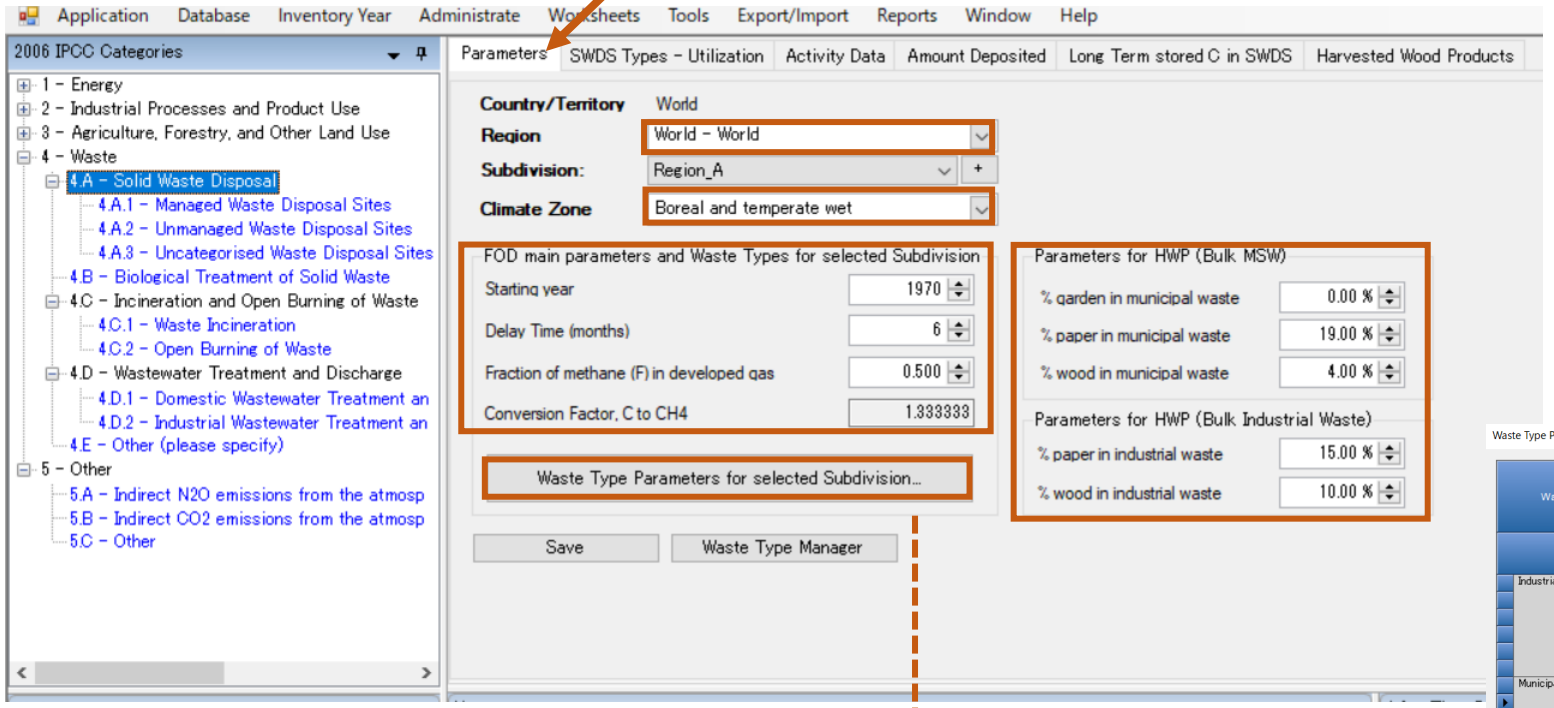
SOLID WASTE DISPOSAL

Parameters worksheet (after populating Waste Type Manager)

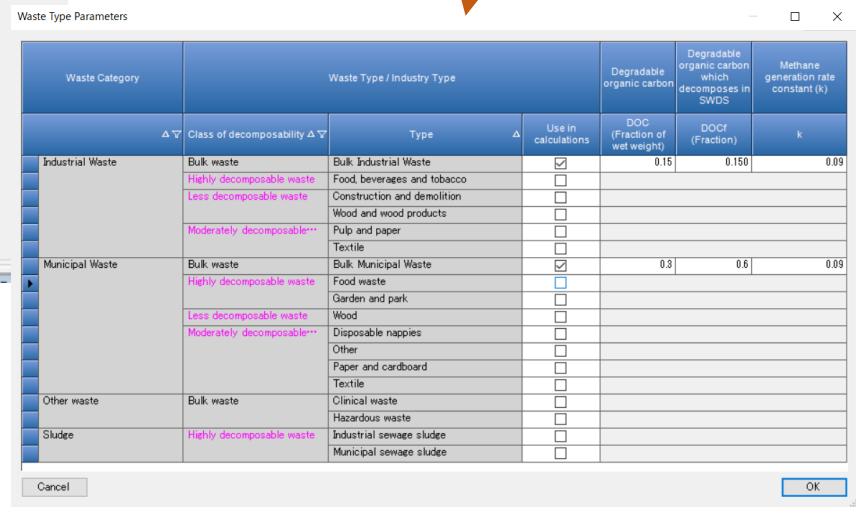
- Select region and climate zone: IPCC defaults on other worksheets will be adjusted to selected regions/climate zone
- Initial settings for FOD method (start year, delay time, etc.)
- Waste Type Parameters for Selected Subdivision: Select waste category/types and update associated parameters to be used for calculation of CH_4 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



