HoliSoils
Working together for forest soils

D3.2 Report on existing GHG monitoring methods for forest mineral soils in countries of the EU

Holistic management practices, modelling and monitoring for European forest soils, HoliSoils

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Deliverable D3.2: Report on existing GHG monitoring methods		
Report of methods of GHG monitoring relevant for our part in HoliSoils: GHG reporting in forest soils of European countries. The information is based on the UNFCCC inventory reports the EU countries published.		
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CO	Confidential, only for members of the consortium (including the Commission Services)	
CI	Classified, information as referred to in Commission Decision 2001/844/EC	
Nature of the Deliverable		
R	Document, report	x
DEM	Demonstration, pilot, prototype, plan design	
DEC	Websites, patents filing, market studies, press & media actions, videos etc.	
OTHER	Software, technical diagram etc.	
Ethics	Ethics deliverables	

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Contents

1. Introduction

With signing the UNFCCC treaty, all signing countries obliged themselves to yearly report their GHG balances. This includes all sinks and sources of GHGs from six sectors: Energy; Industrial Processes; Agriculture; Land Use, land use change and forestry (LULUCF); Waste and Waste Water and Others. This report will concentrate on the LULUCF sector. Here, we only observe the land-use category *4.A.1: Forest land remaining forest land* (**FL-FL**). The predominant GHG here is CO_2 and forests act as a sink, not as a source. All National Inventory Reports (NIR) differentiate five relevant carbon pools: biomass (above-ground, below-ground), dead organic matter (deadwood, litter), soil organic matter and non-CO_2-gases from those pools (IPCC Guidelines 2006, p.4.7). This report focuses on the **soil organic matter (SOM)** pool in **mineral soils**. The GHG monitoring of forest mineral soils focuses on the measurement of soil carbon (C) content and the consequential calculation of C stocks and C stock changes. For the reporting, the IPCC Guidelines specified three tiers how countries can obtain their data:

Tier 1 is based on some country-specific measured values, but data sources are often globally available and therefore coarse. The IPCC provides equations and default parameters for Tier 1 reporting. This method is applied quite often, because C stocks in forest soils are often assumed stable if management does not change. Tier 2 methods can be the same as in Tier 1, but with better data (country- or region-specific). Tier 3 is the use of higher order methods. This includes models and inventories fitting the national circumstances (IPCC 2006, p.1.11, Box 1.1).

Following, we list the methods for C content monitoring for forest soils in countries of the European Union, sorted by tiers as stated by the countries in their NIR. We focus on C in the mineral soil, excluding the litter layer (often reported separately as dead organic matter in combination with deadwood) and the organic layers (not reported). Organic soils are also excluded in this deliverable, they will be reviewed elsewhere by WP 3. We list how the countries obtain their data, including a source to the respective NIR as a reference.

2. GHG monitoring methods

2.1 Tier 1

The majority of EU member states uses the Tier 1 approach to report their GHGs (see Table 1). For mineral forest soil, they should compute the changes in C stock after a management change in relation to the C stock of a reference condition (IPCC 2006, p. 2.29). Based on this definition, the majority of Tier 1 applying countries assume no stock changes due to no change in forest management. Some countries base this decision on results from forest soil inventories (e.g. ICP Forest, BioSoil), where no significant change of C stocks was detected (see Table 1).

Table 1: Tier 1 countries and their data acquisition for UNFCCC reporting in the FL-FL category

EU Country	GHG Monitoring	Data acquisition	source
Belgium	depending on region	regional differences if there is an inventory, repetitions, cycles and design	NIR 2022, p. 243
Bulgaria	yes, at ICP Forest sites	171 plots, ICP Forest sampling design	NIR 2022, p. 243, 314, 323f, 334ff
Croatia	no	assumption of no stock change, no data collection	NIR 2022, p. 236, 243
Cyprus, Republic of	no	no data collection, reference default values used	NIR 2022, p. 200
Denmark	yes	SINKS project: soil sampling in 1990 and 2007-10 (within BioSoil); future data from SINKS2: 2009-10 & 2020	NIR 2022, p. 480f
Estonia	no	no own data collection*	NIR 2022, p. 304, 325
France	yes, not representative for the whole French forest	assumption of no stock change**, Soil Quality Measurement Network (RMQS) established	NIR 2022, p. 658
Greece	no	assumption of no stock change, no data collection	NIR 2022, p. 364
Hungary	no	assumption of slow stock change (increased DOM input), report as no stock change***, no soil data collection	NIR 2022, p. 391
Latvia	yes	Level 1 ICP Forest sites, 2006, 2012	NIR 2022, p. 360
Lithuania	yes, ICP F (1998) and BioSoil (2006)	assumption of no significant stock change => reported NE (not estimated)	NIR 2022, p. 351f
Luxembourg	no	assumption of no stock change, no data collection	NIR 2022, p. 505

