IPCC Inventory Software

Guide to Land Representation

Draft as of 6 June 2023

Contents

This Guide was prepared by the Technical Support Unit (TSU) of the IPCC Task Force on National Greenhouse Gas Inventories (TFI) to help users of the IPCC Inventory Software.

It has not been subject to formal IPCC review processes.

Introduction

Data Input in the IPCC Inventory Software -hereafter *Software*- to estimate GHG emissions and removals from Land (3.B) categories in a National Greenhouse Gas Inventory (NGHGI)[1] follows these steps:

Step 1. Input in the **Land Use Manager** all **land-use subdivisions**

Step 2. Input in the **Land Representation Manager** all **Regions** that compose the territory to which the GHG inventory applies

Step 3. For each Region, input a **consistent and independent time-series of activity data** in the **Land Representation Manager**

Step 4. For each **C pool**, input **C stock gains and losses or C stocks at different points in time** *(depending on methods selected)*

In this **Guide** to **Land Representation**, guidance to implement Steps 1 to 3 is provided by the Technical Support Unit of the IPCC Task Force on National Greenhouse Gas Inventories (TFI TSU).

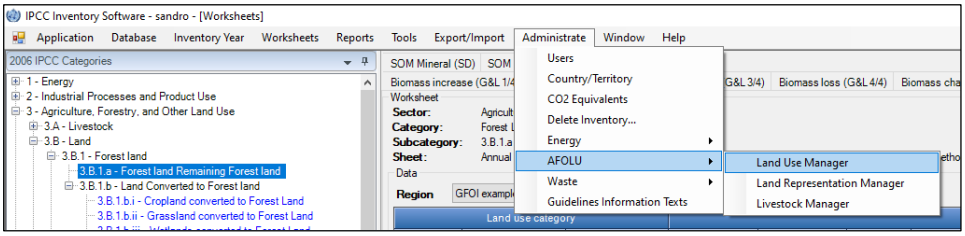
Software users must be familiar with the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (*2006 IPCC Guidelines*) methods and read the *Software manual* (downloadable from the *Help* menu) before going through this guide. This guide does not replace guidance provided in the *2006 IPCC Guidelines*.

Throughout this guide, text entered in lilac color represents category information taken from the *2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands - (Wetlands Supplement)*

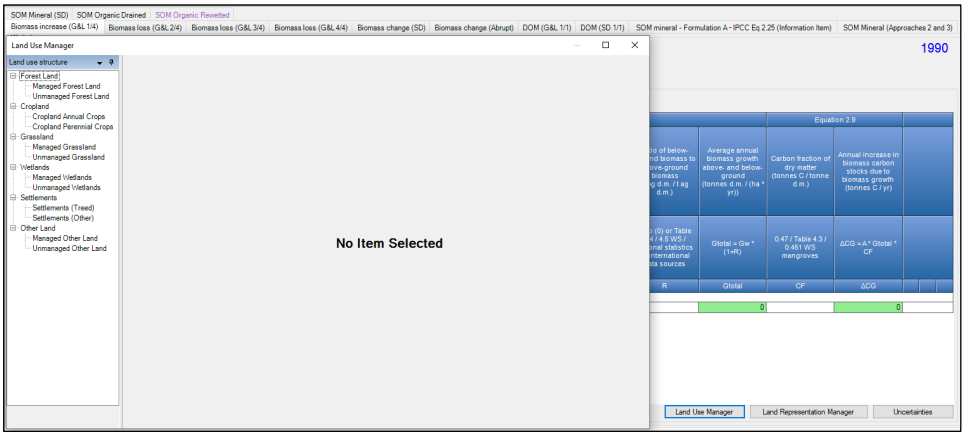
[1] Same guidance applies to the use of the *Software* for sub-national entities.

Land Use Manager (LUM)

Land Use Manager is a tabbed dialog window. The user can open it from **Administrate** main menu, **AFOLU** sub-menu



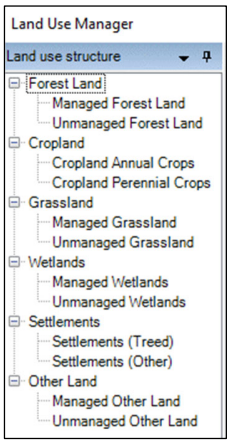
or from the bottom of any worksheets of 3.B categories



On the left-hand side, the **Land Use Manager** shows the **6 IPCC land use categories**

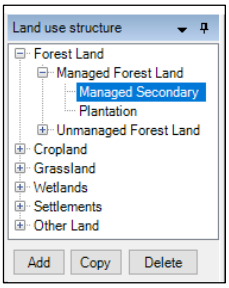
- Forest land
- Cropland
- Grassland
- Wetlands
- Settlements
- Other land

and **12 subcategories** (2 for each Land use category)

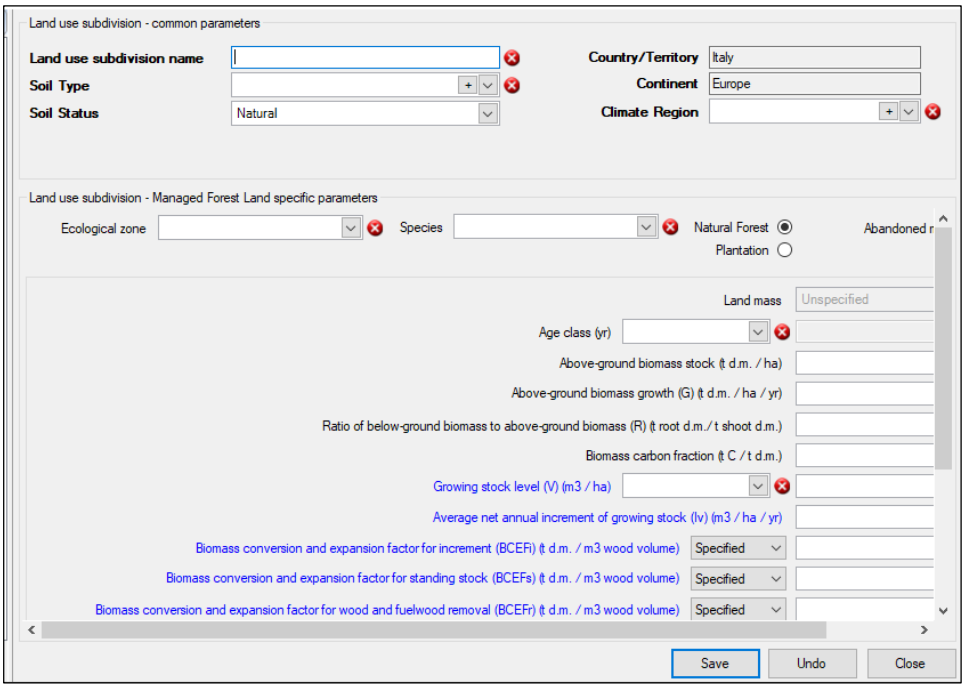


While Forest land, Grassland, Wetlands and Other land categories are disaggregated in subcategories depending on whether those are managed[2] or unmanaged[3] lands -since GHG emissions and removals from unmanaged land are excluded from the NGHGI- while Cropland and Settlements are disaggregated depending on the presence of perennial biomass stocks -since the IPCC methodological approach to estimate GHG emissions and removals from perennial biomass significantly differ from that applied to annual biomass.

To add a land subdivision, select the relevant subcategory and click the **add** button at the bottom of the window.

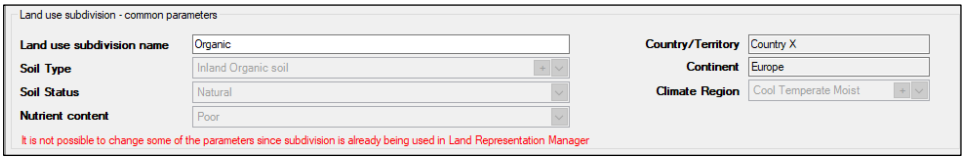


Doing so a window mask opens where to input those data that the *Software* requires, at minimum, to estimate C stock changes in relevant C pools at selected Tier level. As for instance:



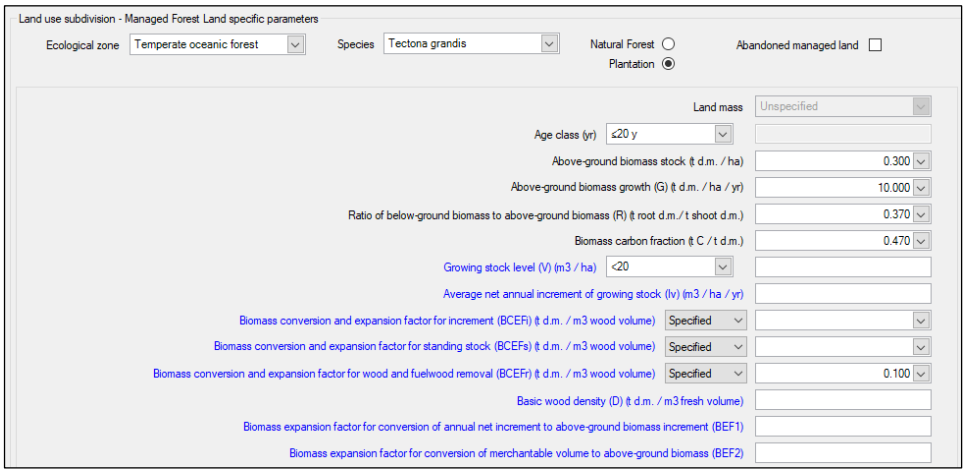
The **Land use subdivision** mask is composed of 2 parts:

- ✓ the **Top**, which contains parameters common to any subcategory [with labels in **bold**]:



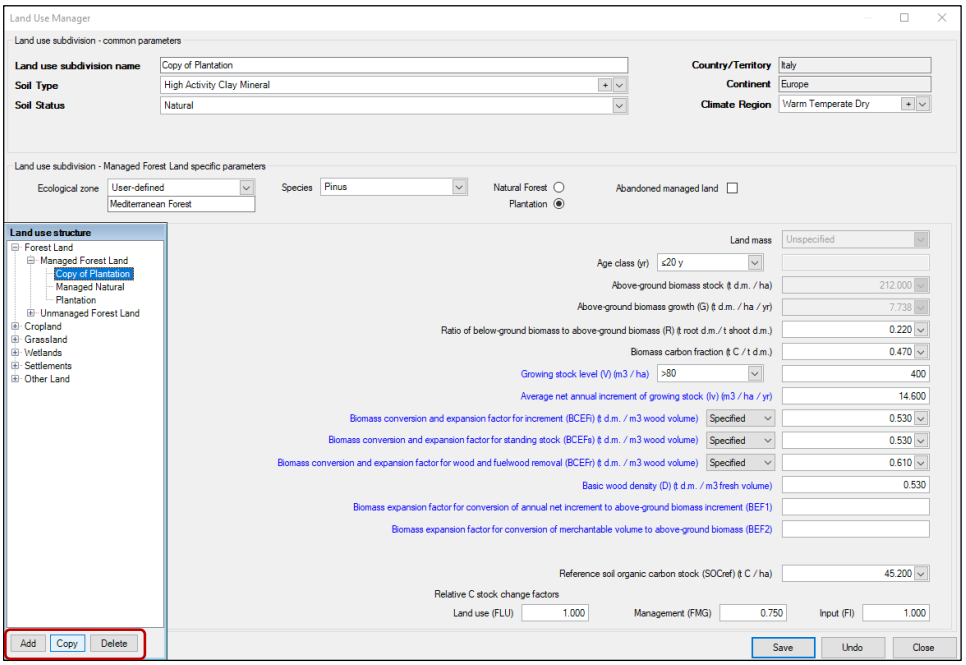
- ✓ the **Bottom**, which contains subcategory specific information:

[2] Managed land is land where human interventions and practices have been applied to perform production, ecological or social functions.
[3] Unmanaged land is a land not qualified as managed.



Labels in blue are applied to information relevant for the implementation of IPCC Tier 2 methods.

Where the subdivision to add is a variation of a subdivision already entered (e.g. a different age class) a speedy way, which also minimizes potential errors, is to make a copy of the selected subdivision and then change the information according to the new subdivision that is to be entered. This is done by clicking the *Copy* button at the bottom of the *Land use structure* window, as shown below:



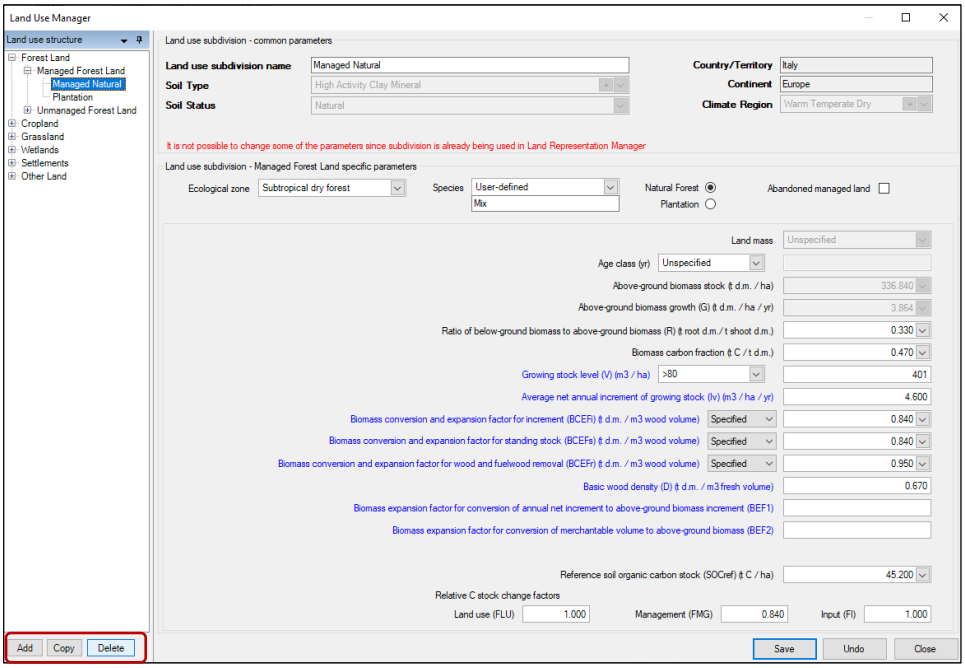
Subdivisions are generally used to distinguish different types of vegetation, as well as different management systems and/or age classes; although those are a stratification that can be applied to any other user's need.

Tip: to record info input in the DataBase (DB) press the button Save.

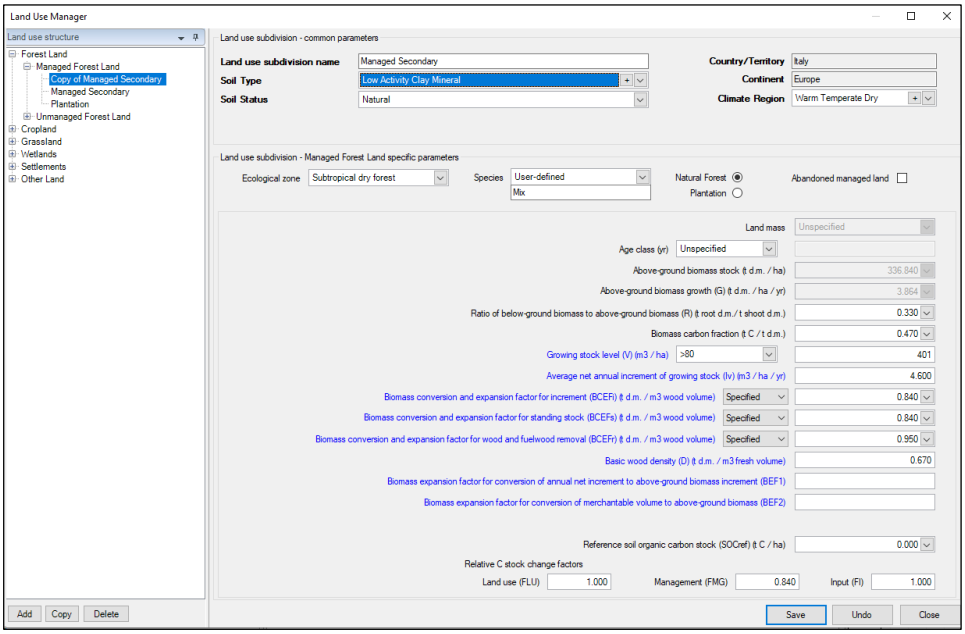
Tip: Once the subdivision is applied to one or more units of land in the land representation manager, the following fields:

- ✓ Soil type
- ✓ Soil Status
- ✓ Climate Region

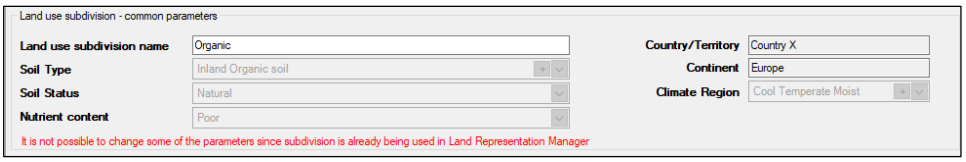
cannot be changed anymore. Where an error is identified in any of those fields, the Land subdivision (and its data) is to be deleted -to do so click on the button Delete at the bottom of the window:



then information is to be input again.



