

Carbon sequestration: Forest and soil

'objective of the presentation is to give a general picture on possibilities to achieve standard for accounts for carbon sequestration in the revised SEEA'



GgCO ₂ eq.	
Forest land	-32 835
Biomass	-32 666 (uptake 127 300, release 94 600)
Dead organic matter	-3 269
Mineral soil	-3 625
Organic soil	6 725
Cropland	3 081
Biomass	-3
Mineral soil	-1 534
Organic soil	4 618
Grassland	4 057
Mineral soil	4 016
Organic soil	41
Wetland	1 380
Organic soil	1 380
Biomass burning	6
N fertilisation	17
Liming	249
Harvested wood products	-1 220
TOTAL	-25 265

Source: Greenhouse gas emissions in Finland 1990-2007
National Inventory Report under the UNFCCC
and the Kyoto Protocol. 8. April 2009

Land use, land use change and forestry (LULUCF) in greenhouse gas reporting

In reporting greenhouse gases according to the UN climate convention and the Kyoto protocol, the LULUCF category is sub-divided into:

- Forest land,
- Cropland,
- Grassland,
- Wetlands,
- Settlements and
- Other land.

Forest land in greenhouse gas reporting

The Forest land consists of:

1. Forest land remaining forest land
 - 1.1. Managed (intensively/extensively)
 - 1.2. Natural, undisturbed
2. Land converted to forest land
 - 2.1. Managed (intensively/extensively)
 - 2.2. Natural, undisturbed

The GHG reporting covers only managed forests. Managed forests are subject to periodic or ongoing human interventions.

Forest land in greenhouse gas reporting

For the forests the key entity is **annual change in carbon stock**. It is the sum of:

Change in carbon stocks in living biomass

- + Increase due to above and below ground biomass growth
- Decrease due to fellings, fuelwood gathering, disturbances

Change in carbon stocks in dead wood and litter

Change in carbon stocks in mineral and organic soil

Equations to changes in carbon stocks of cropland, grassland, wetlands, settlements and other land are also available from the IPCC Good Practice Guidance for LULUCF, as well as instructions for calculations.

Annual change in carbon stock of forest and other wooded land

Annual change in carbon stocks =

- + Annual change in carbon stocks in living biomass (above- and belowground biomass) =
 - + Increase due to biomass growth
 - Above ground biomass increment (stem, stump, branches, bark, seeds, foliage)
 - Below ground biomass increment (live roots)
 - Decrease due to biomass lost
 - Loss due to commercial fellings (extracted volume, fraction of biomass left to decay in forest)
 - Loss due to fuelwood gathering (volume, density, expansion factor to total biomass a.ground)
 - Other losses (due to disturbances)
- + Annual change in carbon stocks in dead organic matter (dead wood and litter)
 - Change in carbon stock in dead wood (standing, lying in the ground, in the soil)
 - Change in carbon stock in litter (litterfall; leaves, twigs, small branches, fruits, flowers, bark, (-)decomposition)
- + Annual change in carbon stocks in soils
 - Change in carbon stock of mineral soil (organic fraction of mineral soil)
 - Change in carbon stock of organic soil

IPCC Good Practice Guidance for LULUCF; some equations...

- **Equation 3.2.31 Annual change in carbon stocks in mineral soils in land converted to forest land..... 3.62**
- **Equation 3.2.32 Annual change in carbon stocks in mineral soils upon afforestation1 3.63**
- **Equation 3.2.33 CO₂ emissions from drained organic soils in land converted to forest land..... 3.63**
- Equation 3.3.1 Annual change in carbon stocks in cropland remaining cropland..... 3.70
- **Equation 3.3.2 Annual change in carbon stocks in soils in cropland remaining cropland 3.74**
- **Equation 3.3.3 Annual change in carbon stocks in mineral soils for a single cropland system 3.75**
- **Equation 3.3.4 Annual change in carbon stocks in mineral soils in cropland remaining cropland 3.78**
- **Equation 3.3.5 CO₂ emissions from cultivated organic soils in cropland remaining cropland 3.79**
- Equation 3.3.6 Annual carbon emissions from agricultural lime application 3.80
- Equation 3.3.7 Total change in carbon stocks in land converted to cropland 3.83
- Equation 3.3.8 Annual change in carbon stocks in living biomass in land converted to cropland..... 3.85
- Equation 3.3.9 Change in carbon stocks as a result of clearing biomass in a land use conversion 3.86
- Equation 3.3.10 Carbon losses from biomass burning, on-site and off-site 3.86
- Equation 3.3.11 Carbon losses from biomass decay 3.87
- **Equation 3.3.12 Annual change in carbon stocks in soils in land converted to cropland..... 3.89**
- **Equation 3.3.13 Total annual emissions of N₂O from mineral soils in land converted to cropland..... 3.93**