Malta	?	assumption of no stock change, no data collection?	NIR 2022, p. 253
Netherlands	no	Overlap of land use maps with soil type maps and inclusion of C stocks for each land use and soil type combination (NIR, p. 201), but still assumption of C stock equilibrium (p. 198f)	NIR 2022, p. 199, 201
Poland	no	assumption of C stocks still increasing with reforestation after WWII, no monitoring	NIR 2022, p. 242
Romania	no	assumption of no stock change, no structured data collection	NIR 2022, p 539
Slovakia	yes, ICP F, NFI and additional research sites	assumption of no stock change	NIR 2022, p. 337
Slovenia	yes, ICP F (1996), BioSoil (2006), NFSI (2016)	no significant stock change in mineral soil detected	NIR 2022, p. 251f
Spain	no	assumption of no stock change, no data collection	NIR 2022, p. 446

*Estonia uses an average emission factor based on Swedish EFs from 1990-2019 for stock change calculation due to insufficient country-specific data (NIR 2022, p. 325)
**A French study showed that forest soils act as a C sink. The thereby calculated factors are not representative for the whole French forest, so France decided to use the conservative approach of assuming no stock change until representative data are available (NIR 2022, p. 658)
***Hungary assume a slow C stock increase due to increased DOM input, but report conservatively with no stock change (NIR 2022, p. 391)

2.2 Tier 2

Only two European countries use the Tier 2 approach to report their forest soil C stocks and the C changes (see Table 2). Portugal gains their data from inventories as part of bigger, international projects. Germany has an independent national forest soil inventory. The inventory design (grid size, plot size, sampling depths, number of soil samples etc.) of all inventories can be found online.

Table 2: Tier 2 countries and their data acquisition for UNFCCC reporting in the FL-FL category

EU Country	GHG Monitoring	Data acquisition	source
Germany	yes	NFSI (1987-93, 2006-08)	NIR 2022, p. 608
Portugal	yes	ICP F (1995, 2005), BioSoil (1999) and LUCAS (2009)	NIR 2022, p. 1-16, 6-27

2.3 Tier 3

Five countries use a Tier 3 approach for their GHG monitoring: Austria, Finland, Ireland, Italy and Sweden. Austria, Finland, Ireland and Italy give detailed information on their models and the calculation processes of C stock changes. While Austria includes mineral soil data from inventories into their model approach, Finland, Ireland and Italy chose to calculate mineral soil C by biomass data from NFIs. Sweden applies a Tier 3 approach (NIR 2022, p. 382) for mineral soil carbon based on data from their Forest Soil Inventory.

Table 3: Tier 3 countries and their data aquisition for UNFCCC reporting in the FL-FL category

EU Country	GHG Monitoring	Data acquisition	source
Austria	Yasso07	NFSI and BioSoil	NIR 2022, p. 423, 443f
Czechia	CFS-CBM	CBM data not completely verified, NFSI repetition results expected mid 2020s	NFI 2022, p. 286, 292
Finland	Yasso07	soil data was calculated by model from NFI data (biomass, litter, input rates etc.)	NFI 2022, p. 306, 316, 318
Ireland	CBM-CFS3	NFI (soil type) and model calculations for turnover rates etc.	NFI 2022, p. 213
Italy	for-est	NFIs, calculation of soil C (changes) from aboveground data	NFI 2022, p. 260, 615
Sweden	NFSI	NFSI, harmonized to BioSoil/ICP F after 2003, 10-year cycle	NIR 2022, p. 360, 372f, 382

3. Conclusion

Basically, there are three main methodological categories for GHG monitoring for forest land remaining forest land:

- no monitoring and assuming no stock change in mineral forest soil due to no changes in land use, management and/or species
- national inventory/inventories or monitoring systems in forest soils (representative and not representative for whole country)

- calculations of C stocks and stock changes by models

Those three methods are not to be equated with the three tiers, as we see overlaps in all three of them. Particularly for Tier 1 approaches, this means that countries interpret the application of tiers differently or chose to differ from the IPCC guidelines. In the tables above, we see that several countries have country-wide data on their forest mineral soils, but still chose a Tier 1 approach for GHG reporting. Some countries even state in their reports, that they saw an increase in soil C and still chose to report the conservative "no stock change" with Tier 1. Both Tier 2 countries should have enough country-specific data to fulfil the requirements for a Tier 3 approach. The reasons for those decisions remain unknown.

Further, the sampling design – and therefore, the exact GHG monitoring method - (grid size, plot size, sampling depths, number of soil samples etc.) often remains unclear, especially if the inventory was not part of a project like BioSoil or ICP Forest. One problem here is, amongst others, an outdated online documentation with invalid access or publications with restricted access (by paywall or by access rights).

4. Literature

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