Land use subdivision mask, top section



The top section contains up to 7 fields. 5 fields are present in each and every subdivision -**Land use subdivision name**, **Soil Type**, **Country/Territory**, **Continent**, **Climate Region**- while other 2 are provided for some of the subdivisions -**Soil Status**, **Nutrient content**.

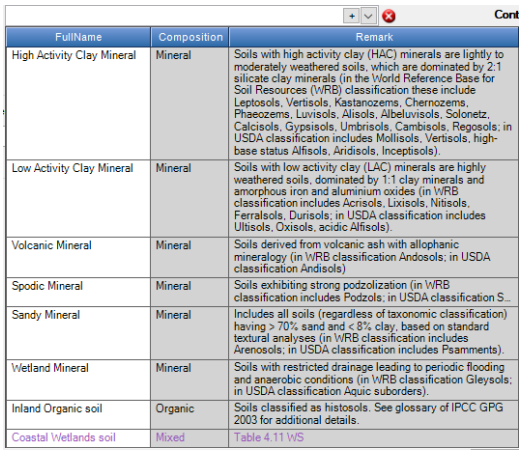
Land use subdivision name

This is a field where unique information is to be input -i.e. 2 subdivisions cannot have the same alphanumerical combination in the name-. Given that in the land representation manager subdivisions are listed by the name, it is suggested to provide in the name information that can easily recall the characteristics specific of that subdivision.

Soil Type

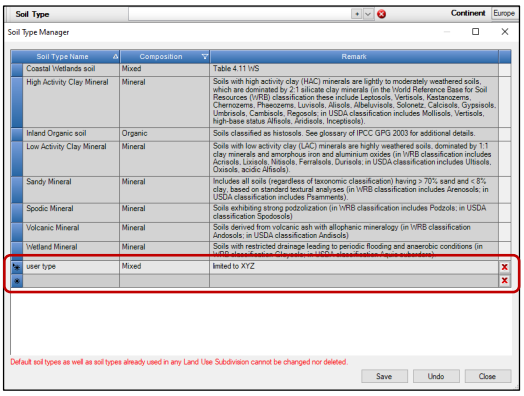
The *Software* provides in a dropdown menu the complete list of IPCC soil types listed in Chapter 2 of the AFOLU Volume, plus Coastal Wetlands soil (Chapter 4, *Wetlands Supplement*[4]). Namely:

- **Mineral soils**:
  - ✓ High Activity Clay (HAC)
  - ✓ Low Activity Clay (LAC)
  - ✓ Volcanic
  - ✓ Spodic
  - ✓ Sandy
  - ✓ Inland mineral Wetland
- **Organic soils**:
  - ✓ Inland Organic
- **Mixed soils**:
  - ✓ Coastal Wetlands



FullName	Composition	Remark
High Activity Clay Mineral	Mineral	Soils with high activity clay (HAC) minerals are lightly to moderately weathered soils, which are dominated by 2:1 silicate clay minerals (in the World Reference Base for Soil Resources (WRB) classification these include Leptosols, Vertisols, Kastanozems, Chernozems, Phaeozems, Luvisols, Alisols, Albeluvisols, Solonetz, Calcisols, Gypsisols, Umbrisols, Cambisols, Regosols; in USDA classification includes Mollisols, Vertisols, high-base status Alfisols, Aridisols, Inceptisols).
Low Activity Clay Mineral	Mineral	Soils with low activity clay (LAC) minerals are highly weathered soils, dominated by 1:1 clay minerals and amorphous iron and aluminium oxides (in WRB classification includes Acrisols, Lixisols, Nitisols, Ferralsols, Durisols; in USDA classification includes Ultisols, Oxisols, acidic Alfisols).
Volcanic Mineral	Mineral	Soils derived from volcanic ash with allophanic mineralogy (in WRB classification Andosols; in USDA classification Andisols)
Spodic Mineral	Mineral	Soils exhibiting strong podzolization (in WRB classification includes Podzols; in USDA classification S...
Sandy Mineral	Mineral	Includes all soils (regardless of taxonomic classification) having > 70% sand and < 8% clay, based on standard textural analyses (in WRB classification includes Arenosols; in USDA classification includes Psamments).
Wetland Mineral	Mineral	Soils with restricted drainage leading to periodic flooding and anaerobic conditions (in WRB classification Gleysols; in USDA classification Aquic suborders).
Inland Organic soil	Organic	Soils classified as histosols. See glossary of IPCC GPG 2003 for additional details.
Coastal Wetlands soil	Mixed	Table 4.11 WS

In addition, by clicking on the symbol the user opens a dialog tab where user-specific soil types can be input:



Soil Type Name	Composition	Remark
Coastal Wetlands soil	Mixed	Table 4.11 WS
High Activity Clay Mineral	Mineral	Soils with high activity clay (HAC) minerals are lightly to moderately weathered soils, which are dominated by 2:1 silicate clay minerals (in the World Reference Base for Soil Resources (WRB) classification these include Leptosols, Vertisols, Kastanozems, Chernozems, Phaeozems, Luvisols, Alisols, Albeluvisols, Solonetz, Calcisols, Gypsisols, Umbrisols, Cambisols, Regosols; in USDA classification includes Mollisols, Vertisols, high-base status Alfisols, Aridisols, Inceptisols).
Inland Organic soil	Organic	Soils classified as histosols. See glossary of IPCC GPG 2003 for additional details.
Low Activity Clay Mineral	Mineral	Soils with low activity clay (LAC) minerals are highly weathered soils, dominated by 1:1 clay minerals and amorphous iron and aluminium oxides (in WRB classification includes Acrisols, Lixisols, Nitisols, Ferralsols, Durisols; in USDA classification includes Ultisols, Oxisols, acidic Alfisols).
Sandy Mineral	Mineral	Includes all soils (regardless of taxonomic classification) having > 70% sand and < 8% clay, based on standard textural analyses (in WRB classification includes Arenosols; in USDA classification includes Psamments).
Spodic Mineral	Mineral	Soils exhibiting strong podzolization (in WRB classification includes Podzols; in USDA classification Spodosols)
Volcanic Mineral	Mineral	Soils derived from volcanic ash with allophanic mineralogy (in WRB classification Andosols; in USDA classification Andisols)
Wetland Mineral	Mineral	Soils with restricted drainage leading to periodic flooding and anaerobic conditions (in WRB classification Gleysols; in USDA classification Aquic suborders).
user type	Mixed	limited to XYZ

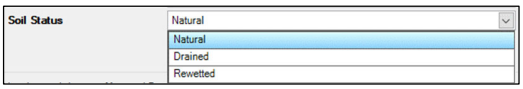
Default soil types as well as soil types already used in any Land Use Subdivision cannot be changed nor deleted.

The input and subsequent selection of user-specific soil types prevents IPCC default values to be present in the dropdown menu of parameters.

[4] *2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands*

Soil Status

The *Software* provides in a dropdown menu 3 options. **Natural** -this is the default option applied by the *Software*-, **Drained**, **Rewetted**:



According to the soil status, the *Software* populates with the units of land of the relevant subdivisions the calculation worksheets of AFOLU categories for drainage and rewetting as:

For CO_2:

- **3.B Land Use Categories**:
  - ✓ SOM Organic Drained
  - ✓ SOM Organic Rewetted

For N_2O:

- **3.C.4 Managed soils**:
  - ✓ Drainage of managed organic soils
  - ✓ Rewetting of managed organic soils

For CH_4:

- **3.C.8 Drained Organic Soils**
- **3.C.9 Drainage Ditches**
- **3.C.10 Rewetting of Organic Soils**
- **3.C.11 Rewetting of Mangroves and Tidal marshes**
- **3.C.11 Rewetted and Created Wetlands in Inland Wetland Mineral Soils**

Tip: **Soil Status** field is not present for subdivisions of category Other land.

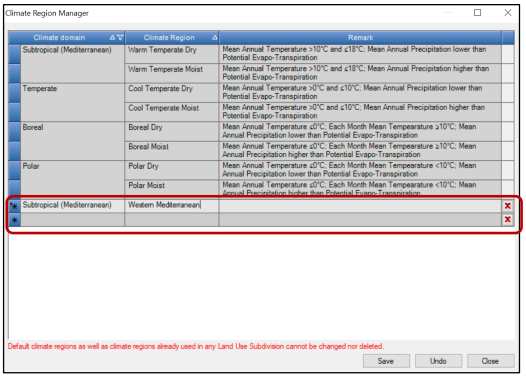
Climate Region

The *Software* provides in a dropdown menu the complete list of IPCC Climate Regions listed in Chapter 2 of the AFOLU Volume. Namely:

Domain	Region
Subtropical (Mediterranean)	Warm Temperate Moist
	Warm Temperate Dry
Temperate	Cool Temperate Moist
	Cool Temperate Dry
Boreal	Boreal Moist
	Boreal Dry
Polar	Polar Moist
	Polar Dry

The selection of the climate zone determines the IPCC default values that the *Software* populates in the dropdown menus of the parameters.

By clicking on the symbol  the user opens a dialog tab where user-specific climate zones can be input:



The input and subsequent selection of user-specific climate zones prevents IPCC default values to be present in the dropdown menu of parameters.

Land use subdivision mask, bottom section

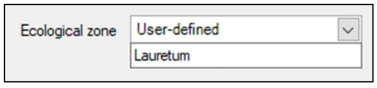
Hereafter the bottom section of the mask for each land use subcategory is shown with guidance for the data compilation. As a general rule, where applicable, the *Software* provides in a dropdown menu the IPCC default values applicable to the subdivision, while the user can always input its own user-specific values regardless the provision by the *Software* of the IPCC default value.

Parameters populating the mask are limited to those needed to estimate C stock change, parameters to estimate non-CO_2 emissions are generally input directly in the calculation worksheets. Further, not necessarily all parameters needed to estimate C stock changes are populated in the mask, while need instead to be input directly into the calculation worksheets. This is to allow more flexibility to deal with rapidly changing parameters of units of land.

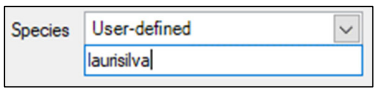
Forest land

Forest land subdivisions have 3 specific parameters to be input:

Ecological zone, the dropdown menu presents the IPCC default zones, as shown in the *2006 IPCC Guidelines* figure 4.1, relevant for the climate zone selected. The user can input a user-specific species by selecting *User-defined*, see below.



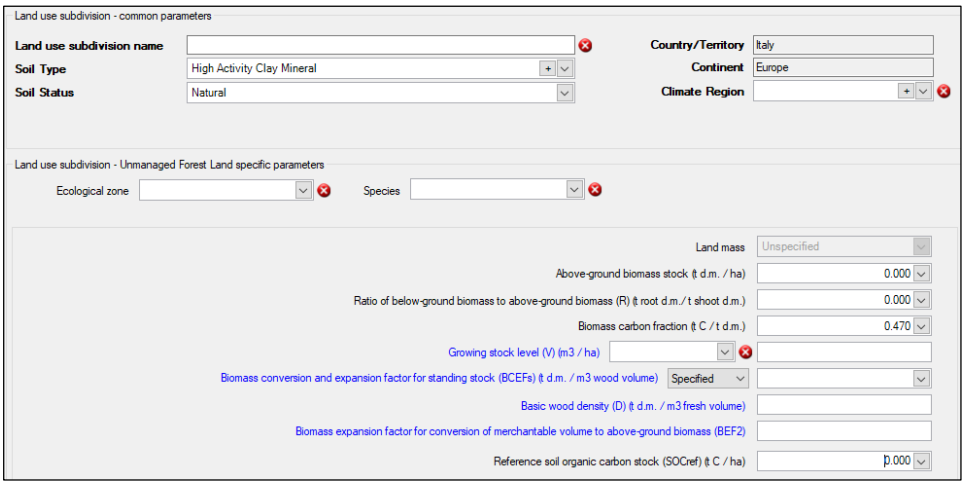
Species, the dropdown menu presents the list of species for which IPCC provides default values for parameters to be input in the mask. The user can input a user-specific species by selecting *User-defined*, see below.



This parameter does not necessarily require the input of a tree species, it can more likely be used to input forest types e.g. *Laurisilva*.

Land mass is active only for Asian countries since the *2006 IPCC Guidelines* tables 4.7 and 4.9 provides different default values for Asia (Continental) vs Asia (Insular); thus, accordingly to the territory to be inventoried user shall select among *Insular* or *Continental* or *Unspecified*. The selection of *Insular* or *Continental* determines that the *Software* provides associated IPCC default values in the dropdown of parameters Aboveground biomass stock and Aboveground biomass growth. The selection of *Unspecified* prevents IPCC default values to be present in the dropdown menu of those parameters.

Unmanaged Forest land



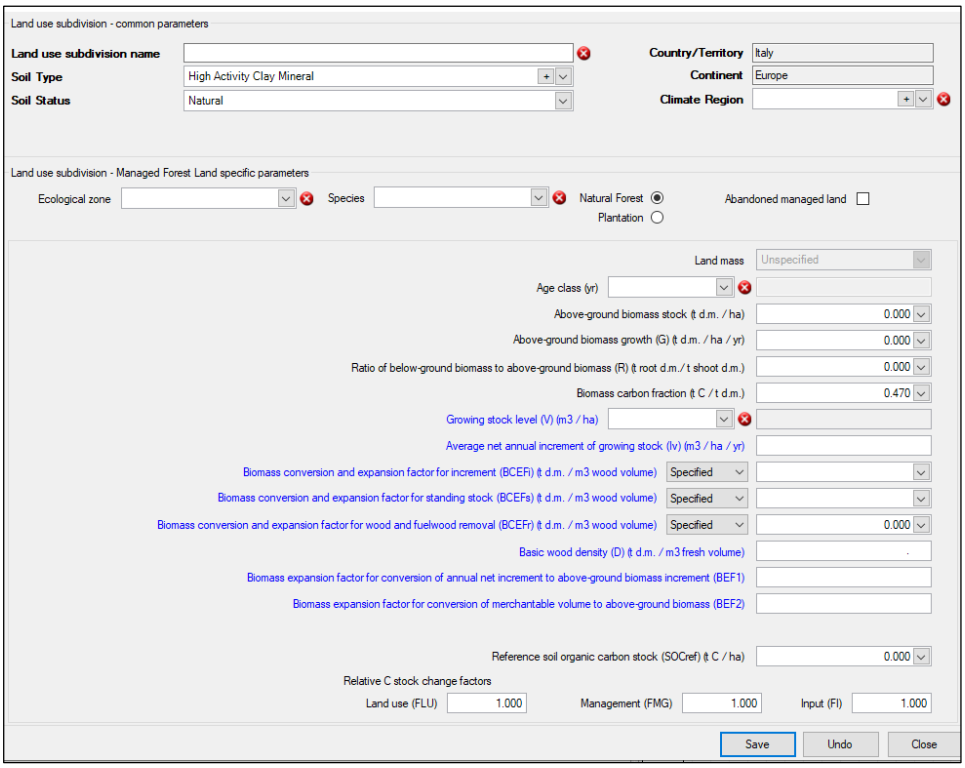
Since C stock changes in unmanaged land are considered not anthropogenic, parameters to be input in the bottom portion of the land use subdivision mask defines the biomass C stock that, in case of conversion to other land uses can be lost. Thus, the **Land mass** parameter is greyed, and no data can be input.