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

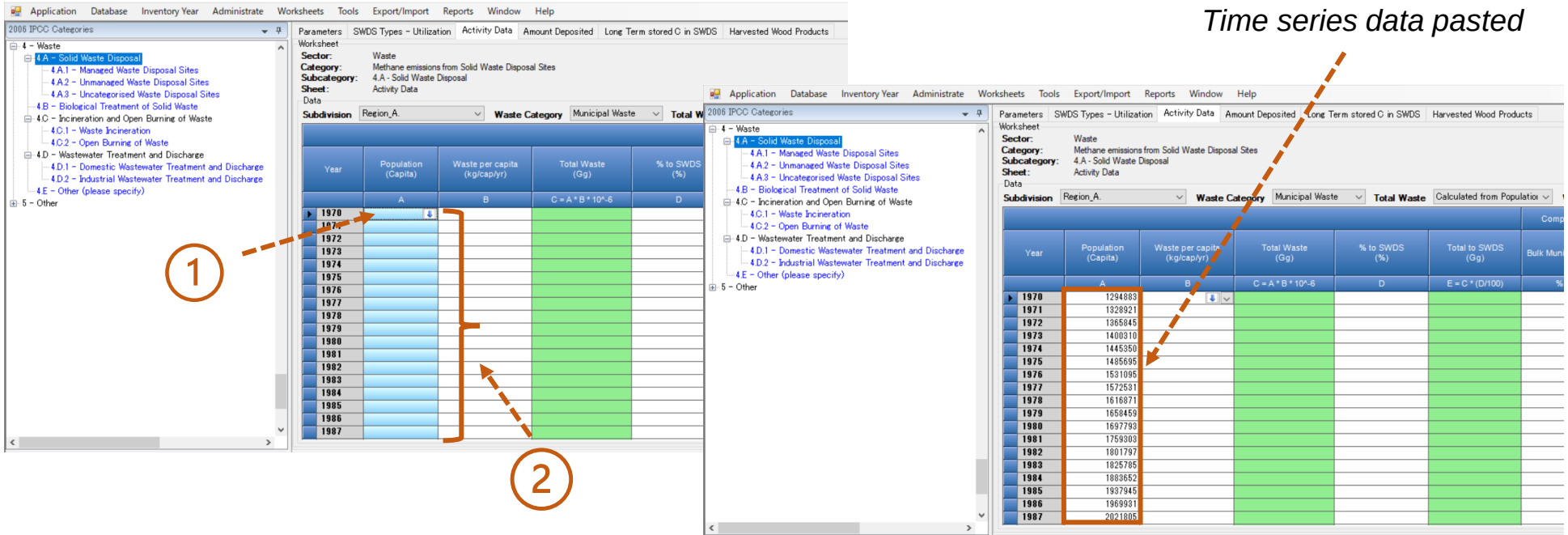


Estimating Emissions: Worksheets

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)

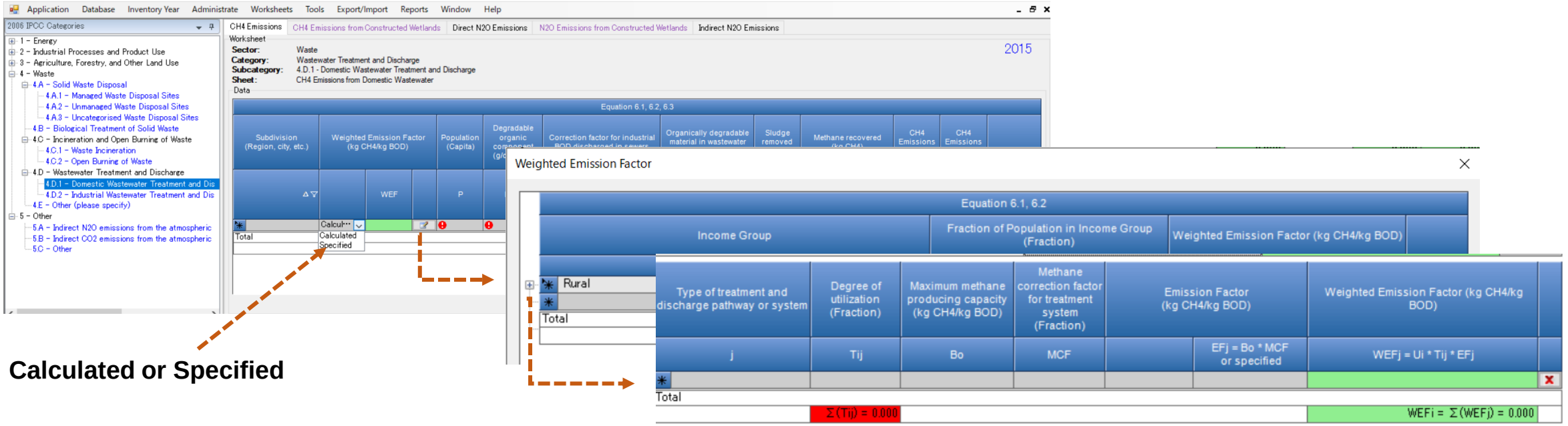


Estimating Emissions: Worksheets

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)



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

STAY IN TOUCH


ipcc-nggip.iges.or.jp


nggip-tsu@iges.or.jp

STAY CONNECTED


ipcc_ch

ipcc


@ipcc


ipcc