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Guidance on developing and reporting the Forest Reference Levels in accordance with Regulation (EU) 2018/841

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Guidance on developing and reporting the Forest Reference Levels in accordance with Regulation (EU) 2018/841

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OVERVIEW

This technical guidance document has been prepared for DG Climate Action, to support the EU Member States in complying with the 'LULUCF Regulation', *Regulation (EU) 2018/841 of the European Parliament and of the Council of 30 May 2018 on the inclusion of greenhouse gas emissions and removals from land use, land use change and forestry in the 2030 climate and energy framework, and amending Regulation (EU) No 525/2013 and Decision No 529/2013/EU (Text with EEA relevance)*[1]. In particular, the aim of this document is to provide guidance to the Member States on the establishment of Forest Reference Levels (FRLs) and National Forestry Accounting Plans (NFAPs) as required by the LULUCF Regulation.

The LULUCF Regulation requires the Member States to submit their NFAPs, including a proposed FRL, to the Commission by 31 December 2018 for the period from 2021 to 2025, and by 30 June 2023 for the period from 2026 to 2030. While the guidance provided in this document is not binding for the Member States, it seeks to help the Member States to interpret the LULUCF Regulation, and provides examples of possible technical approaches for preparing the FRLs and NFAPs.

The structure of this guidance document is illustrated in Figure 1. The document is organized into three sections, accompanied by three Annexes. Section 1 provides an introductory summary of the state of the forest-related accounting rules, and gives an overview of the key differences between the FRL approach under the LULUCF Regulation and the previous approach under the Kyoto Protocol (KP). Section 2 details a step-wise methodology for the construction of robust and transparent FRLs by Member States. The steps have been developed by a group of thematic experts, based on discussions with DG Climate Action and Joint Research Centre of the European Commission (JRC), as well as workshops with experts from the Member States. These steps seek to portray a wide array of different solutions for developing the FRL to take into account the large variation in the natural conditions and forest sector characteristics across the EU Member States. Section 3 provides a detailed analysis of the criteria and guidance for determining FRL, as set out in Annex IV.A of the LULUCF Regulation, and a suggested table of contents for the submission of the NFAPs, taking into account the requirements as set out in Annex IV.B of the LULUCF Regulation.

In the annexes to this technical guidance document, we provide a checklist of information to be documented in the NFAPs, as well as an illustrative handbook of the different steps for the development of the FRL. In addition, we provide suggestions and examples of reporting tables that the Member States may consider to use in their reporting of the NFAPs.

1 Available online at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2018.156.01.0001.01.ENG&toc=OJ:L:2018:156:TOC

Section 1	Section 2	Section 3	Annexes
• Overview of the principles for GHG accounting in LULUCF sector and forestry, the current state of reporting, and an overview of the legislative text	• Guidance to possible approaches to develop the FRLs, and advice on how to ensure transparent reporting • Hands-on examples on different calculation steps and possible methods	• Detailed analysis of the criteria for the FRL set out in the Annex IV of the Regulation • Example table of contents for the submission of the NFAP, in accordance with the requirements of the Annex IV of the Regulation.	• Annex I: Check list for the NFAPs • Annex II: Handbook for establishing FRLs • Annex III: Filled in examples of reporting tables as suggested in Section 2 • Annex IV: Overview of Member States' reporting under KP

Figure 1. Structure of this technical guidance document.

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GLOSSARY

This glossary covers the terminology used in this Guidance Document. The terms that are specifically defined in the LULUCF Regulation (Regulation (EU) 2018/841)[2] are marked with an asterisk (*), and those previously defined in the Decision No 529/2013/EU[3] with a plus-sign (+). Direct quotes of definitions as stated in the LULUCF Regulation or the Decision are typed in *"blue italics"*.

Accounting. Rule-based assessment of the impact on GHG emissions and removals that take place under a compliance period. The impact is accounted through comparison of actual GHG emissions and removals from GHGI categories during a compliance period with the counterfactual value, following the accounting rules set for the given category.

Afforested land*. *"Land use reported as cropland, grassland, wetlands, settlements or other land, converted to forest land."* (Article 2(1)) Note that the process under the LULUCF Regulation is different to the KP, and also the definition of the afforested land in the context of the LULUCF Regulation differs from the definition of afforestation in the IPCC Guidelines for National Greenhouse Gas Inventories (2006).