Carbon stock in the Global Forest Resource Assessment (FRA)

- Information on carbon stock indicates the contribution of Forest and Other wooded land to the carbon cycle. It is used by international processes that monitor greenhouse gases and climate change.
- Unit of reporting is Million metric tonnes. Reported figures refer Area classified as Forest and as Other wooded land.
- Categories and definitions used in FRA correspond to those by the Intergovernmental Panel on Climate Change (IPCC).
- Carbon content in biomass is usually derived using conversion factors. Reported figures on carbon stock are closely related to figures on biomass stock and growing stock.
- Conversion factors from timber and biomass stock are not directly used for carbon stock changes of the soil.

FRA categories of carbon stock

T 8 Carbon stock	
Carbon in above-ground biomass	Carbon in all living biomass above the soil, including stem, stump, branches, bark, seeds, and foliage.
Carbon in below-ground biomass	Carbon in all biomass of live roots. Fine roots of less than 2 mm diameter are excluded, because these often cannot be distinguished empirically from soil organic matter or litter.
Carbon in dead wood	Carbon in all non-living woody biomass not contained in the litter, either standing, lying on the ground, or in the soil. Dead wood includes wood lying on the surface, dead roots, and stumps larger than or equal to 10 cm in diameter or any other diameter used by the country.
Carbon in litter	Carbon in all non-living biomass with a diameter less than the minimum diameter for dead wood (e.g. 10 cm), lying dead in various states of decomposition above the mineral or organic soil.
Soil carbon	Organic carbon in mineral and organic soils (including peat) to a specified depth chosen by the country and applied consistently through the time series.

An example of conversion factors. Finland 2009.

Conversion factors:

Species	ef	dw(Mg/m ³)	cc	cf(MgC/m ³)
pine	1,527	0,39	0,519	0,3091
spruce	1,859	0,385	0,519	0,3715
non-coniferous	1,678	0,49	0,505	0,4152

Conversion equation: $cf = ef * dw * cc$

ef = expansion factor from stem volume to total tree biomass

dw = conversion factor to dry matter

cc = C-content

cf = conversion factor from stem volume to total biomass C content

Conclusions to be considered

- The GHG reporting on changes of carbon stocks cover only managed forests. This category equals to the FRA categories Other naturally regenerated forest and Planted forest.
- From the SEEA assets point of view, timber in those above mentioned forest categories equals to the SEEA asset category EA.1411 Cultivated (timber resources). Changes in the carbon stock of cultivated timber resources can directly be derived from the FRA and GHG reporting on timber, tree biomass and carbon.
- For the SEEA asset accounts for forests, changes in the stock of carbon in forests consisting of Non-cultivated timber are as important as those changes in forests consisting of Cultivated timber. The scope of the SEEA exceeds the scope of the GHG reporting framework.

Conclusions to be considered

- In general, changes in carbon stock of timber, rest of wood biomass and forest soil can be included into the SEEA asset accounts for forested land and timber.
- Rough estimates for annual opening and closing stocks of carbon can be derived from data and estimations on annual changes in stocks.
- However, it should be considered whether full balance sheets on carbon stocks are important for the SEEA standard at this stage of the revision.
- Changes in stocks offer the main information for the decision making on optional uses of forests, such as e.g. intensive timber production or protection of forests to prevent climate change.