Parameters in black ink are needed for Tier 1, although can be used at higher tiers too, while parameters in blue ink are needed for Tier 2, either in substitution of Tier 1 parameters or additionally:

- Aboveground biomass stock, the dropdown menu provides IPCC default value, if available, although user can input its own data. It applies to Tier 1 only, thus in case a value is input in *Growing stock level* then this parameter is greyed, and no input is allowed; although the *Software* calculates the *Aboveground biomass stock* as the product of the *Growing stock level* by the *Biomass conversion and expansion factor for standing stock* or by *BEF2*D*.
- Ratio of below-ground biomass to above-ground biomass, the dropdown menu provides IPCC default value, if available, although user can input its own data. It applies to all tiers.
- Biomass carbon fraction, the dropdown menu provides IPCC default value, although user can input its own data. It applies to all tiers.
- Growing stock level, the dropdown menu provides IPCC default value, although user can input its own data in the next box. The *Growing stock level* is also used by the *Software* to select the relevant BCEF value to present in the dropdown menu, if available.
- Biomass conversion and expansion factor for standing stock, the dropdown menu provides IPCC default value, if available, although user can input its own dat. It can be either *Specified*, and in such a case the value is input in the next box, or *Calculated* as *BEF2*D* and consequently values of *Basic wood density* and of *Biomass expansion factor of merchantable volume to above-ground biomass* are to be input.
- Basic wood density, if *BEF2*D* is selected for *Biomass conversion and expansion factor for standing stock*, then a value is to be input by the user; otherwise is left blank.
- Biomass expansion factor of merchantable volume to above-ground biomass, if *BEF2*D* is selected for *Biomass conversion and expansion factor for standing stock*, then a value is to be input by the user; otherwise is left blank.
- Reference soil organic carbon stock, the dropdown menu provides the IPCC default value for the combination of mineral soil type and climate zone selected, and for unmanaged forests the SOC_{REF} is not further adjusted through stock-change factors since no management occurs. This parameter is not provided for subdivisions that have instead *organic soils*; while for *Coastal wetlands soils* the parameter is instead labelled as *Soil Carbon Stock*, and it refers to the total SOC without any further adjustment through stock change factors.

Tier 3, depending on data used, is to be accommodated in the above listed variables.

Managed Forest land



Natural Forest vs **Plantation** given that the *2006 IPCC Guidelines* provide different default values for Plantations for the following parameters: *Above-ground biomass*, *Above-ground net biomass growth*, *Above-ground net volume growth*, *Average net annual increment*; selecting the forest typology allows the *Software* to populate the dropdowns of those parameters with relevant IPCC default values.

Abandoned managed land, is relevant for reporting under the UNFCCC with non-Annex I Reporting Tables 1 and 2 (Decision 17/CP.8). Thus, it is to be checked if the subdivision is a formerly managed land and only if the user wishes to use such reporting tables; otherwise, just leave it unchecked.

Additionally to parameters described for *Unmanaged Forest land*, *Managed Forest land* requires the following parameters. Parameters in black ink are needed for Tier 1, although can be used at higher tiers too, while parameters in blue ink are needed for Tier 2, either in substitution of Tier 1 parameters or additionally:

- Age class, the dropdown menu provides IPCC default age classification in *older than 20-year* and *from 0 to 20 years*, which selection determines the IPCC default values that the *Software* populates in the dropdown menus of the biomass stand and biomass growth parameters.

Age class (yr)	Remark
≤20 y	
>20 y	
Unspecified	
User-defined range	

  In addition, the user can select *Unspecified* or *User-defined range*. For the latter, the user is to input, in the next box, the user defined range, e.g.:

  The selection of a non-IPCC age class prevents IPCC default values to be present in the dropdown menu of parameters. It applies to all tiers.

- Aboveground biomass growth, the dropdown menu provides IPCC default value, if available, although user can input its own data. It applies to Tier 1 only, thus in case a value is input in *Average net annual increment of growing*

stock then this parameter is greyed, and no input is allowed; although the *Software* calculates the *Aboveground biomass growth* as the product of the *Average net annual increment of growing stock* by the *Biomass conversion and expansion factor for increment* or by *BEF1*D*.

- Average net annual increment of growing stock, the value to input is the increment[5], either the current increment, the average current increment, or the mean increment, where all correspond to the gross increment minus the natural background mortality[6].
- Biomass conversion and expansion factor for increment, the dropdown menu provides IPCC default value, if available, although user can input its own data. It can be either *Specified*, and in such a case the value is input in the next box, or *Calculated* as *BEF1*D* and consequently values of *Basic wood density* and of *Biomass expansion factor of annual net increment to above-ground biomass increment* are to be input.
- Biomass expansion factor of annual net increment to above-ground biomass increment, if *BEF1*D* is selected for *Biomass conversion and expansion factor for standing stock*, then a value is to be input by the user; otherwise is left blank.
- Biomass conversion and expansion factor for wood and fuelwood removal, the dropdown menu provides IPCC default value, if available, although user can input its own data. It can be either *Specified*, and in such a case the value is input in the next box, or *Calculated* as *BEF2*D* and consequently values of *Basic wood density* and of *Biomass expansion factor of merchantable volume to above-ground biomass* are to be input.
- Relative C stock change factors, at Tier 1 are by IPCC default all equal to 1; since forest SOC is considered to be the reference for all other land use categories. Users can input a user-specific value according to data collected.

  Note: In Forest land the F_{LU} stock-change factor is used to adjust SOC by the natural disturbance regime i.e. F_D.

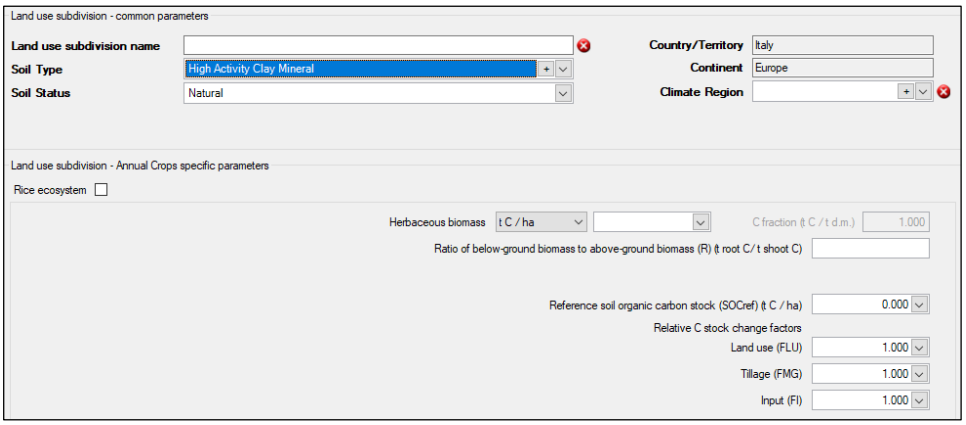
Tier 3, depending on data used, is to be accommodated in the above listed variables.

[5] The type of increment likely depends on the breadth of age class
[6] This does not include mortality/losses caused by disturbances

Cropland

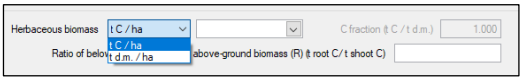
Cropland methods provided by IPCC significantly differs depending on the type of biomass present in the land. Thus, Cropland is subdivided in 2 subcategories dealing with that land with annual biomass only and that land with perennial biomass, although the latter subcategory may also include an annual biomass component.

Annual Cropland



Rice ecosystem is to be checked in order to instruct the *Software* to report units of land with the rice ecosystem subdivision in relevant worksheets for 3.C.7 (*Rice Cultivation*).

Herbaceous biomass can be input either in *tonne of C*, and in such a case the IPCC default value can be selected from the drop-down menu -although a user-specific value can either be input-, or in *tonne of dry matter*.

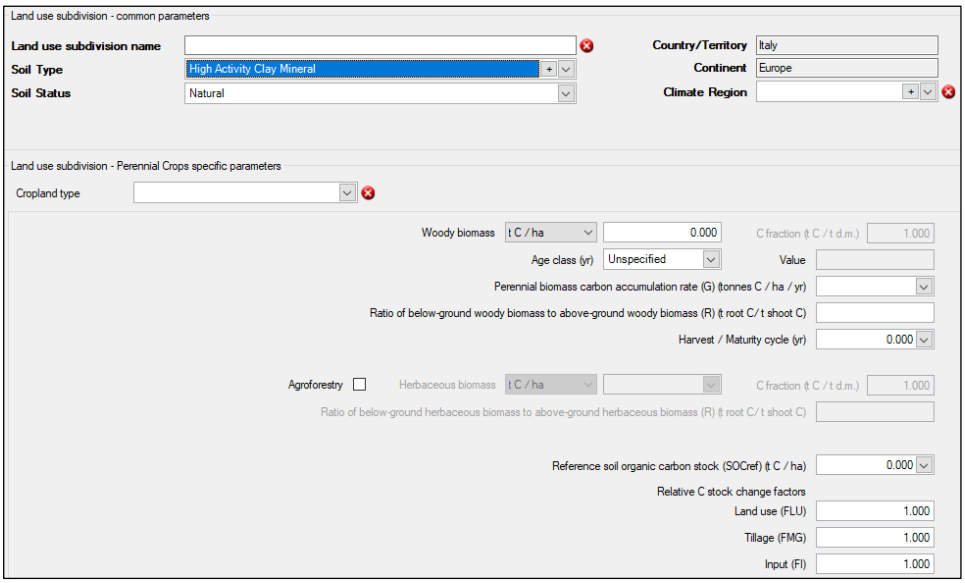


In the latter case, there is not an IPCC default value and the C fraction of dry matter is to be input, see below:

For all other parametes see *Managed Forest land*.

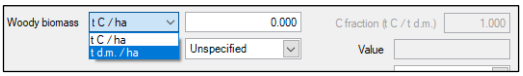
Tier 3, depending on data used, is to be accommodated in the above listed variables.

Perennial Cropland

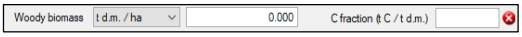


Cropland type provides IPCC default types of perennial crop systems. The user can input a user-specific species by selecting *User-defined*, see below.

Woody biomass can be input either in *tonne of C* or in *tonne of dry matter*.



In the latter case, the C fraction of dry matter is to be input as well, see below:



The value to be input as *woody biomass* is the total biomass at maturity (i.e. before the final harvest).

Parameters specific for this subdivision are:

- Age class, if input makes the *Woody biomass* automatically calculated (and thus its box is greyed and no data input allowed) as the *Age class* multiplied by the *Perennial biomass carbon accumulation rate*.
- Perennial biomass carbon accumulation rate requires an input from the user. To ensure mass conservation, it is to be calculated as *Woody biomass* divided by *Harvest cycle*.
- Harvest/Maturity cycle, the dropdown menu provides IPCC default value, if available, although the user can input its own data

Agroforestry is to be checked if an annual biomass component is to be added to the estimates. For parameters of annual biomass component see *Annual Cropland*.

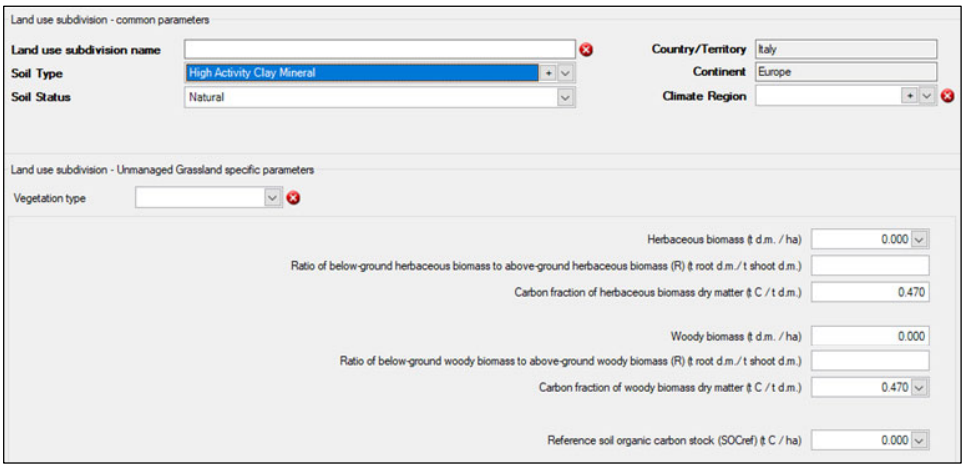
For all other parametes see *Managed Forest land*.

Tier 3, depending on data used, is to be accommodated in the above listed variables.

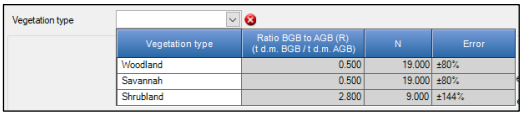
Grassland

Different types of vegetation can be classified under Grassland, ranging from land covered by grass only and managed, e.g. pastures, to land with significant woody vegetation that, although does not meet the forest thresholds, largely determines the C dynamic of the land.

Unmanaged Grassland



Vegetation type is to be selected from a dropdown menu containing IPCC default types corresponding to the climate zone selected.



Vegetation type	Ratio BGB to AGB (R) (t d.m. BGB / t d.m. AGB)	N	Error
Woodland	0.500	19.000	±80%
Savannah	0.500	19.000	±80%
Shrubland	2.800	9.000	±144%

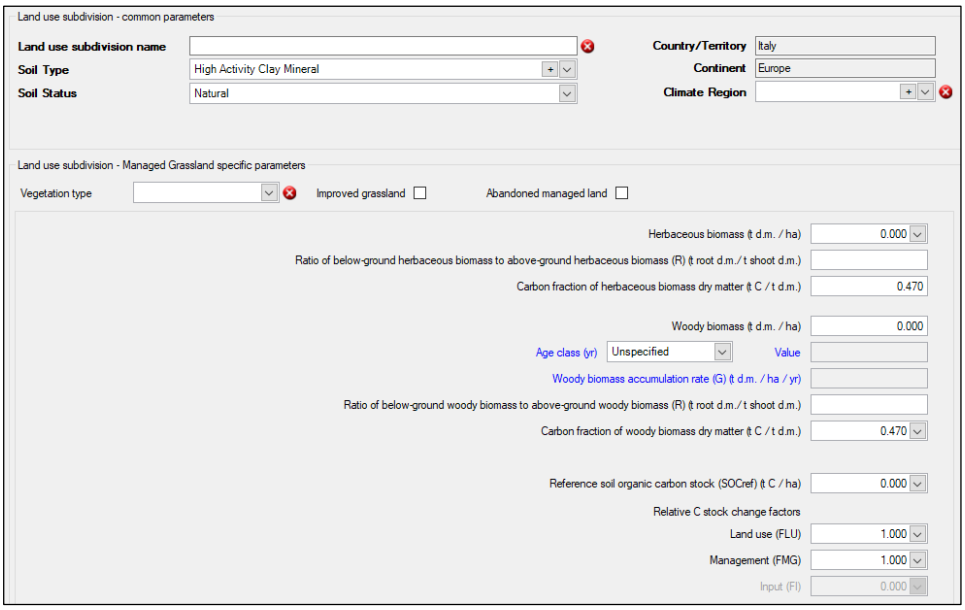
The selection of the vegetation type determines the value of the *root-to-shoot ratio* the software shows in the relevant boxes (either for *annual biomass* or for *perennial biomass*), although the user can overwrite that default value with its own data.

For all other parametes for annual biomass see *Annual Cropland*, while for those of woody biomass see *Perennial Cropland*.

Tier 3, depending on data used, is to be accommodated in the above listed variables.

Note: likewise *Unmanaged Forest land*, the *Reference soil organic carbon stock* (SOC_{REF}) is not further adjusted through stock-change factors since no management occurs.

Managed Grassland



Improved grassland is to be checked if the subdivision is subject to additional input of organic matter, e.g. manure and/or sludge application. Otherwise, FI is greyed and any input from the user is not allowed.

Abandoned managed land, is relevant for reporting under the UNFCCC with non-Annex I Reporting Tables 1 and 2 (Decision 17/CP.8). Thus, it is to be checked if the subdivision is a formerly managed land and only if the user wishes to use such reporting tables; otherwise, just leave it unchecked.

Parameters specific for this subdivision are:

- Age class and Woody biomass accumulation rate is the annual net gain[7] of woody biomass and it is not to be compiled for Tier 1 estimates. Given that unlimited accumulation of biomass is not possible, this parameter is an active parameter only if the *Age-class* is input:

  Where *Age class* and *Woody biomass accumulation rate* are input, the *Woody biomass* is automatically calculated (and thus its box is greyed, and no data input allowed) as the *Age class* multiplied by the *Woody biomass accumulation rate*. Further, the user shall also estimate C stock losses in the relevant worksheets to avoid counting for endless C accumulation in the land subdivision.

  Where *Age class* is left *Unspecified*, the box is greyed and any input from the user is not allowed, and *Woody biomass* is input by the user:

For all other parametes for annual biomass see *Annual Cropland*, while for those of perennial biomass see *Perennial Cropland*.

Tier 3, depending on data used, is to be accommodated in the above listed variables.

