



NATIONAL GREENHOUSE GAS INVENTORY SYSTEM OF MALAWI

FUELWOOD COLLECTION & COMBUSTION EMISSIONS CALCULATOR

Standard Operating Procedures



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ACRONYMS AND ABBREVIATIONS

AD	Activity Data
EF	Emission Factor
GHG-IS	Greenhouse Gas Inventory System
QA/QC	Quality Assurance/Quality Control
SOP	Standard Operating Procedure
WISDOM	Woodfuel Integrated Supply/Demand Overview Mapping
NRB	Non-Renewable Biomass
BEST	Malawi Biomass Energy Strategy
IPCC	Intergovernmental Panel on Climate Change
UNFCCC	United Nations Framework Convention on Climate Change
EAD	Environmental Affairs Department
NSO	National Statistical Office
PERFORM	Protecting Ecosystems and Restoring Forests in Malawi
USAID	United States Agency for International Development



I.0 INTRODUCTION

The Government of Malawi with USAID's Protecting Ecosystems and Restoring Forests in Malawi (PERFORM) has developed the Greenhouse Gas Inventory System (GHG-IS) to support Malawi's Low Emissions Development Strategy. The GHG-IS uses a series of Microsoft Excel emissions calculators that combine methods and data from Intergovernmental Panel on Climate Change (IPCC) Guidelines (2006) with Malawi-specific data to produce estimates of emissions from each sector (see box). These emission calculators are accompanied by Standard Operating Procedures (SOPs) which provide comprehensive guidance on using the calculators.

The Fuelwood Emissions Calculator produces estimates of emissions to contribute to accounting of emissions in two sectors: (1) energy and (2) land use, land use change and forestry (LULUCF). Emissions associated with the combustion of fuelwood for energy contribute to total emissions reported in the energy sector and emissions associated with unsustainable fuelwood extraction contribute to emissions from the land use sector.

This SOP for the Fuelwood Emissions Calculator and serves to: (1) provide overview of steps required to operate the Fuelwood Emissions Calculator; (2) direct analysts through the collection and entry of activity data; and (3) guide the interpretation and reporting of resulting emission estimates.

Under the GHG-IS, emissions from the fuelwood sector in Malawi are accounted following the Intergovernmental Panel on Climate Change (IPCC) Tier I approach and accounts for emissions resulting from the combustion of fuelwood to produce energy as well as emissions from forest degradation caused by the unsustainable extraction which leads to the depletion of carbon stocks in standing forests. The greenhouse gases (GHGs) emitted from these sources include CO₂, CH₄, and N₂O.

The main Government entity responsible for the GHG-IS Fuelwood Emissions Calculator is the Environmental Affairs Department (EAD). Personnel responsible for collecting, entering, and analyzing data for the GHG-IS will need to be assigned in accordance with the guidance set forth in the GHG-IS Master Document and will need to work with relevant government agencies to collect appropriate data for evaluating emissions from the energy sector.

Sectors accounted for in Malawi's GHG-IS

Energy: Emissions resulting from production and use of fuels for energy.

Industrial Processes and Product Use: Emissions from producing cement and lime.

Agriculture, Forestry, and other Land Use: Emissions from livestock and agricultural soil management (i.e., fertilizer application), forests remaining forests (degradation from unsustainable fuelwood harvest), and land use change.

Waste: Emissions from wastewater treatment and discharge, incineration and open burning of waste, and solid waste disposal.



2.0 OVERVIEW OF THE FUELWOOD EMISSIONS CALCULATOR

The Fuelwood Emissions Calculator is currently built to accommodate data entry and estimate emissions from 2013 to 2040. It includes the following tabs (i.e., Excel worksheets):

