# Estimating LULUCF sector emissions

## Emissions in the forestry sector

#### Afforestation

The biomass increment on afforested area is estimated by G4M taking into account forest age, management and site specific soil conditions after 2000. G4M afforestation rates are calibrated to reproduce UNFCCC/KP data as elaborated by the Joint Research Centre of the European Commission. Future afforestation area is dependent on exogenous drivers received from GLOBIOM-EU, i.e. projections of land prices, wood prices and land available for afforestation. The forest age, biomass and carbon stock development are tracked over the simulation period for each afforested grid cell and differ due to grid specific growth rates. Changes in soil organic carbon related to afforestation are also considered based on initial soil carbon content from Kindermann ([2008](#_ENREF_5)), accumulation rate from Czimczik et al. ([2005](#_ENREF_1)) and aboveground biomass in forest age cohorts.

#### Deforestation

Emissions from deforestation are calculated as the sum of the area of forest converted to other land use per grid cell times the average biomass stock per grid cell, aggregated to country level after 2000. G4M deforestation rates are calibrated to reproduce UNFCCC/KP data as elaborated by the Joint Research Centre of the European Commission. We assume that all biomass carbon is released immediately at the point of forest conversion and that up to 40% of soil organic matter is dynamically lost after deforestation ([Czimczik et al., 2005](#_ENREF_1)). The rate of soil organic matter decomposition is a function of long-term average annual temperature and precipitations in each grid cell ([Willmott et al., 1998](#_ENREF_9)) according to Esser ([1991](#_ENREF_2)).

#### Forest management

The main forest management options considered by G4M are variation of thinning and choice of rotation length. These forest management activities can increase or decrease the biomass carbon stock in the forest. Emission projections are driven by the forest growth model, the age class distribution of the forest, management activities and wood removals. Forest management emissions and removals estimated by the models were rescaled using historical data from the countries for the period 2000-2010 (on average we increase our forest management sink by around 20%). This ensures consistency between country data and models’ data in terms of coverage of non-biomass pools and greenhouse gas sources as well as absolute level of emissions and removals from biomass as the rescaling reconciles differences in estimates related to a different input data, parameters or estimation methods.

#### Emissions from harvested wood products

Emissions from harvested wood products (HWP) are estimated following the Durban Accords (Decision 2/CMP.7) and respective Tier 2 IPCC guidelines. GLOBIOM-EU provides specific categories of wood use for sawnwood, pulpwood, energy wood and other wood. On the basis of these variables the HWP carbon stock *HWP C stock* is calculated using first-order decay functions with category specific default half-lives (HL, 35 years for sawn wood, 25 years for wood-based panels and other wood products, 2 years for paper and 0 years for energy production; no accounting for imported wood according to guidelines). The following equation is applied.

*HWP C stocki+1 = e-k \* HWP C stocki + [(1-e-k)/k] \* Inflowi (1)*

Where *i* is the year, *HWP C stock* the carbon stock in the particular HWP category at the beginning of year *i*, *k* is the decay constant of first-order decay for HWP category (k = ln(2)/HL), *Inflow* is the annual inflow to the particular HWP category. It is assumed that the HWP pools are in steady state (inflow=outflow) at the initial time *t0* (year 2000). The emissions from HWP are finally estimated by calculating the differences between the yearly carbon stocks as provided by GLOBIOM-EU averaged over a 10 year period.

## Emissions from cropland management

Soil carbon emissions from cropland are represented dynamically in GLOBIOM-EU using the approach presented by Schneider ([2007](#_ENREF_7)). Spatially explicit soil carbon response functions for different crop rotations and tillage systems were estimated using the biophysical crop model EPIC. Initial SOC contents are based on Jones et al. ([2005](#_ENREF_4)) and Lugato et al. ([2014](#_ENREF_6)). SOC emissions are calculated in GLOBIOM-EU as the sum of sequestration rates (as estimated by EPIC) over all cropland activities per year. For a more detailed description of the methodology we refer to Frank et al. ([2015](#_ENREF_3)). We account for emissions from cropland remaining cropland, perennials (ligno-cellulosic crops and short rotation tree plantations) and land converted to cropland or energy plantations.

## Emissions from grassland management

SOC emissions from grassland management are calculated by multiplying grassland area (grassland remaining grassland and land converted to grassland) with a country specific emission factor. The emission factor is derived from UNFCCC reported data by dividing reported emissions from grassland remaining grassland and land converted to grassland by the corresponding areas. SOC emissions from grasslands for countries where UNFCCC data are not available are calculated based on a generic emission factor of -1.83 t CO2/ha/y ([Soussana et al., 2004](#_ENREF_8)). However, this approach contains significant uncertainties i.e. countries can apply different methods to report grassland emissions which may lead to assignment of diverging emission factors even for countries with similar grassland properties and management. Even though this is a simplification to overcome data gaps, deriving the emission factor from UNFCCC data obviously leads overall to a better consistency with historic data since country specific factors are reflected.

## Emissions from wetlands, settlements and other lands

Emission projections for wetlands, settlements and other land are included in our approach to provide a complete set of emissions and to ensure the comparability to historic LULUCF emissions reported by countries to UNFCCC. However, areas and emissions for all three categories presented are based on UNFCCC reported data and kept constant.

# References

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