[7] Gross increment minus mortality

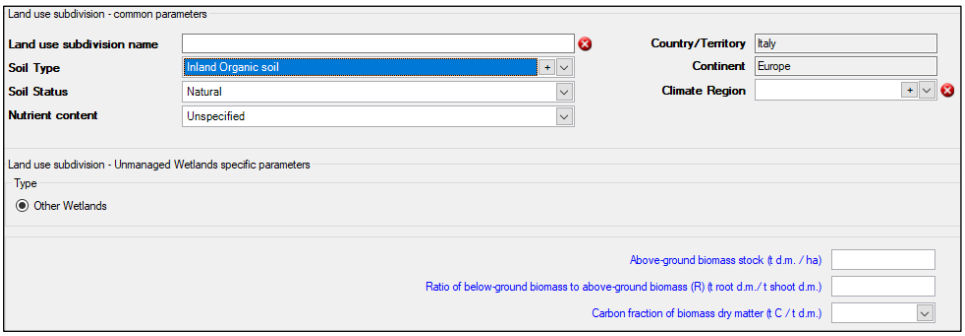
Wetlands

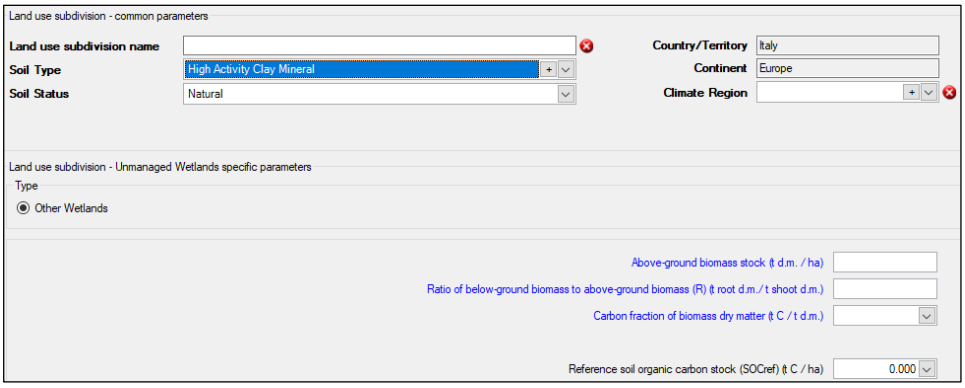
IPCC disaggregates *Wetlands* in three types:

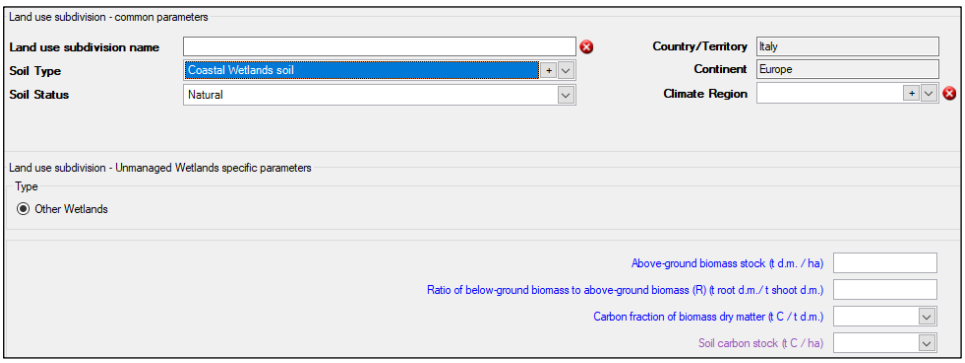
- Peatlands under peat extraction
- Flooded land
- Other Wetlands

While *Peatlands under peat extraction* and *Flooded land* are always managed systems, *Other Wetlands* may include unmanaged and managed land.

Unmanaged Wetlands







For parametes for biomass see *Unmanaged Forest land*.

Depending on the soil type selected the mask shows a different parameter.

For *Inland Organic soils* no *Reference SOC* is needed.

For *Wetland Mineral soils* the *Reference SOC* that, likewise *Unmanaged Forest land*, is not further adjusted through stock-change factors since no management occurs.

For *Coastal Wetlands soils*:

- Soil carbon stock, the dropdown menu provides IPCC default values, as sourced from the *Wetlands Supplement* if available, although user can input its own data. *Coastal Wetlands soils* include a mix of mineral and organic soils and depending on the activity to which the land is subject (see *Excavated soil status* in *Settlements - Other*) the total SOC is needed to estimate associated SOC losses.

Type is not to be selected since there is only 1 wetlands type in *Unmanaged Wetlands*.

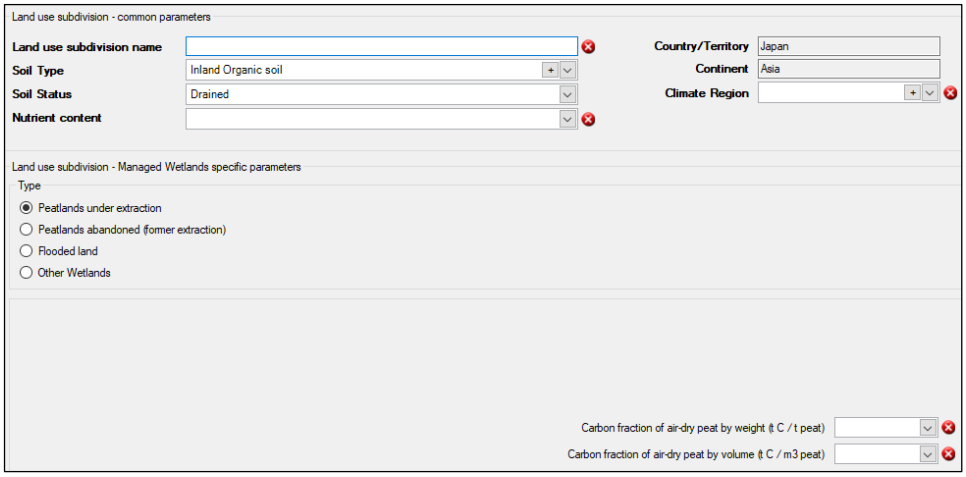
Tier 3, depending on data used, is to be accommodated in the above listed variables.

Managed Wetlands

Depending on the Wetlands type selected the mask shows a different set of parameters.

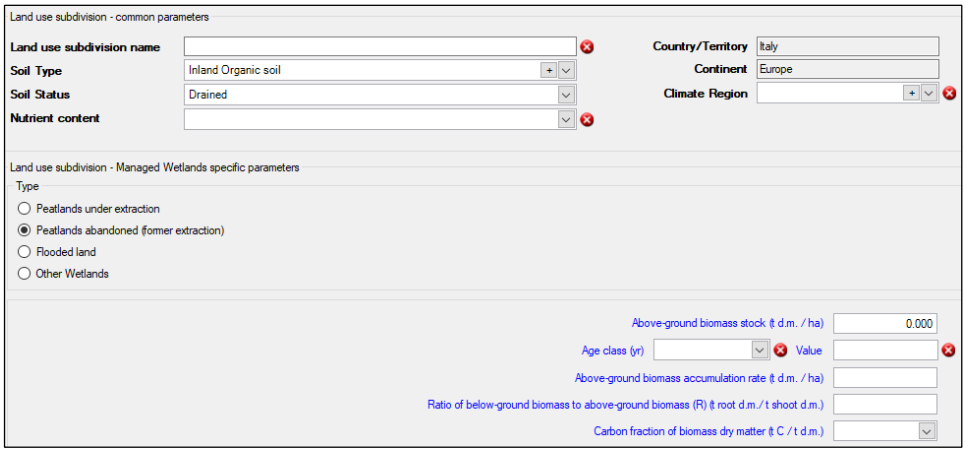
Type is to be selected from the dropdown menu among 4 IPCC types. Type selection determines what type of activities is reported and thus what relevant parameters are provided in the mask.

- Peatlands under extraction where the 2 parameters relevant are mutually exclusive (the user has to compile only one of the two):

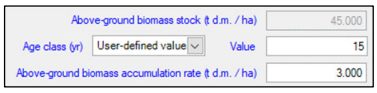


  - ✓ Carbon fraction of air-dry peat by weight, the dropdown menu provides IPCC default values, if available, although user can input its own data.
  - ✓ Carbon fraction of air-dry peat by volume, the dropdown menu provides IPCC default values, if available, although user can input its own data.

- Peatlands abandoned (former extraction) where 4 relevant parameters are provided to be compiled only if the user wishes to estimate vegetation re-installment after abandonment:



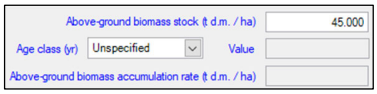
  - ✓ Age class and Above-ground biomass accumulation rate is the annual net gain[8] of biomass and it is not to be compiled for Tier 1 estimates. Given that unlimited accumulation of biomass is not possible, this parameter is an active parameter only if the *Age-class* is input:



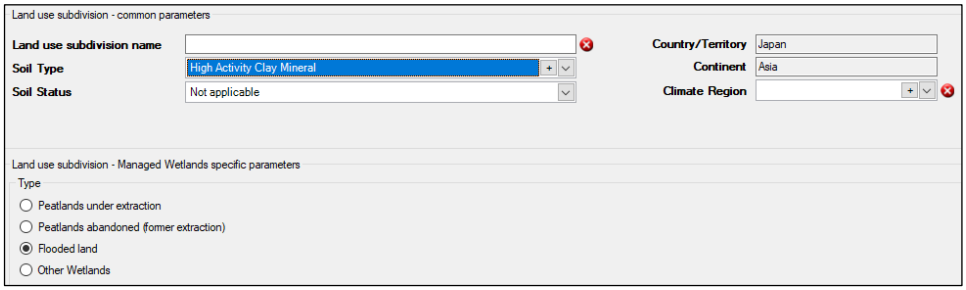
[8] Gross increment minus mortality

Where *Age class* and *Above-ground biomass accumulation rate* are input, the *Above-ground biomass stock* is automatically calculated (and thus its box is greyed, and no data input allowed) as the *Age class* multiplied by the *Above-ground biomass accumulation rate*. Further, the user shall also estimate C stock losses in the relevant worksheets to avoid counting for endless C accumulation in the land subdivision.

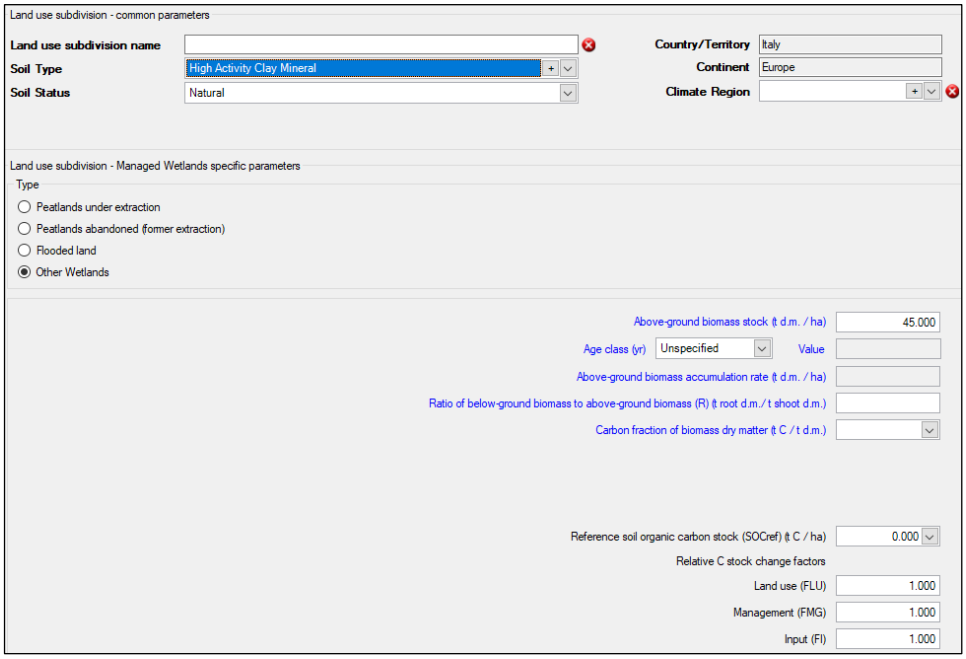
Where *Age class* is left *Unspecified*, the box is greyed and any input from the user is not allowed, and *Above-ground biomass stock* is input by the user:



- Flooded land does not entail calculation of C stock changes, so no parameters are needed:



- Other Wetlands:



If a mineral soil is selected, the SOC stock change factors have to be input. IPCC does not provide default values for *Managed Wetlands*, although guidance for land under conversions is provided in Chapter 5 of the *Wetlands Supplement*.

Note: Chapter 5 of the *Wetlands Supplement* provides refined SOC_{REF} values for *Inland Wetland mineral soil*.

For biomass parametes see *Peatlands abandoned (former extraction)*.

Settlements

IPCC provides methodological guidance to estimate biomass C stock changes at Tier 2 only (Equations 8.2 and 8.3). While SOC change estimates, at Tier 1 and 2, depend on the proportion of land that is:

- paved
- covered by turfgrass
- cultivated
- treed

Thus, the *Software* has 2 subcategories for *Settlements*:

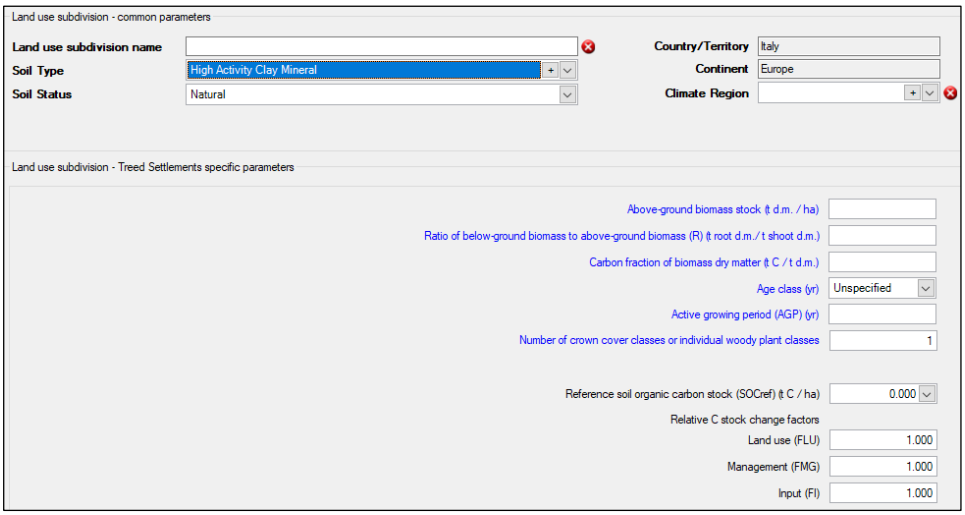
- **Settlements (Treed)**
- **Settlements (Other)**

Settlements (Treed) encompasses the portion covered by trees only[9], while *Settlements (Other)* encompasses the other 3 land cover types.

Thus, users shall share the total area of settlement between the 2 subcategories and for the subcategory *Settlements (Other)* users shall further estimate the proportion of area covered by each of the non-tree cover types.

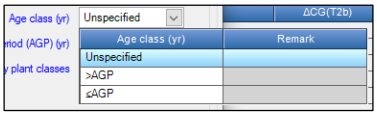
[9] It does not include other land cover types mixed within trees.

Settlements (Treed)



Parameters specific for this subdivision are:

- Age class intends to distinguish those treed land where trees are still in an active growing period (AGP), parameter for which IPCC assumes a 20-years default, and those that are not. For those that are in an active growing period -i.e. Age class ≤ AGP- the net growth is to be estimated in the relevant worksheet, for those that are not -i.e. Age class > AGP- no biomass changes are to be estimated.



  Where *Unspecified* is selected, the *Software* allows an unlimited carbon accumulation in the biomass C pool for the *Gain&Loss* method, thus *Unspecified* is to be selected only if the *Stock-Difference* method is applied to the biomass C pool to the unit of land under this land subdivision.

- Active growing period is to be input by the user. IPCC default value is 20 years.
- Number of crown cover or individual woody plant classes both IPCC equations -8.2 and 8.3) calculate biomass C stock changes as the sum of stock changes occurring on subset of the tree population i.e. the class. The use of classes deals with variability in growth rates among different sub-population (e.g. different age for same tree species) or differences in the tree species or group of species.