Table 1 FUELWOOD EMISSIONS CALCULATOR TABS

TAB NAME	PURPOSE
Workbook Overview	Provides an overview of the calculator and basic instructions on how to utilize the workbook.
Change Log	List of all changes made to the calculator, and documents if they have been QA/QC'ed. The change log must be updated every time the calculator is updated or modified.
AD_Tracker	Displays all the AD that needs to be entered on the calculator, per year of inventory. Clicking on the name of the AD shows the tab where the AD must be entered. Staff responsible for updating the calculator with new data must update the table in this tab to indicate whether the AD in a given year was complete, assumed to be 0, partially entered, missing, or entered but still requiring validation and QA/QC - these options appear in the dropdown menu in each cell of the table.
Total Emissions	Reports two sets of emissions: (1) total annual CO ₂ emissions due to forest degradation produced by fuelwood collection ("non-renewable" biomass), and (2) total annual CH ₄ and N ₂ O emissions due to fuelwood combustion for residential and commercial use. Estimates are based on the AD entered and the EF used. Emissions on this tab are entered into the Land Use Change Emissions Calculator and Energy Sector Emissions Calculator, as instructed.
Emissions_Breakdown	Fuelwood emissions disaggregated by activity (i.e. fuelwood collection, residential combustion, and commercial combustion), and by gas (i.e. CO ₂ , CH ₄ , and N ₂ O).
Activity Data	AD needed to estimate annual fuelwood emissions from forest degradation and fuelwood combustion. AD: Annual tons of biomass consumed for commercial purposes, and annual country population. This tab should be updated as new AD becomes available every year.
Defaults	Emission factors (EF) for each component of fuelwood combustion, charcoal production, and forest damage process. Emission factors should only be updated if improved information is made available on emissions from fuelwood combustion or charcoal production.



The tabs and tables are color-coded to indicate their function following this key:

Table 2 COLOR KEY FOR TAB AND TABLE FUNCTIONS

COLOR	FUNCTION
Orange	Results of total yearly emissions estimates, either by sector or aggregated.
Yellow	Quality Control checks for specific data-entry tasks that are likely to have errors, and Activity Data Tracker.
Green	Activity data.
Blue	Default coefficient factors that contribute to emission factors. Should be periodically reviewed by sectoral experts and updated as new information are developed.
Purple	Coefficients developed in the reporting format and units that other inventory calculators require as inputs.
Grey	Products of equations that represent intermediary steps between activity data and final emissions estimates. For review only, should not need update unless the formula has been corrupted. To recover the formula, the calculator manager should visit the reference listed on the table heading (usually an equation from the IPCC Guidelines).

The tables within each tab of the Energy Emissions Calculator include a heading that describes:

- The IPCC-defined coefficient name (i.e., activity data, IPCC coefficient, etc.)
- A plain-language definition of the coefficient name
- Units of measurement
- Reference to where the coefficient is referred to in the IPCC 2006 Guidelines
- Frequency of review
- Notes where additional context is needed. Where deviations from IPCC 2006 Guidelines or assumptions have been made (see section **Error! Reference source not found.**) these will be noted here.

3.0 GHG ACCOUNTING USING THE FUELWOOD EMISSIONS CALCULATOR

Malawi's GHG-IS is designed to allow for clear and consistent accounting for emissions by limiting data entry in the emissions calculators to activity data (AD)¹. The process for collecting, entering, and reviewing those data are described below.

3.1 ACTIVITY DATA PRODUCTION

¹ The magnitude of human activity resulting in emissions or removals taking place during a given period of time
<https://unfccc.int/process/transparency-and-reporting/greenhouse-gas-data/greenhouse-gas-data-unfccc/definitions>



To account for emissions from fuelwood extraction and use, data on biomass consumption and population are needed. Specific AD needs are presented in Table 3 below.

Table 3 ACTIVITY DATA NEEDS FOR EMISSIONS FROM FUELWOOD USE

Data Description	UNIT
National statistics on annual tons of biomass consumed for commercial purposes	<i>Tonnes per year (t y⁻¹)</i>
Population	<i>Persons</i>

These are developed by the National Statistical Office (NSO) and the Economic Planning and Development Office. The specific sectoral focal points to contact for these data are listed in the *GHG-IS Master Document*.

These data are produced every year. In accordance with the timelines and guidance set forth in the established master GHG-IS Calendar, data should be entered into the Fuelwood Emissions Calculator during the first trimester of the year, every year.

3.2 ACTIVITY DATA ENTRY

Once EAD personnel have collected the AD for the period, they must be entered into the following green **Activity Data** tab in the Fuelwood Emissions Calculator.

Data in the blue **Defaults** tab and grey **Lists** tab will populate automatically, according to the equations and assumptions indicated in their table headings. Total emissions are automatically calculated multiplying AD by its corresponding EFs and will appear in the **Emissions_Total** and **Emissions_Breakdown** tabs. Emissions from forest degradation due to fuelwood collection (in tons of CO₂ for each year) and from fuelwood combustion for energy purposes (in tons of CH₄ and N₂O for each year, which are then converted to tons of CO₂e) are clearly disaggregated in the **Emissions_Total** tab, along with a graph that visually describes the information offered in each of the Fuelwood Emissions tables.