Carbon pool*. *"The whole or part of a biogeochemical feature or system within the territory of a Member State and within which carbon, any precursor to a greenhouse gas containing carbon or any greenhouse gas containing carbon is stored."* (Article 3(1)).

Carbon stock*. *"The mass of carbon stored in a carbon pool."* (Article 3(1)).

Compliance period (CP). The period 2021–2030, to which the LULUCF Regulation sets out the commitments of the Member States for LULUCF, and the rules for the accounting of emissions and removals from LULUCF and for checking the compliance of Member States with those commitments (Article 1). Note that for accounting purposes, the CP is split in the LULUCF Regulation into two periods: 2021 to 2025, and to 2026 to 2030. While the overall accounting rules set out in the LULUCF Regulation are the same for the whole CP, there are some differences in the requirements of wetlands for the first and second CP. After each 5-year period, the Commission will carry out a comprehensive review of the data (Article 14(2)) and determine compliance with the "no debit" commitment of each Member State as set out in Article 4.

Deforested land*. *"Land use reported as forest land converted to cropland, grassland, wetlands, settlements or other land."* (Article 2(1)).

Dynamic age-related forest characteristics. The LULUCF Regulation refers to "*dynamic age-related forest characteristics*" (Article 8(5)). In this guidance document, age-related characteristics are understood to refer to the state of 'maturity' of the forest, which can be characterized e.g. with mean age of a stand, its biomass density, and age or diameter class distribution. "Dynamic" is understood to refer to the development of these characteristics over time, such as the movement of a stand from one age or diameter class to another over time.

Emissions+. *"Anthropogenic emissions of greenhouse gases into the atmosphere by sources."*

Forest*. *"An area of land defined by minimum values for area size, tree crown cover or an equivalent stocking level, and potential tree height at maturity at the place of growth of the trees as specified for each Member State in Annex II [of the LULUCF Regulation].*

2 Available online at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2018.156.01.0001.01.ENG&toc=OJ:L:2018:156:TOC
3 Decision No 529/2013/EU, available online at: https://publications.europa.eu/en/publication-detail/-/publication/5327fa89-e78d-41bd-9465-2974d473a1a5/language-en

It includes areas with trees, including groups of growing, young natural trees, or plantations that have yet to reach the minimum values for tree crown cover or equivalent stocking level or minimum tree height as specified in Annex II, including any area that normally forms part of the forest area but on which there are temporarily no trees as a result of human intervention, such as harvesting, or as a result of natural causes, but which area can be expected to revert to forest." (Article 3(1)).

Forest management[+]. *"Any activity resulting from a system of practices applicable to a forest that influences the ecological, economic or social functions of the forest."*

Forest management practice(s) (FMP). The LULUCF Regulation text is not explicit about the definition of 'forest management practice'. In Article 8(5), the term is in singular form (*"practice"*), while Annex IV.B asks to describe *"practices"*. Please see Section 2, Step 2 for possible interpretations of this term. In the context of this guidance document, a forest management practice refers to a set of management activities being carried out at different phases of the stand development. FMP can thus be seen as a set of activities carried out and aimed at fulfilling specific functions assigned to a forest (production, protection, etc.), including, e.g., the regeneration modality, the species planted, the schedule and intensity of thinning and final cut.

Forest reference level (FRL)[*]. *"An estimate, expressed in tonnes of CO_2 equivalent per year, of the average annual net emissions or removals resulting from managed forest land within the territory of a Member State in the periods from 2021 to 2025 and from 2026 to 2030, based on the criteria set out in this Regulation [2018/841]."* (Article 3(1)) In accounting terms, FRL is the counterfactual value of emissions and removals that would occur in managed forest land, in absence of any future change in management practices compared to the reference period.

Half-life value[*]. *"The number of years it takes for the quantity of carbon stored in a category of harvested wood products to decrease to one half of its initial value."* (Article 3(1)).

Harvested wood product (HWP)[*]. *"Any product of wood harvesting that has left a site where wood is harvested."* (Article 3(1)). Note that in the accounting for HWP as detailed in Article 9, the emissions and removals resulting from changes in the carbon pool of HWP are to be reflected according to Annex V approach for the following HWP products: paper, wood panels, sawn wood (see Article 9(1)).