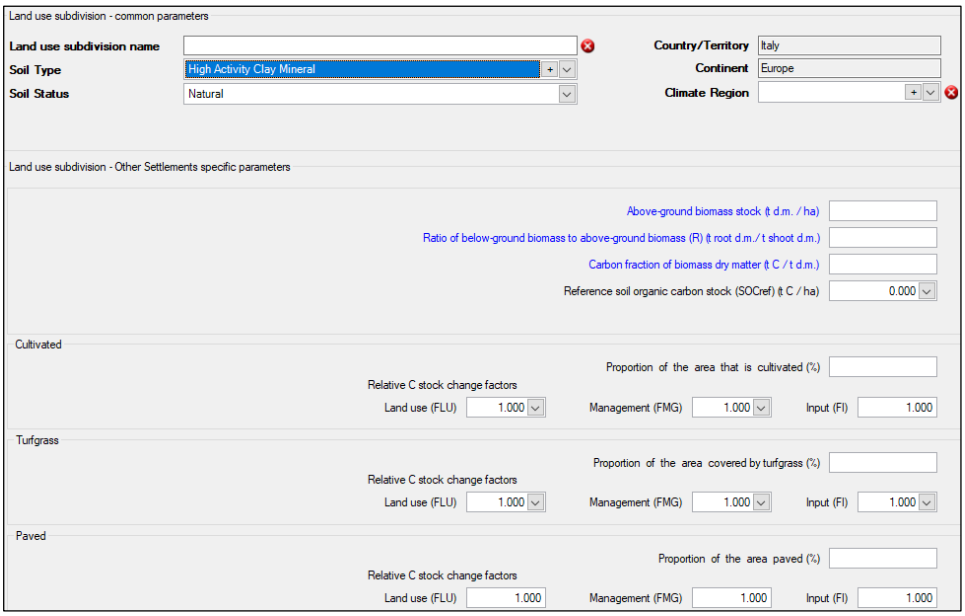
  The user has three variables: *land subdivision*, *age class*, *number of crown cover or individual woody plant classes* to deal with variability in the net accumulation rate, although the *Gain&Loss* method allows to estimate net C gain only and only till the vegetation achieve its long-term biomass C stock. Thus, where losses are to be estimated the *Stock-Difference* method is to be applied between C stock estimates at time 1 and a time 2, where C stock at time 2 is calculated as C stock at time 1 plus C stock gains between time 1 and 2 minus C stock gains between time 1 and 2; however, the current version of the *Software* does not implement such calculation of C stock at time 2.

- For *Settlements (Treed)* the Tier 1 value for all Relative SOC change factors is equal to 1.

For all other parametes for biomass see *Managed Wetlands*.

Tier 3, depending on data used, is to be accommodated in the above listed variables.

Settlements (Other)



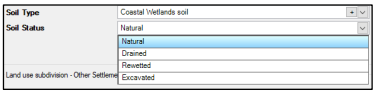
Parameters specific for this subdivision are:

- Proportion of the area that is cultivated, Proportion of the area covered by turfgrass, Proportion of the area paved input shall sum up to 100%.

  The user may instead share the area of non-treed settlements among three subdivisions each of one dealing with a single land cover, and thus assign 100% to the proportion of the relevant land cover.
- For *Settlements (Other)* the IPCC Tier 1 values of the *Relative SOC change factors* are:
  - ✓ For *Cultivated*, are those for *Cropland*[10], with no-till F_{MG} values and F_I equal to 1
  - ✓ For *Turfgrass*, are those for *Improved Grassland*,[11] with no-till F_{MG} values and F_I equal to 1
  - ✓ For *Paved*, the product of F_{LU}, F_{MG} and F_I is 0.8 times the corresponding product for the previous land use/management (i.e., 20% of SOC of previous land use/management will be lost as a result of disturbance, removal or relocation of soil).
    The current version of the Software has not capacity to compile the Relative SOC change factors as 0.8 of those of the previous land subdivision. To deal with this, the only option currently available is to create *land-conversion-specific* subdivisions for *Paved* areas in *Settlements (Other)*., in such a way the F_{LU}, F_{MG} and F_I can be input as 80% of the value of the previous subdivision. For example, a subdivision named *forest land converted to paved land* has the value of 0.8 for each of the 3 *Relative SOC change factors*.

For all other parametes for biomass see *Managed Wetlands*.

Where the *soil type* selected is *Coastal Wetlands*, an additional *soil status* option -i.e. *Excavated*- is available in the dropdown menu:



This is to deal with conversion of *Coastal Wetlands* to infrastructures -e.g. port, harbour and marina construction, aquaculture ponds, salt production ponds-. Accordingly, when *Excavated* is selected, no C stock parameters are needed to be input since the excavated land is without any resident C stocks.

---

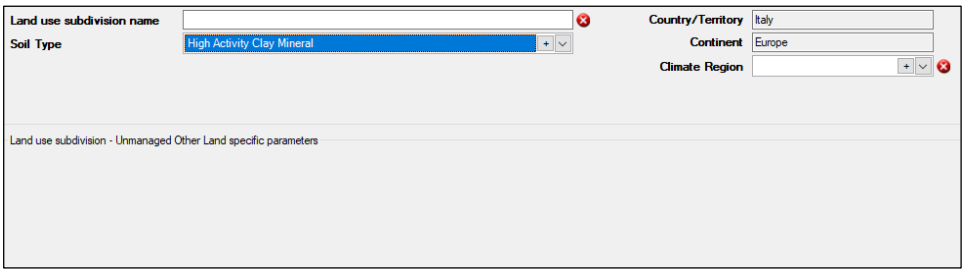
[10] AFOLU Table 5.5
[11] AFOLU Table 6.2

Tier 3, depending on data used, is to be accommodated in the above listed variables.

Other land

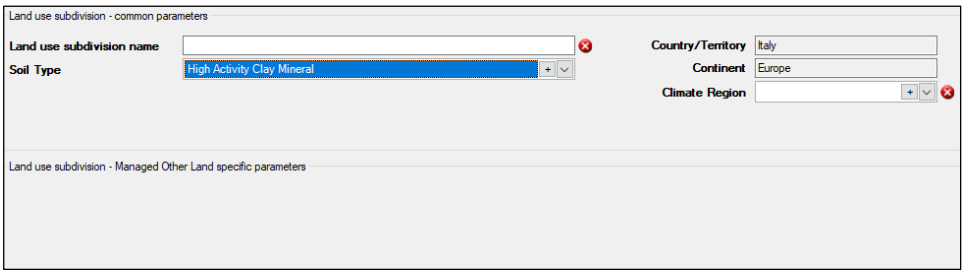
It includes all land without significant C stocks. This means that *Other land remaining Other land* has not any significant C stock changes and thus the software does not provide any calculation worksheets for category 3.B.6.a.; furthermore, every conversion to *Other land* determines the complete loss of C stocks resident in the land according to its previous use/management.

Unmanaged Other land



Given that *Other land* has not significant resident C stocks, no C stock parameters are present in the *Unmanaged Other land* mask.

Managed Other land



Given that *Other land* has not significant resident C stocks, no C stock parameters are present in the *Mmanaged Other land* mask.

Reporting requirement for C pools at Tier 1 and Tier 2

C pools for which C stock changes are to be estimated according to Tier 1 or 2 of the *2006 IPCC Guidelines*

C pool		Forest land		Cropland		Grassland		Wetlands		Settlements		Other land	
		R	**C**	**R**	**C**	**R**	**C**	**R**	**C**	**R**	**C**	**R**	**C**
Biomass	**Aboveground**	X	X	X[3]	X	X	X	---	X	X	X		X
	Belowground	X[1]	X	X[3]	X	X	X	---	X	X	X		X
DOM	**Dead Wood**	X	X[2]	X	X[2]	X	X[2]	---	X[2]	X	X[2]		X[2]
	Litter	X	X[2]	X	X[2]	X	X[2]	---	X[2]	X	X[2]		X[2]
Soil Organic Matter	**mineral**	X	X	X	X	X	X	---	---	X	X		X
	organic[5,6]	X	X	X	X	X	X	X[4]	X[4,7]	X	X		X
Harvested Wood Product		X											

A **black X** *indicates that according to Tier 1 C stock changes in the relevant C pool are to be estimated, and a* **blue X** *indicates those C stock changes to be additionally estimated according to Tier 2. Tier 3 applied to any C pool in any land use category requires users to estimate annual C stock changes in that C pool (either as net change between times or as a sum of all gains and losses).*
R *indicates subcategories where land is not undergoing a change in use, while* **C** *indicates those where land is undergoing a change.*

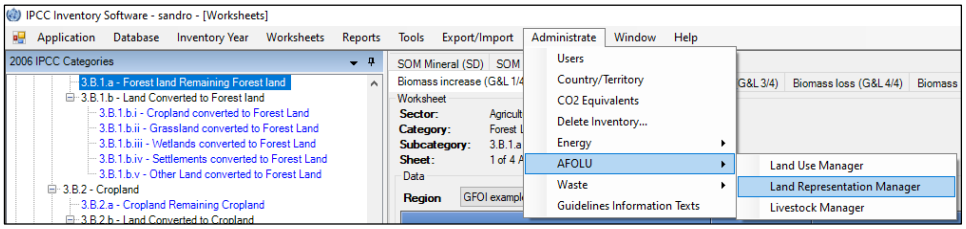
Notes: 1. although IPCC provides default values of **R** *(root:to:shoot ratio) and so user may estimate changes in belowground biomass at Tier 1 too; 2. Given that the 2006 IPCC Guidelines do not provide default values for DOM user estimates changes in DOM at Tier 2 or 3 only; 3. limited to perennial biomass; 4. including due to peat extraction; 5. where organic soils are drained, IPCC default method applies; 6. the Wetlands Supplement extends IPCC default methodology to rewetted soils; 7. the Wetlands Supplement extends to those soils in Coastal Wetlands that are a mix of mineral and organic origin*

Land Representation Manager (LRM)

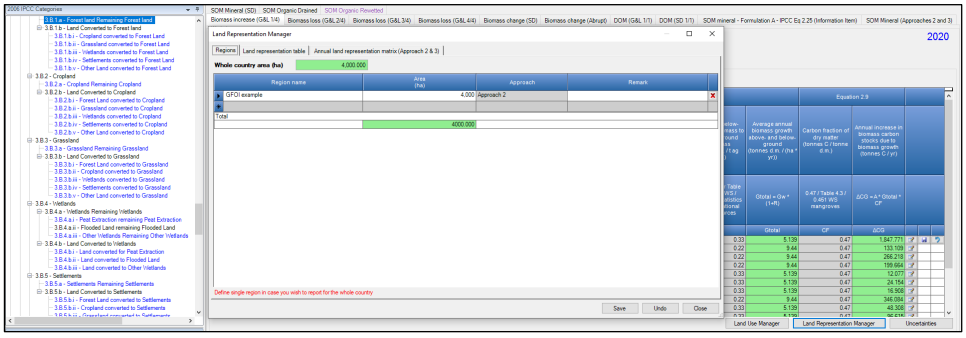
Land Use Representation. Manager is a tabbed dialog window containing 3 tabs:

- ✓ **Regions**,
- ✓ **Land Representation table**,
- ✓ **Annual land representation matrix** *(limited[12] to Approaches 2 & 3 for land representation).*

The user can open it from **Administrate** main menu, **AFOLU** sub-menu



or from the bottom of any worksheets of 3.B categories

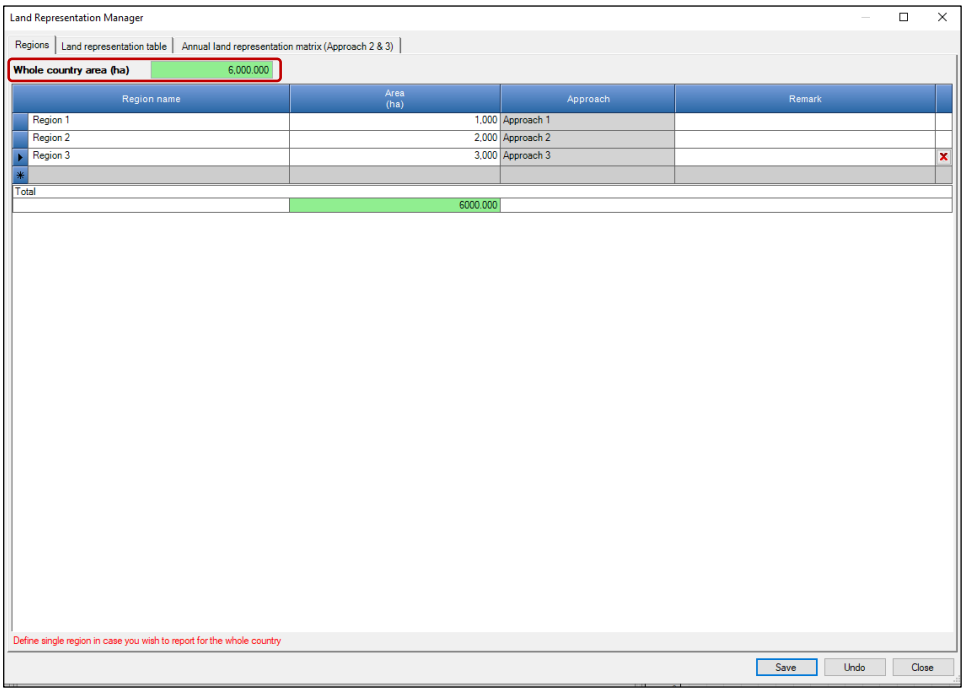


All information shown in the 3 tabs is relative to currently chosen inventory year.

[12] Given Approach 1 for Land Representation does not identify land use changes the matrix cannot be built.

Regions Tab

This tab allows subnational representation of land by stratifying the national territory in subnational units, here defined as **Regions**. It requires inputting the total area of the country, although apportioned among Regions, as well as selecting for each Region the approach for the land representation.



The user can either input a single Region that covers the entire territory, for which the GHG inventory is prepared, or a number of Regions. In the latter case, for each Region an independent and consistent time series of activity data is to be input by the user *[section on "Land representation table tab"]*.

Whole country area: User must enter total area of the territory for which the GHG inventory is prepared.

The area value input is saved automatically (no need to press **Save**) and can be changed through a new input.

The field has a background color that indicates:

- Green – sum of areas across defined regions matches whole country area.
- Orange – sum of areas across defined regions is less than whole country area.
- Red – sum of areas across defined regions is greater than whole country area.

Tip: In case of Orange/Red color, placing mouse pointer over the field shows tooltip with a warning and the area difference between the total and the sum of areas input in the Regions fields.

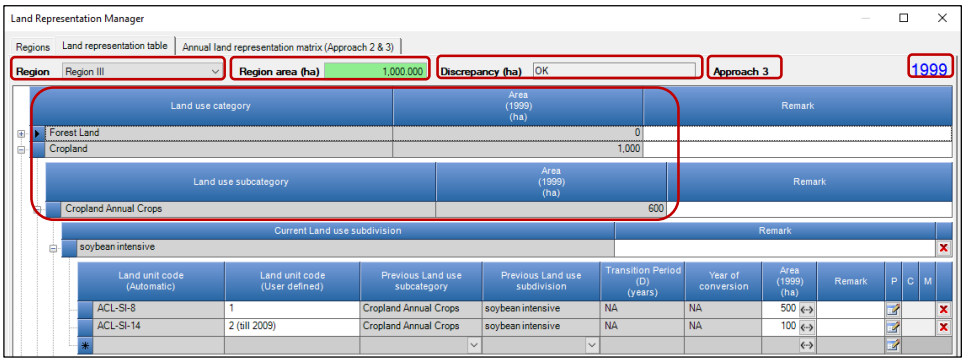
Table: User can define one or more regions with the following attributes:

- ✓ **Region name** – to be input.
- ✓ **Area** – area of the region in ha – to be input.
- ✓ **Approach** – 1, 2, 3 – **for land representation** – to be selected.
- ✓ **Remark** – user can input here notes relevant for the row of data *(information is neither transferred to reporting tables nor can be printed)*

Tip: to record info input in the DataBase (DB) press the button Save. Once saved the information cannot be changed anymore. Where an error is identified in information input, the Region (and its data) is to be deleted -to do so click the red **x** on the right hand of the table- and input again with the correct information.

Land representation table Tab

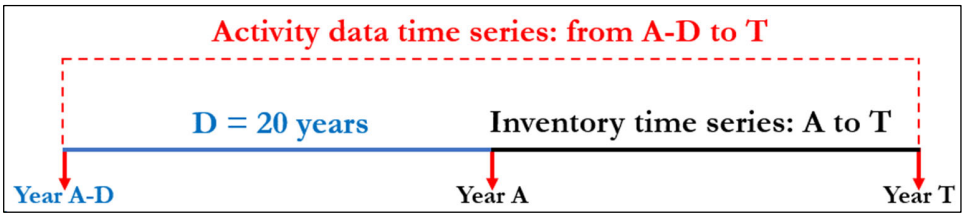
Allows defining units of land for the selected Region according to Region's defined Approach for land representation.



The Land representation Tab requires user to input a consistent land representation. Where a consistent land representation is a time series of annual area estimates of units of land, as disaggregated according to stratification, that:

- ✓ reports the total area of the territory constant across the entire time series
- ✓ classifies land using a consistent methodology across the entire time-series (no artifact land conversions caused by changes in the classification method/background-data)
- ✓ in each year **Y**, all units of land under conversion are reported within the *Land converted to* relevant category until the end of the transition period (**D**)
- ✓ in each year **Y**, all units of land that did not undergo a conversion in the last **Y-D** years are reported within the *Land remaining* relevant category.