When the calculator has been updated and/or the AD has been entered, rename the file to be saved file with today's date. **Do not overwrite existing versions**. For example, "Fuelwood Emissions Calculator – July_17_2018".

3.3 QA/QC & APPROVAL OF EMISSION ESTIMATES

It is imperative that quality assurance/quality control measures are undertaken to ensure data are correctly entered. The following steps must be followed by the individual responsible for QA/QC every time AD are entered into the Fuelwood Emissions Calculator.

1. Whenever the data entry analyst makes a change or a series of changes, review the new version of the workbook by reading the **Change Log** tab.
2. If there are any new changes that have not been reviewed yet, proceed to review all changes considering the following checklist:



- For all activity data tables (green), confirm the values entered for the current year have been correctly entered and are plausible. If a large change is shown since the previous reporting period, make sure that the reason for this difference has been identified and documented in the **Change Log** notes.
 - Confirm that the conversion of units from L or kg of fossil fuel to kg and TJ on the grey tables has been done using the appropriate conversion factor from the coefficient table (blue).
 - Confirm that the emission factors (blue) are appropriately converting AD to tons of CO₂e.
3. On the emissions reporting tab (orange) confirm that all emissions estimates for the current year are within a reasonable range ($\pm 20\%$) from previous year. If a change over this threshold is observed, the reason must have been identified and documented in the Change Log by the person responsible of entering the data. Note in the Change Log tab any comments related to changes that have been QA/QC'd. If any errors were resolved, note the change and set the status to **'OK'd'**.
 4. If any errors could not be resolved immediately, change the status to 'needs resolution' while a solution is determined. Seek out the expertise of teammates to resolve unexplained errors. Once resolved, update the change log again for this entry and change status to 'OK'd'.
 5. Update the status of the AD entered on the **AD_Tracker** tab.

3.4 REPORTING OF EMISSIONS FROM FUELWOOD COLLECTION AND COMBUSTION

Emissions estimated using the Fuelwood Emissions Calculator will contribute to estimating emissions from the energy sector and the LULUCF sector. Therefore, appropriate outputs need to be accounted for under each sectoral total in the GHG-IS Master Calculator.

Once reviewed, appropriate EAD personnel should enter the emissions estimated using the Energy Emissions Calculator and the Land Use Change Emissions Calculator into the Master GHG-IS Calculator, which compiles all sectoral emissions for UNFCCC reporting purposes. The estimated emissions from both sectors will also need to be included in Malawi's GHG Inventory Annual Report, both as total tons of CO₂e and per GHG (i.e., CO₂, CH₄, and N₂O), if applicable.

3.5 ASSUMPTIONS MADE IN ACTIVITY DATA, COEFFICIENTS, AND EMISSION FACTORS

While the IPCC 2006 Guidelines were followed when choosing equations and default factors, it was necessary to make some additional assumptions for Malawi due to data gaps or expert opinion. To ensure transparency and consistency, these assumptions are listed in the 'Notes' cell of the relevant coefficients and are further elaborated in Table 4 below.

Table 4 LIST OF ASSUMPTIONS

COEFFICIENT	ASSUMPTION
AD commercial	Based on estimates for 2016 from Malawi Woodfuel Integrated Supply/Demand Overview Mapping (WISDOM) (2019). Converted from tonnes dry matter to tonned air dry by (0.85)
Population	Extrapolated per-capita consumption from BEST, based on World Bank population statistics.



Saturation	Percent of households that use the listed fuel as their MAIN cooking and heating source. Values for 2010, 2013, 2016 from Malawi Census and IHS. Other values are interpolations between those years
Per capita household consumption by MAIN users	Based on estimates for 2016 from Malawi Woodfuel Integrated Supply/Demand Overview Mapping (WISDOM) (2019). WISDOM converted average per-capita consumption from BEST (2009) to per-capita for MAIN users using 2008 census population and IHS saturation values.
Kiln Yield	Assumes 4.45 t air-dry wood per t charcoal, Malawi Biomass Energy Strategy (BEST 2009)
fNRB	see http://www.wisdomprojects.net/global/csdetail.asp?id=31# "Pan-tropical analysis of woodfuel supply, demand and sustainability" page 137 "NRB values with consideration for biomass available from LULCC - NRB additional to deforestation/afforestation material - Expected% - Malawi tot" = 12.2%