Being **A** the first year of a time series and **T** the last one, a Time series of activity data consists of annual area (ha), for each of the units of land, for each year of the inventory time period (**A-T**) plus for a number of years, previous than year **A**, equivalent to the transition period (**D**) applied to conversions of land use/management i.e. **A-D**. For example, **A** is the year 2005, **T** is the year 2024 and **D** is a 20-year period, then the time series of activity data needed is from **A-D** (2005-20=1985) to **T** (2024).



Region – dropdown menu for choosing one of the defined regions to work with. By choosing region, region's area is filled in automatically together with info on Approach defined for that region in the tab *Regions*. Multi-level table below is automatically filled with data on IPCC land use categories and associated area (as the sum of areas input for the units of land belonging to the category/sub-category).

Region can be any level of stratification of the territory the user wishes to apply, e.g. administrative regions, ecological zones, parks, land subject to specific project activities, as well as a mix of those. *Nevertheless, it is suggested to use the stratification in "Regions" to aggregate all that land that has same soil type and climate zone while subject to different land use/management.* Other levels of disaggregation -e.g. administrative, ownership, management systems- can be managed through the use of land-use subdivisions as well as of units of land[13]. For each Region the *Software* requires an independent[14] and consistent Land Representation.

[13] A unit of land is an area homogenous per climatic and pedologic characteristic as well as per current and past use/management.
[14] No land transfer allowed among different Regions

Region area – background color meaning:

- Green – sum of areas across land use subcategories equals region's total area.
- Orange – sum of areas across land use subcategories is less than region's total area.
- Red – sum of areas across land use subcategories is greater than region's total area.

Discrepancy – In case of Orange/Red color, shows the area difference between Region's total area and area input in the *Land representation table* for that Region. Negative value means that the area input in the *Land representation table* is larger than the area input for the Region in the *Regions tab*; a positive value vice versa indicates that the area input in the *Land representation table* is smaller than the area input for the Region in the *Regions tab*. Otherwise, the zero value means no discrepancy.

Current inventory year is indicated on the right-hand side.

Table levels

The Multi-level table contains all 6 IPCC land use categories as well as all 12 land use subcategories, where the user can input 4 levels of information for each unit of land:

- 1st level, where to select the current land use category of the unit of land
- 2nd level, where to select the current land use subcategory of the unit of land
- 3rd level, where to select the current land use subdivision of the unit of land
- 4th level, where to input all information that qualifies the unit of land conversion status, the area and the methods applied to estimate C stock changes in each C pool.

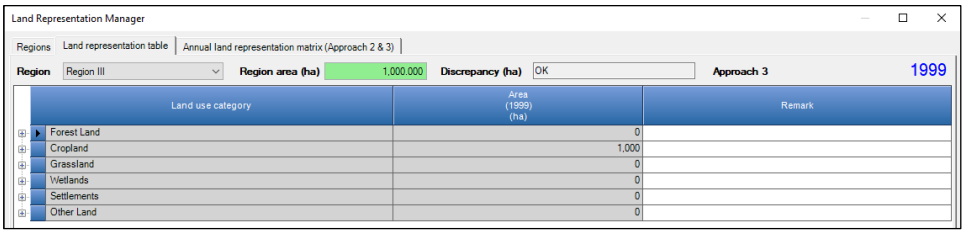
Finally, in the

- 5th level, information on historical conversions of the land is stored.

NOTE: Units of land SHALL be input from the first year of the inventory time series onwards

1st level

Contains the 6 IPCC land use categories:



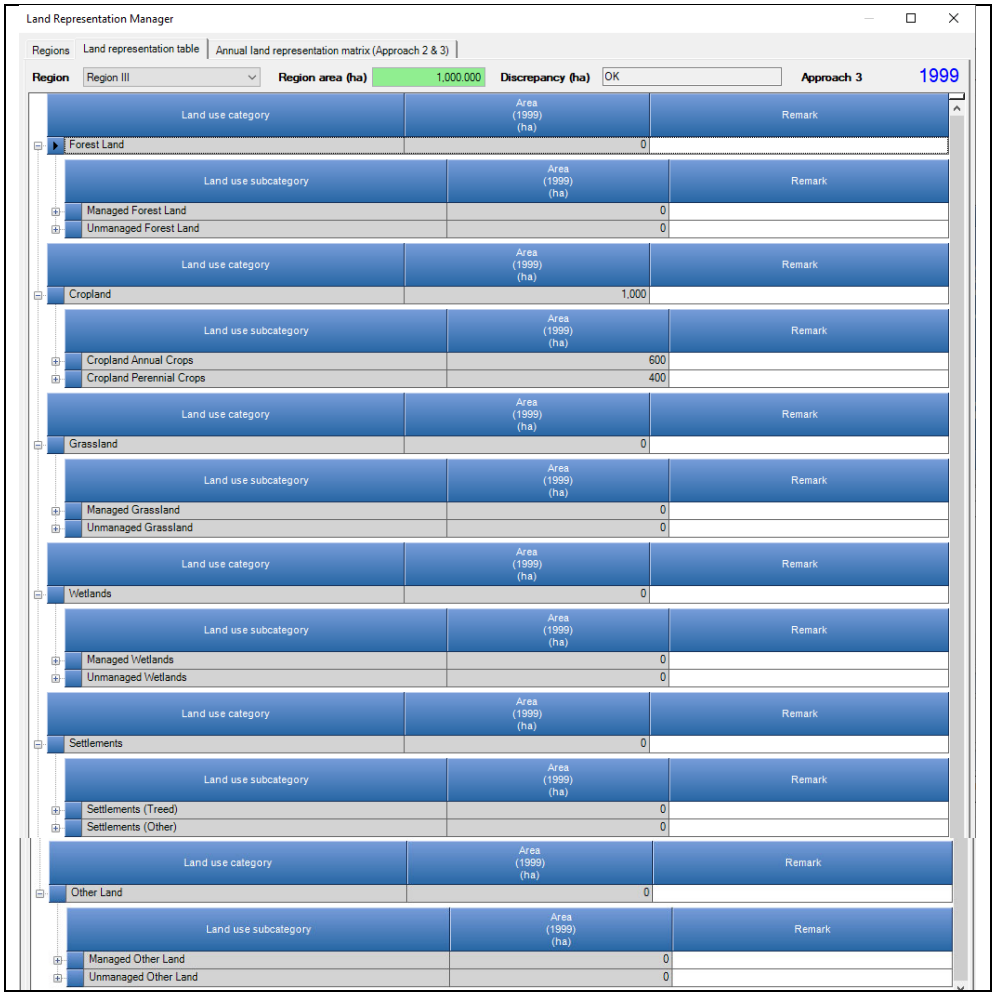
In **Remark**, the user can input notes relevant for the entire category *(information is neither transferred to reporting tables nor can be printed)*

Clicking on the lower level of the relevant category opens. So, to input a unit of land click on the of its current use.

Tip: in case of Approach 3, in the first inventory year of the inventory time series i.e. year **A**, the land use category to be selected for a unit of land may not be the actual land use/management in the first inventory year; it could instead be the land use/management in the time period **A-D** to **A** if any use/management change occurred in that time period *[section on 5th level]*.

2nd level

Contains 12 land use subcategories, 2 for each IPCC land use category:



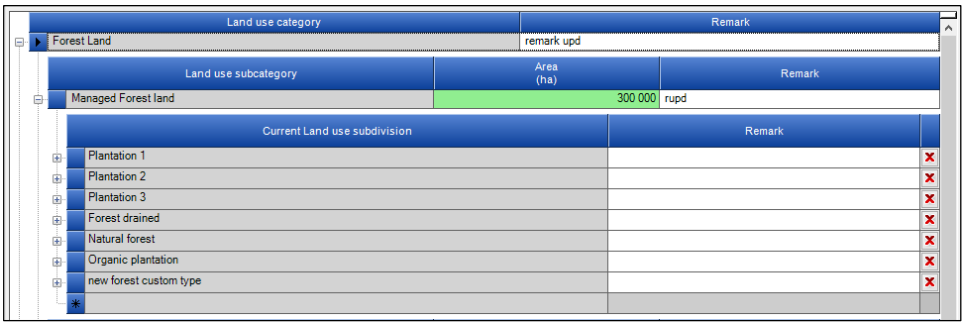
Area – specified area of the subcategory for a chosen inventory year.

In **Remark**, the user can input notes relevant for the entire subcategory *(information is neither transferred to reporting tables nor can be printed)*

Clicking on the lower level of the relevant subcategory opens. So, to input a unit of land click on the of its current use.

3rd level

Contains all land use subdivisions input by the user in the Land Type Manager (LTM) for the relevant subcategory.



In **Remark**, the user can input notes relevant for the entire subdivision *(information is neither transferred to reporting tables nor can be printed)*

Clicking on the lower level of table opens where information on previous use/management of the unit of land as well as its area is to be input. So, to input a unit of land click on the of its current type.

Tip: placing mouse pointer over any subdivision shows tooltip with information on that subdivision as input in the Land Type Manager.

4th level

Allows inputting Units of land, according to the Approach for the Land Representation selected for the Region. The set of guidance to input information on units of land is subdivided in 2 subsets:

- ✓ Data input guidance to create a new unit of land. *Note that some steps do not apply to all Approaches, as indicated*
- ✓ Data input guidance to add/modify information of a unit of land

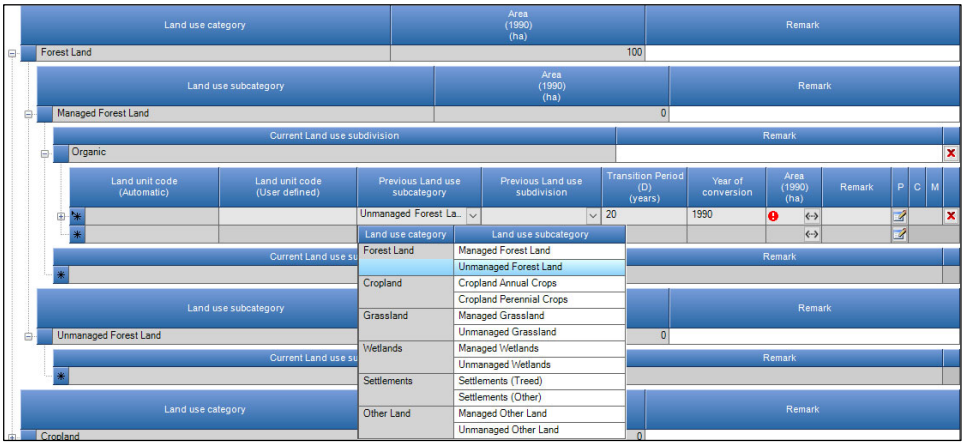
Data input guidance to create a new unit of land

For each unit of land at its first input, the following step-by-step procedure applies:

- **first step** selecting, from the dropdown menu, the **previous land use subcategory**. *This does not apply to Approach 1*
- **second step** selecting, from the dropdown menu, the **previous land use subdivision**. *This does not apply to Approach 1*
- **third step** adding the **user-defined land unit code**[15]
- **fourth step** adding the **Transition period**. *This does not apply to Approach 1*
- **fifth step** adding the **Year of conversion**. *This does not apply to Approach 1*
- **sixth step** adding the **Area**. *For Apporach 1 only, the area of the unit of land 20-year before is to be added too*
- **seventh step** selecting, from the Land Unit Parameters table under column "P", the **method to** be applied to **estimate C stock changes** in each C pool
- **eighth step** adding any notes in the Remark field
- **ninth step** save the unit of land by clicking the **Save** button

[15] The user can insert an alphanumerical code to track, and so recognize, the unit of land across the entire inventory time series.

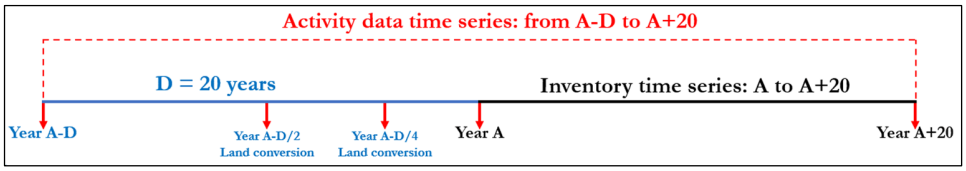
First step, select, from the dropdown menu, the land use subcategory the unit of land had in the previous inventory year:



Note: In a consistent land representation, the time-series of land activity data needed begins **D** years before the first inventory year, where **D is the transition period applied to land use/management conversions**. Nevertheless, units of land are input in the *Software* from the first inventory year onwards only. Consequently, given the first year of an inventory time series **A**, where the user is adding a unit of land:

- When **Approach 2** is applied: the information to be input as previous subcategory is the subcategory to which the unit of land belonged in the year **A-D**. Where the **previous land use subcategory** or **previous land use subdivision** is different than the current one, a conversion occurred and thus the users is required to input the length of the Transition period D [*Fourt step*] as well as the year of conversion [*Fifth step*]
- When **Approach 3** is applied: the unit of land may have undergone multiple land use/management chanages in the period from year **A-D** to year **A**, and consequently multiple changes need to be input for the same unit of land. In such a case, moving from the year **A-D** onwards, the user shall select as current land use category/subcategory and subdivision the category/subcategory and subdivision the land had after the conversion, even if the land in the first inventory year has a different current land use; same applies for subsequent land use/management chnages that occurred before the first inventory year. Where the **previous land use subcategory** or **previous land use subdivision** is different than the current one, a conversion occurred and thus the users is required to input the length of the Transition period D [*Fourt step*] as well as the year of conversion [*Fifth step*]. For example:

  For an inventory time series from year **A** to year **A+20**, a times series of activity data for the period **A-D** to **A+20** is needed. The activity data time series of unit of land **X** shows a first conversion -*managed forest land to annual cropland*- in the year **A-(D/2)** and a second conversion -*annual cropland to managed grassland*- in the year **A-(D/4)**; no conversion in inventory year **A** and in any following inventory years occurred.

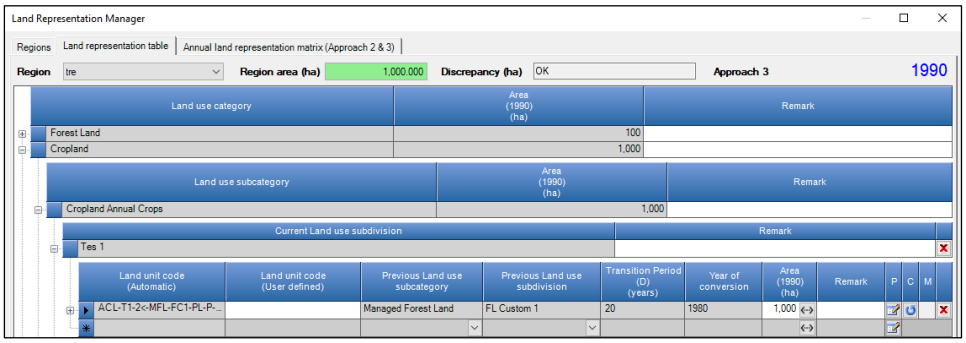


  Given that:

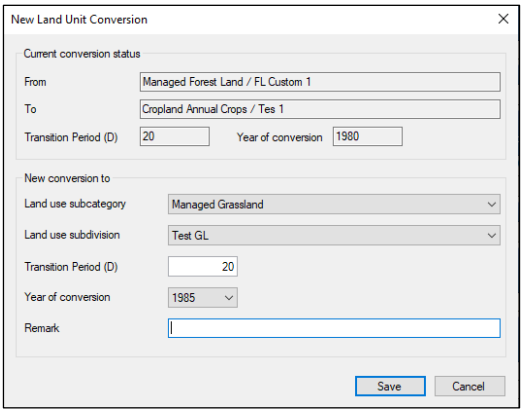
  - ✓ data input shall start from the first inventory year -i.e. year **A**- onwards, and
  - ✓ data input of land use/management changes occurred before the first inventory year shall also be made be made from the first yearof that period -i.e. year **A-D**- onwards,

  the data input in the inventory year **A** in the *Software* land representation manager follows the following steps:

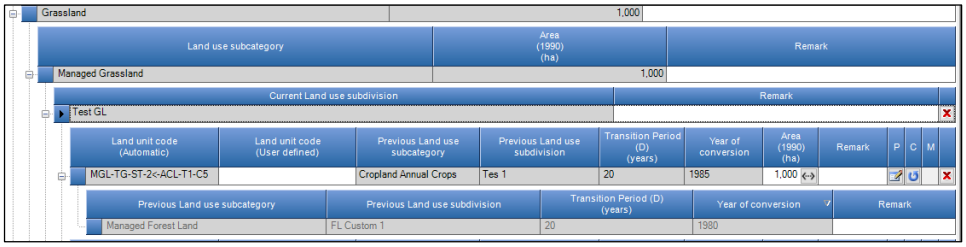
  - first, input the conversion from *managed forest land* to *annual cropland* occurred in the year **A-(D/2)**, where *annual cropland* is the *current land use subcategory* and *managed forest land* is the *previous land use subcategory*:



- second, input the conversion from *annual cropland* to *managed grassland* occurred in the year **A-(D/4)**, where *managed grassland* is the *current land use subcategory* and *annual cropland* is the *previous land use subcategory*. This is done by using the functionality for "further conversion" "  " that is available when Approach 3 for land representation is applied *[section on "Data input guidance limited to units of land under Approach 3 for land representation"]*



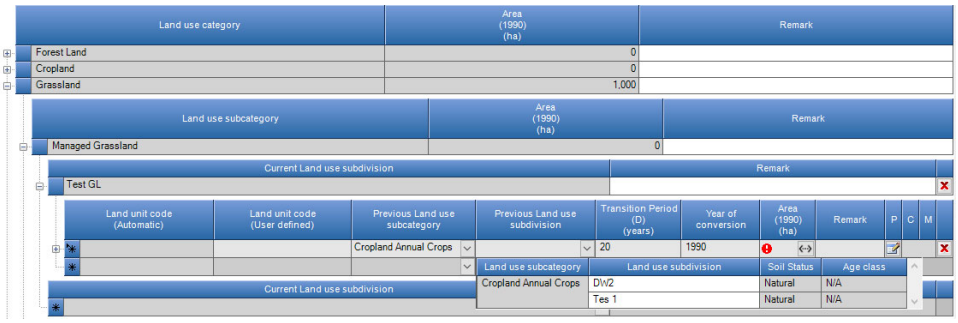
Thus, in the first inventory year **A** the unit of land is shown in the land representation manager as:



which means that the unit of land was first classified under cropland and finally classified under grassland; although information on first conversion remains associated with the unit of land, but shown in gray to indicate that such dynamic isn't anymore ongoing in the year **A**.

In case of **Approach 1** for land representation, this **first step** does not apply since land use/management changes are neither identified nor tracked.

Second step, select, from the dropdown menu, the land use subdivision the unit of land had in the previous inventory year:



Note: see **Note** at **first step**. Same applies here.

In case of **Approach 1** for land representation, this **second step** does not apply since land use/management changes are neither identified nor tracked.

Tip: Within each region, conversions from one subdivision to another subdivision is restricted by the following rules:

- ✓ cannot convert any subdivisions of managed subcategories -Managed Forest land [MFL], Cropland (both subcategories) [CL], Managed Grassland [MGL], Managed Wetlands [MWL], Settlements (both subcategories) [SL], Managed Other land [MOL]- to any subdivisions of unmanaged subcategories -Unmanaged Forest land [UFL], Unmanaged Grassland [UGL], Unmanaged Wetlands [UWL], Unmanaged Other land [UOL]-
- ✓ soil type in previous and current land subdivision shall be the same *[Land Use Manager]*
- ✓ climate region in previous and current land subdivision shall be the same *[Land Use Manager]*
- ✓ for Forest land only, ecological zone in previous and current land subdivision shall be the same *[Land Use Manager]*

Third step, input the **user-defined land unit code**, while the *Software* compiles the **automatic land unit code** *[section on "Automatic unit of land codes"]*.

Land unit code (Automatic)	Land unit code (User defined)	Previous Land use subcategory	Previous Land use subdivision	Transition Period (D) (years)	Year of conversion	Area (1990) (ha)	Remark	P	C	M
*	example 1	Cropland Annual Crops	Tes 1	20	1990					

Although this is not a mandatory information to input, it is recommended to do so in order to facilitate the data inputs in the calculation Worksheets for C stock changes and associated GHG emissions and removals. Indeed, in those worksheets a number of units of land are visualized together and the **land unit code** allows to distinguish among those when adding in the Worksheets required information.

Automatic unit of land codes

In any given point of time, the automatic code is generated from Current land use subdivision under which the unit of land is classified. In case there is an ongoing transition, automatic code also contains a code of the subdivision from which the unit of land is being converted together with indication of the age of conversion (using "Cx" suffix, which means *x^{th} year in conversion* (relative to current inventory year, see picture below):

Land unit code (Automatic)	Land unit code (User defined)	Previous Land use subcategory	Previous Land use subdivision	Transition Period (D) (years)	Year of conversion	Area (2010) (ha)	Remark	P	C	M
PCL-AP-UD-10	3	Cropland Perennial Crops	agroforestry - pepper	NA	NA	400				
PCL-AP-UD-15<-ACL-SI-C0	2	Cropland Annual Crops	soybean intensive	20	2010	100				
PCL-AP-UD-18<-ACL-SI-C...	0	Cropland Annual Crops	soybean intensive	20	2000	100				

Coding elements according to land use categories are shown hereafter:

Forest land

[M,U]FL-NAMEabbr-[PL,NF]-FTabbr-LUID

[M,U] = either Managed or Unmanaged

NAMEabbr = Subdivision name abbreviation (automatically generated from Subdivision name)

[PL,NF] = either Plantation or Natural forest

FTabbr = Forest type name abbreviation (automatically generated from Forest type name)

LUID = unit of land database ID

Example:

MFL-OP-PF-TG-48 = Managed Forest land - Organic plantation - planted forest - *Tectona grandis* - 48 DB ID

Cropland

[P,A]CL-NAMEabbr-[CTp,RE]-LUID

[P,A] = either Perennial or Annual

NAMEabbr = Subdivision name abbreviation (automatically generated from Subdivision name)

[CTp,RE] = CTp – either crop type abbreviation (for perennial) or RE in case of rice ecosystem (for annual)

LUID = unit of land database ID

Example:

PCL-BF-OP-62 = Perennial cropland – Belvedere Farm - Oil palm - 62 DB ID

Grassland

[M,U]GL-NAMEabbr-VegType-[IMP]-LUID

[M,U] = either Managed or Unmanaged

NAMEabbr = Subdivision name abbreviation (automatically generated from Subdivision name)

VegType = vegetation type

IMP – only in case of improved grassland

LUID = land unit database ID

Example:

MGL-TG-ST-IMP-67 = Managed GL - Test grassland – Steppe – improved - 67 DB ID

Wetlands

[M,U]WL-NAMEabbr-[P,F,O]-LUID

[M,U] = either Managed or Unmanaged

NAMEabbr = Subdivision name abbreviation (automatically generated from Subdivision name)

[P,F,O] = either Peatlands (P) or Flooded land (F) or Other land (O)

LUID = unit of land database ID

Example:

MWL-P2-P-82 = Managed WL - Peatlands 2 – Peatlands - 82 DB ID

Settlements

[T,O]SL-NAMEabbr-LUID

[T,O] – either Treed or Other

NAMEabbr = Subdivision name abbreviation (automatically generated from Subdivision name)

LUID = land unit database ID

Example:

TSL-S1-59 = Treed SL - Settlements 1 - 59 DB ID

Other land

[M,U]OL-NAMEabbr-LUID

[M,U] = either Managed or Unmanaged

NAMEabbr = Subdivision name abbreviation (automatically generated from Subdivision name)

LUID = unit of land database ID

Example:

MOL-OL1-67 = Managed OL - Other land 1 – 67 DB ID

Additional Suffix (Approach 2 and 3 only)

Relative to current inventory year: Cx (where x indicates the xth year in which the land is under conversion.

Note: the xth year in which the conversion occurs has number 1

Fourth step, input the **Transition period**, in years. By default the value of **20-year** is used by the *Software*:

Land unit code (Automatic)	Land unit code (User defined)	Previous Land use subcategory	Previous Land use subdivision	Transition Period (D) (years)	Year of conversion	Area (1990) (ha)	Remark	P	C	M
	example 1	Cropland Annual Crops	Tes 1	20	1990	1,000				

The **Transition period** is the time period according to which the *Software* tracks the previous land use subcategory/subdivision of a unit of land undergoing a land use subcategory/subdivision conversion.

In case of **Approach 1** for land representation, this **fourth step** does not apply since land use/management changes are neither identified nor tracked.

Fifth step, select the **Year of conversion** from a dropdown menu populated by the *Software* with all years of the time period **Y-D**:

Land unit code (Automatic)	Land unit code (User defined)	Previous Land use subcategory	Previous Land use subdivision	Transition Period (D) (years)	Year of conversion	Area (1990) (ha)	Remark	P	C	M
	example 1	Cropland Annual Crops	Tes 1	20	1990	1,000				

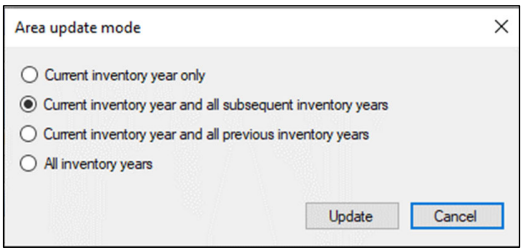
By default the inventory year **Y** is used by the *Software*.

In case of **Approach 1** for land representation, this **fifth step** does not apply since land use/management changes are neither identified nor tracked.

Sixth step, input the **Area**, in hectares (ha), of the unit of land in the relevant inventory year.

Land unit code (Automatic)	Land unit code (User defined)	Previous Land use subcategory	Previous Land use subdivision	Transition Period (D) (years)	Year of conversion	Area (1990) (ha)	Remark	P	C	M
*	example 1	Cropland Annual Crops	Tes 1	20	1990	1,000				

Once the **area** is input, the user selects to which time period of the inventory timeseries the area value input applies. To do so, the user opens a dialog box by clicking on the "  " symbol next to the area value input, and then select the desired option:



The Dialog Box contains 4 options. By default the option **Current inventory year and all subsequent inventory years** applies, which means that if this is the option the user wishes to apply, no action will be needed.

Approach 1 specific rule

In case of **Approach 1** for land representation, this **sixth step** requires to add the area for a year equal to **Y-20**, where **Y** is the inventory year for which information is being input. For example data input for a unit of land in the year 1990 for an Approach 1 Land representation requires the input of the area that same unit had in 1970:

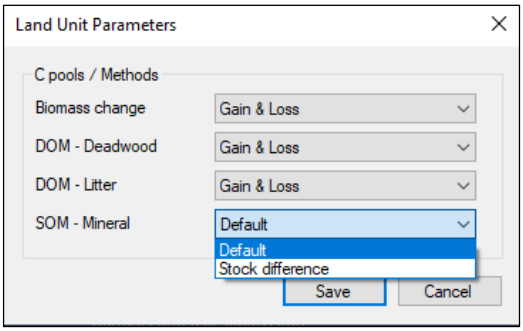
Land unit code (Automatic)	Land unit code (User defined)	Area (1990) (ha)	Area (1970) (ha)	Remark	P
MFL-O-PL-TG--5	example 2	1,000	900		

This information is critical to allow the *Software* to implement Formulation A of Equation 2.25 for the calculation of SOC changes

Note: even if the area of the unit of land area in a given year Y is 0 (zero) the area of 20 years before must be input

Seventh step, select the methodology to be applied to each C pool to calculate the C stock changes. IPCC provides 2 methodological approaches to estimate C stock changes in C pools (*Section 2.2.1 - Overview of carbon stock change estimation*): the Gain & Loss method and the Stock-Difference method.

To do so, the user opens a dialog box by clicking on the "" symbol under the letter "" (Pools):



The Dialog Box contains 4 Carbon pools: **Biomass**, **Dead Organic Matter – Deadwood**, **Dead Organic Matter – Litter**, **Soil Organic Matter – Mineral**. For each C Pool the methodology is to be selected between the IPCC default methodology[16], which is the **Gain & Loss**, and the IPCC alternative methodology, which is the **Stock-Difference**. For each C pool, by default the option **Gain & Loss** applies, which means that if this is the option the user wishes to apply, no action will be needed.

[16] To calculate SOC changes in mineral soils, IPCC default method applies equation 2.25, in Formulation A or B according to the Approach applied to the Land representation

Eighth step, input any information on the unit of land the user wishes to recall or just to show to future users:

Land unit code (Automatic)	Land unit code (User defined)	Previous Land use subcategory	Previous Land use subdivision	Transition Period (D) (years)	Year of conversion	Area (1990) (ha)	Remark	P	C	M
*	example 4	Managed Grassland	Test GL	20	1990	1,000	abandoned land			

In **Remark**, the user can input notes relevant for the entire subdivision *(information is neither transferred to reporting tables nor can be printed)*

.

Ninth step, save the information input by clicking on the **Save** button (bottom of the window). When saving, the *Software* record all information on the unit of land in the database and assign an **automatic land unit code**.

Land unit code (Automatic)	Land unit code (User defined)	Previous Land use subcategory	Previous Land use subdivision	Transition Period (D) (years)	Year of conversion	Area (1990) (ha)	Remark	P	C	M	
MFL-FC1-PL-P-6<-MGL-T...	example 4	Managed Grassland	Test GL	20	1990	1,000	abandoned land				

Once saved, information cannot be changed anymore with the exception of the following fields:

- ✓ **user-defined land unit code**
- ✓ **area**
- ✓ **remark**

In case an error is spot in any of the other fields, to correct it the entire row of information needs to be deleted -to do so click on the symbol "✕" at the right hand side-, then all information on the unit of land is to be input again.

Data input guidance to add/modify information of a unit of land

Two additional functionalities are available to modify information input for a unit of land:

- button **M**, to merge it with another unit of land. *This does not apply to Approach 1*
- button **C**, to add a new conversion to a unit of land that is still undergoing a conversion. *This applies to Approach 3 only*

As noted: information input in the following fields:

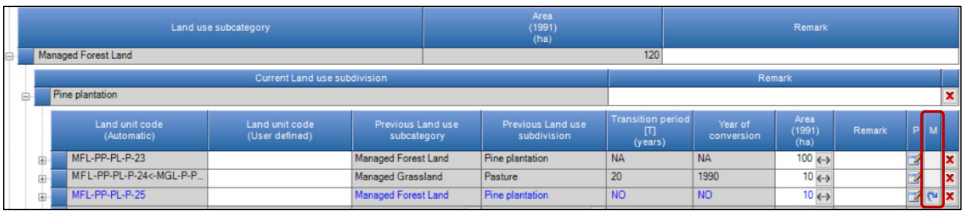
- ✓ **user-defined land unit code**
- ✓ **area**
- ✓ **remark**

can be changed at any time. However, note that a change of the **user-defined land unit code** or of the **remark** input in any of the inventory years is automatically propagated by the *Software* to the entire time series, while for the area the user shall select the time period within the inventory time series to which the new value applies; where no sleection is made by default the option **Current inventory year and all subsequent inventory years** will apply.

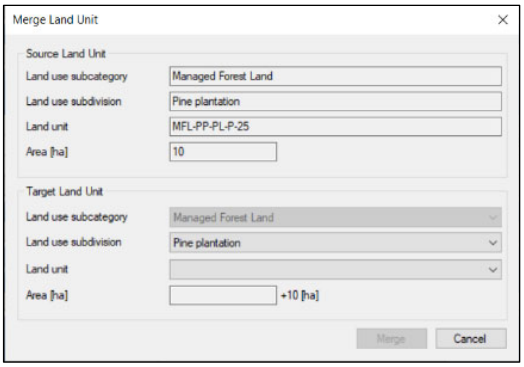
In case an error is spotted in any of the other fields, to correct it the entire row of information needs to be deleted -to do so click on the symbol "✖" at the right hand side-, then all information on the unit of land is to be input again.

Button **"M"** is to be clicked in case the user wishes to merge the unit of land with another unit of land -this makes the *Software* stop tracking the unit of land any further. This functionality applies only to units of land that have undergone completely the transition period of a conversion from one land use category/subdivision to another one, and are therefore shown in blue ink by the *Software*.

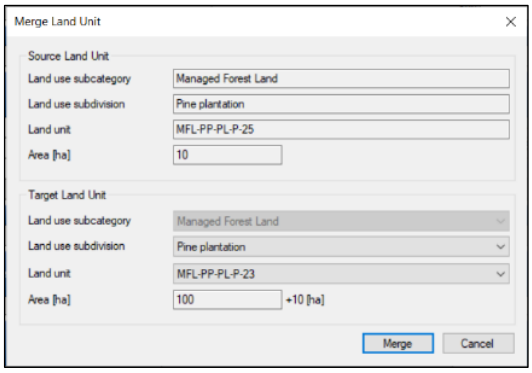
In the example below, the unit of land *MFL-PP-PL-P-25* has completed its conversion to *Managed Forest land – Pine plantation*. Accordingly, the *Software* has changed the associated **Transition period** and **Year of conversion** as NO.