4 UPDATING DEFAULTS AND EMISSION FACTORS

It is not expected that the GHG-IS operators will be responsible for refining or updating default values or emission factors. However, developments in the availability of information and new research may justify updating coefficients to allow emissions estimates to better reflect national circumstances. The process through which equations or default factors are updated may involve a combination of expert review, literature review, original research, and comparison to neighboring countries. Guidelines for updating these factors are not provided here. However, in the event that any factors require updating, the following steps should be followed:

1. Decide if the update should apply to all or only some years. Applying to all years (including past) may necessitate the recalculation of emissions from past years. For example, the availability of new research that offers a more accurate way to account for emissions may necessitate recalculating emissions from past years, whereas changes related to new economic developments in Malawi should only be applied to years that these developments are believed to significant (including future years if appropriate).
2. Directly change the values in the corresponding emission factor table for the appropriate years.
3. For additions or removal of strata (i.e., types of fossil fuel):
 - a. Changes to a single table must be made to all tables that reflect that stratification.
 - b. An appropriate value for each coefficient relevant to that strata must be developed or adopted.
 - c. Add a row by inserting a new row across the entire workbook intersecting with the table.
 - d. Ensure all formulas are copied into new row for that table.
 - e. Check intermediary tables (grey) and final results (orange) to ensure that change causes an anticipated result.
4. Document any changes in the **Change Log** tab.
5. Update the status of the AD entered on the **AD_Tracker** tabs.



6. Deliver any documentation, studies, references etc. that support why the particular change was made to EAD, including a summary of the rationale for the change.

5 EXTERNAL RESOURCES

2006 IPCC Guidelines for National Greenhouse Gas Inventories. Volume 2. Energy, available at <http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol2.html>.

WISDOM (Woodfuel Integrated Supply/Demand Overview Mapping), overview and materials available at <http://www.wisdomprojects.net/global/csdetail.asp?id=31#>

National Greenhouse Gas Inventory System of Malawi. Master Document. October 2018.



ANNEX I. SECTORAL FOCAL POINTS

The sectoral focal points as presented below reflect institutional arrangements implemented for the 2017 Annual Greenhouse Gas Inventory. Future cycles may necessitate adjustments to the table to accurately reflect personnel changes.

GHG-IS Calculator name	Primary EAD Focal Point	Secondary EAD Focal Point	Sectoral focal point Institution	Primary Sectoral Focal Point	Secondary Sectoral Focal Point
Fuelwood Calculator - Land Use Change and Energy sectors	Mphatso Kalembo	Chimwemwe Yonasi	National Statistical Office; Economic Planning and Development Office	Masauto Wachepa	Hanna Chabwera



ANNEX II. SAMPLE DATA REQUEST LETTER

[EAD letterhead]

[name of primary sectoral FP]
[position]
[name of secondary sectoral FP]
[position]
National Statistical Office and Economic Planning and Development Office
[address]

[date]

Dear [name of primary sectoral FP] and [name of secondary sectoral FP],

Through this letter, Environmental Affairs Department formally requests that you share sectoral data necessary to estimate annual greenhouse gas emissions from fuelwood harvest for the energy and the land use sectors. As you know, Malawi has now formalized its annual greenhouse gas accounting and reporting, managed by the Environmental Affairs Department, and we reach out to all sectors every year seeking their collaboration to complete the annual multisectoral greenhouse gas emission estimates.

We request that you kindly share with us the annual national population count, reported as urban population and rural population for [year].

Please share this data in an excel format.

Do not hesitate to reach out to us if this request raises any questions or concerns. We appreciate your collaboration and thank you in advance for your prompt reply to this request.

Regards,

[signature]

[name]
[position]
Environmental Affairs Department



ANNEX III. ACTIVITY DATA NEEDS & SOURCES USED IN 2010-2017

Activity Data (AD) needed	GHG-IS Calculator Name	AD subcategories	Required AD input units	AD relevant in Malawi (2010 - 2017)	Source (2010-2017)
Population	Fuelwood Collection and Combustion Calculator	Rural and urban population	number of people, national level	yes	Data shared by NSO directly via Excel file; also available from World Bank if needed ²
Fuel Saturation	Fuelwood Collection and Combustion Calculator	Rural and urban wood and charcoal	percent	yes	Malawi Census and IHS data release every two years; intermediary annual values interpolated
AD Commercial	Fuelwood Collection and Combustion Calculator	Charcoal and wood	Tonnes per year	Yes	From Drigo 2019 report, WISDOM analysis for Malawi's Forest Reference Level – constant over time until 2021.

² <https://data.worldbank.org/>





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