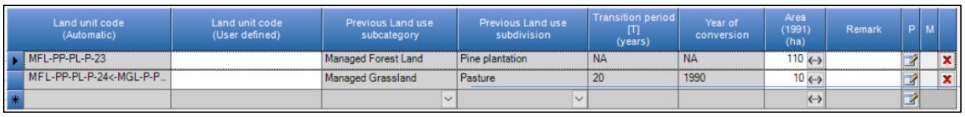
Thus, given that same values for parameters and emission factors apply to unit of land *MFL-PP-PL-P-25* and unit of land *MFL-PP-PL-P-23* the user may decide to merge the 2 units. In such a case, by clicking button "M" in the row of the unit of land *MFL-PP-PL-P-25* the following dialog window opens



Then, the user selects the unit of land to which the unit of land is to be merged (in this example, unit of land *MFL-PP-PL-P-23*)



Once merged, the unit of land *MFL-PP-PL-P-25* disappears and its area is added by the *Software* to the area of the unit of land *MFL-PP-PL-P-23* from the year in which the merging is made onward.



That means that the merging does not occur backward. The following picture is taken from the land representation of the previous year:

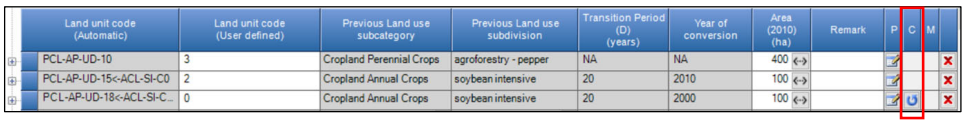
Land unit code (Automatic)	Land unit code (User defined)	Previous Land use subcategory	Previous Land use subdivision	Transition period [T] (years)	Year of conversion	Area (1990) (ha)	Remark	P	M	
MFL-PP-PL-P-23		Managed Forest Land	Pine plantation	NA	NA	100				
MFL-PP-PL-P-24<-MGL-P-P...		Managed Grassland	Pasture	20	1990	10				
MFL-PP-PL-P-25<-MGL-P-P...		Managed Grassland	Pasture	30	1961	10				

In any case, merging is just an option; the user may wish to keep reporting the two units of land separated beyond the conversion period (e.g. since belonging to two different administrations). In such a case the previous subcategory/subdivision can still be examined after expanding the next level (conversion history), and it is shown in grey, as in the example below:

MFL-TGN-NF-TG-89		Managed Forest...	Tectona grandis NF	NO	NO	15 000		

Previous Land use subcategory	Previous Land use subdivision	Transition period [T] (years)	Year of conversion	Remark
Settlements (Treed)	Settlement 1 (T)	20	1971	

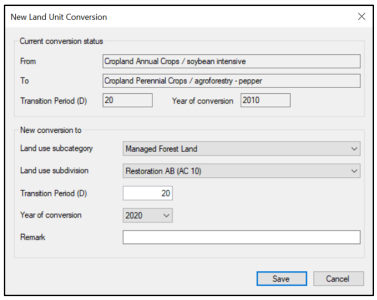
Button **"C"** is to be clicked in case the user wishes to input a new conversion for a land that is still under conversion, and thus it applies under Approach 3 for land representation only.



Land unit code (Automatic)	Land unit code (User defined)	Previous Land use subcategory	Previous Land use subdivision	Transition Period (D) (years)	Year of conversion	Area (2010) (ha)	Remark	P	C	M
PCL-AP-UD-10	3	Cropland Perennial Crops	agroforestry - pepper	NA	NA	400				
PCL-AP-UD-15<-ACL-SI-C0	2	Cropland Annual Crops	soybean intensive	20	2010	100				
PCL-AP-UD-18<-ACL-SI-C...	0	Cropland Annual Crops	soybean intensive	20	2000	100				

Note: the input of conversions for a unit of land is to be done from the first year of the inventory time series forward; trying to input in the reverse order -i.e. from the latest inventory year backward- is not possible.

By pressing the button **C** a new dialog box opens:

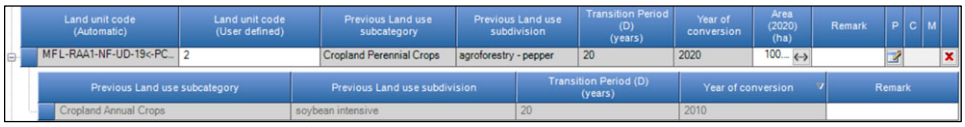


The dialog box is composed of 2 sections:

- The upper section with information, on the *Current conversion status* of the unit of land, as compiled by the *Software*:
  - Previous land subdivision,
  - Current land use subdivision
  - Transition Period
  - Year of conversion
- The lower section with information, on the *New conversion to* of the unit of land, to be input by the user:
  - New Land subcategory,
  - New Land subdivision,
  - Transition Period
  - Year of conversion[17]
  - Remark (if any)

After pressing Save, the unit of land is automatically relocated under the subdivision input in the *New Conversion to* section and the previous subdivision assigned to the unit by the *Software* is the one that was in the *Current conversion status*. The *Software* navigates to the relocated unit of land automatically.

In this example a land under conversion to cropland is further converted to forest land; consequently, the *Software* relocate the subdivision under forest land:



Land unit code (Automatic)	Land unit code (User defined)	Previous Land use subcategory	Previous Land use subdivision	Transition Period (D) (years)	Year of conversion	Area (2020) (ha)	Remark	P	C	M
MFL-RAA1-NF-UD-19<-PC...	2	Cropland Perennial Crops	agroforestry - pepper	20	2020	100...				

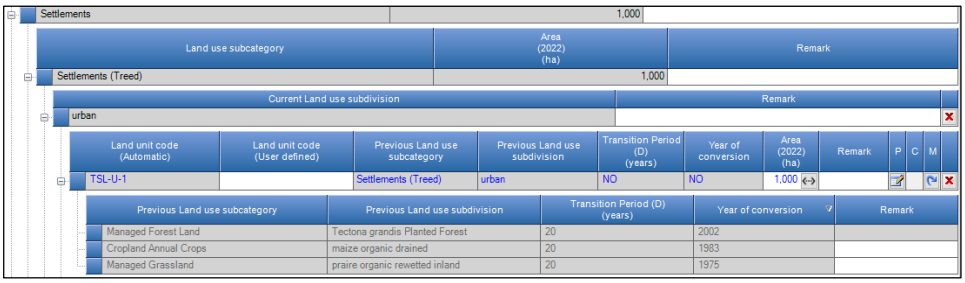
Previous Land use subcategory	Previous Land use subdivision	Transition Period (D) (years)	Year of conversion	Remark
Cropland Annual Crops	soybean intensive	20	2010	

The previous land conversion is shown at a lower lever (5th) in grey.

[17] Year of conversion dropdown contains the list of years from: 'the year of conversion reported under the *Current conversion status* + 1 year' up to the *current inventory year*. In this example, being 2020 the inventory year, the dropdown menu includes the years 2011-2020

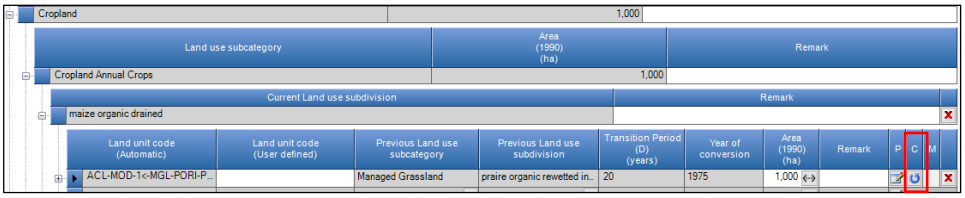
5th level

It shows the complete history of transitions of the unit of land relative to the current inventory year, ordered by year of transition descending and shown in grey (picture below).



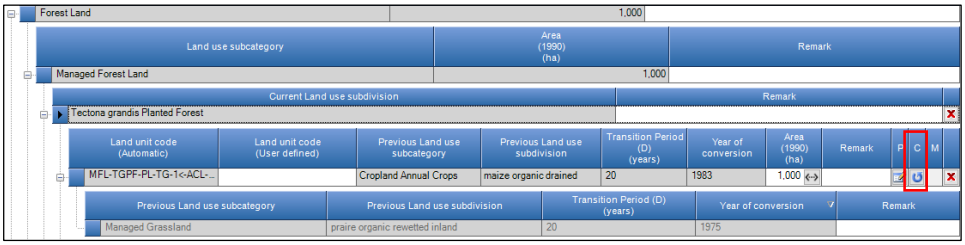
Indeed, the Land unit conversion in a given point of time -i.e. the chosen inventory year- is automatically presented considering current status of land unit together with its history of transitions. For example, a unit of land experiences multiple conversions within the time period analyzed for inventory purposes. Note that although the inventory period is 1990-2022, the inventory compiler has analyzed a time series of data starting in 1971 -i.e. 1971-2022- because of the transition period applied is of 20 years. Then,

in **1975**, the unit of land **transition from** *MGL/praire organic rewetted inland* **to** *ACL/maize organic drained*



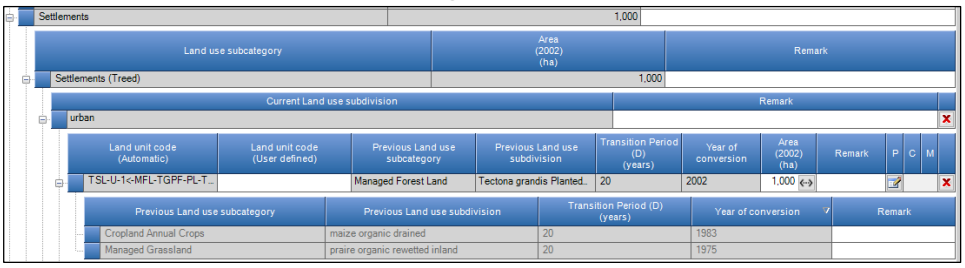
Note: this conversion occurred before the initial year of the inventory time series -i.e. 1990-2020; thus it is input in the year 1990

in **1983**, the unit of land **transition from** *ACL/maize organic drained* **to** *MFL/Tectona grandis Planted Forest*



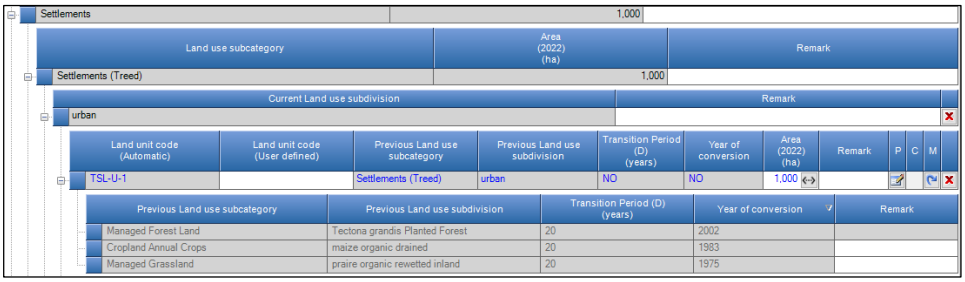
Note: this conversion occurred before the initial year of the inventory time series -i.e. 1990-2020; thus it is input in the year 1990

in **2002**, the unit of land **transition from** *MFL/Tectona grandis Planted Forest* **to** *TSL/urban*



Note: this is the latest conversion of this unit of land and occurred in the inventory year visualized -i.e. Year of conversion = Inventory year = 2002-, thus the button "C" for intervening new conversion is NOT available.

in **2022**, the land unit has gone through the entire transition period (i.e. 20-year) since the last conversion; thus it has been reclassified by the *Software* as a remaining land -i.e. *NO* is applied by the *Software* for the *Transition period [D]* and for the *Year of Conversion*[18]- and colored in blue. History layer shows all the previous conversions:



Settlements	1,000	
Land use subcategory	**Area (2022) (ha)**	**Remark**
Settlements (Treed)	1,000	

Current Land use subdivision	Remark
urban	

Land unit code (Automatic)	Land unit code (User defined)	Previous Land use subcategory	Previous Land use subdivision	Transition Period (D) (years)	Year of conversion	Area (2022) (ha)	Remark	P	C	M
TSL-U-1		Settlements (Treed)	urban	NO	NO	1,000				

Previous Land use subcategory	Previous Land use subdivision	Transition Period (D) (years)	Year of conversion	Remark
Managed Forest Land	Tectona grandis Planted Forest	20	2002	
Cropland Annual Crops	maize organic drained	20	1983	
Managed Grassland	praire organic rewetted inland	20	1975	

Because in 2022 the unit of land is in a *remaining* category, it cannot intervene in any further conversion.

Note: Data input are written in the DB when pressing the **Save** button. Thus, the *Undo* button can be used to discard all changes made since the last save, it does not cancel information that was input before saving. In case of an input saved that is to be corrected, the only way to achieve it is to delete the wrong input (by clicking the red X on the extreme right end of the row) and to re-enter the correct one.

[18] Note that for a unit of land that did not intervene any conversion across the entire time series of the inventory the notation key *NA* is used by the *Software*.

Annual land representation matrix Tab

For land representation approaches 2 and 3, a land matrix Tab provides for the total area of the land representation to be classified either as a land that has not undergone a change between the initial (rows) and final (columns) year of the land-use conversion matrix or as a land that has undergone a change between 2 different subcategories.

Note: that such classification does not correspond to the IPCC categorization in *land remaining under one use/management* and *land under conversion from one use/management to another one*. Although a land reported in a matrix as converted from the initial year to the final year is part of the IPCC *land under conversion* categories, such categories include also land that have undergone a change in use/management in years before the initial year of the land-use conversion matrix.

For instance,

Land Representation Manager

Regions | Land representation table | Annual land representation matrix (Approach 2 & 3)

Region: GFOI example | Region area (ha): 4,000.000 | Approach 2 | 2010

Final	Initial	Forest Land		Cropland		Grassland		Wetlands		Settlements		Other Land			
		Managed Forest Land	Unmanaged Forest Land	Cropland Annual Crops	Cropland Perennial Crops	Managed Grassland	Unmanaged Grassland	Managed Wetlands	Unmanaged Wetlands	Settlements (Treed)	Settlements (Other)	Managed Other Land	Unmanaged Other Land	Final Area (ha)	Net change (ha)
Forest Land	Managed Forest Land	1,000.000	20.000			40.000								1,060.000	60.000
	Unmanaged Forest Land		970.000											970.000	-30.000
Cropland	Cropland Annual Crops		10.000	1,000.000										1,010.000	10.000
	Cropland Perennial Crops													0.000	0.000
Grassland	Managed Grassland					960.000								960.000	-40.000
	Unmanaged Grassland													0.000	0.000
Wetlands	Managed Wetlands													0.000	0.000
	Unmanaged Wetlands													0.000	0.000
Settlements	Settlements (Treed)													0.000	0.000
	Settlements (Other)													0.000	0.000
Other Land	Managed Other Land													0.000	0.000
	Unmanaged Other Land													0.000	0.000
	Initial Area (ha)	1,000.000	1,000.000	1,000.000	0.000	1,000.00...	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4,000.000	0.000

Land Representation Manager

Regions | Land representation table | Annual land representation matrix (Approach 2 & 3)

Region: GFOI example | Region area (ha): 4,000.000 | Approach 2 | 2015

Final	Initial	Forest Land		Cropland		Grassland		Wetlands		Settlements		Other Land			
		Managed Forest Land	Unmanaged Forest Land	Cropland Annual Crops	Cropland Perennial Crops	Managed Grassland	Unmanaged Grassland	Managed Wetlands	Unmanaged Wetlands	Settlements (Treed)	Settlements (Other)	Managed Other Land	Unmanaged Other Land	Final Area (ha)	Net change (ha)
Forest Land	Managed Forest Land	1,060.000	40.000			80.000								1,180.000	120.000
	Unmanaged Forest Land		910.000											910.000	-60.000
Cropland	Cropland Annual Crops		20.000	1,010.000										1,030.000	20.000
	Cropland Perennial Crops													0.000	0.000
Grassland	Managed Grassland					880.000								880.000	-80.000
	Unmanaged Grassland													0.000	0.000
Wetlands	Managed Wetlands													0.000	0.000
	Unmanaged Wetlands													0.000	0.000
Settlements	Settlements (Treed)													0.000	0.000
	Settlements (Other)													0.000	0.000
Other Land	Managed Other Land													0.000	0.000
	Unmanaged Other Land													0.000	0.000
	Initial Area (ha)	1,060.000	970.000	1,010.000	0.000	960.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4,000.000	0.000

in the year 2015, 80 ha are reported as converted -from the initial year to 2015- from *managed grassland* to managed forest land. In the year 2015, those 80 hectares are reported, in the national GHG inventory, under *Grassland converted to Forest land*. However, in the same year additional land is reported under *Grassland converted to Forest land*, for instance the 40 ha reported in the land-use conversion matrix of the year 2010.