Instantaneous oxidation[*]. *"An accounting method that assumes that the release into the atmosphere of the entire quantity of carbon stored in harvested wood products occurs at the time of harvest."* (Article 3(1)).

Legacy effect. Effect or impact of an action or a disturbance that occurs only after some time. This is typical in forestry, where different management decisions or disturbances during the course of the forest rotation time affect the future state of the forests for decades or even hundreds of years after the actual occurrence.

LULUCF Regulation. *Regulation (EU) 2018/841 of the European Parliament and of the Council of 30 May 2018 on the inclusion of greenhouse gas emissions and removals from land use, land use change and forestry in the 2030 climate and energy framework, and amending Regulation (EU) No 525/2013[4] and Decision No 529/2013/EU[5] (Text with EEA*

4 Regulation (EU) No 525/2013. Available online at: https://publications.europa.eu/en/publication-detail/-/publication/4bf8306c-dab2-4fa0-8c83-8d44d760b31f/language-en

5 Decision No 529/2013/EU. Available online at: https://publications.europa.eu/en/publication-detail/-/publication/5327fa89-e78d-41bd-9465-2974d473a1a5/language-en

relevance). The LULUCF Regulation is found here: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2018.156.01.0001.01.ENG&toc=OJ:L:2018:156:TOC.

Managed cropland*. *"Land use reported as: cropland remaining cropland; grassland, wetland, settlement or other land, converted to cropland, or; cropland converted to wetland, settlement or other land."* (Article 2(1)a).

Managed forest land (MFL)*. *"Land use reported as forest land remaining forest land."* (Article 2(2)a).

Managed grassland*. *"Land use reported as: grassland remaining grassland; cropland, wetland, settlement or other land, converted to grassland, or; grassland converted to wetland, settlement or other land."* (Article 2(1)a).

Managed wetland*. *"As of 2026: land use reported as: wetland remaining wetland; settlement or other land, converted to wetland, or; wetland converted to settlement or other land"* (Article 2(1)b). Note that a Member State may include emissions and removals from managed wetland during the period from 2021 to 2025, but it is not a requirement in the LULUCF Regulation (Article 2(2)).

Natural disturbances*. *"Any non-anthropogenic events or circumstances that cause significant emissions in forests and the occurrence of which is beyond the control of the relevant Member State, and the effects of which the Member State is objectively unable to significantly limit, even after their occurrence, on emissions."* (Article 3(1)).

Precursor to a greenhouse gas+. *"A chemical compound that participates in the chemical reactions that produce any of the greenhouse gases listed in Article 3(4)"* (of the Decision 529/2013/EU).

Reference period (RP). The period from 2000 to 2009.

Removals+. *"Anthropogenic removals of greenhouse gases from the atmosphere by sinks."*

Reporting. Emission and removal estimates prepared annually by the countries. The reporting provides the information needed for accounting the impact of human activities on the atmospheric GHG concentration.

Salvage logging+. *"Any harvesting activity consisting of recovering timber that can still be used, at least in part, from lands affected by natural disturbances."*

Sink*. *"Any process, activity or mechanism that removes a greenhouse gas, an aerosol, or a precursor to a greenhouse gas from the atmosphere."* (Article 3.1).

Solid and energy use of forest biomass. The LULUCF Regulation refers to *"solid and energy use of forest biomass"*, but does not provide a specific definition. In absence of other definitions, it is advisable to consider 'solid use' as the use of forest biomass to other than energy purposes. For 'energy use', it is advisable to follow FAO definition[6] for 'wood energy': "*All energy derived from primary and secondary solid, liquid and gaseous biofuels derived from forests, woodlands and trees. Wood energy represents the energy produced after combustion of woodfuels, such as fuelwood, charcoal, pellets, briquettes, etc., corresponding to the net calorific value (NCV) of the fuel*."

6 FAO term portal. Available online at: http://www.fao.org/faoterm

Source*. *"Any process, activity or mechanism that releases a greenhouse gas, an aerosol or a precursor to a greenhouse gas into the atmosphere."* (Article 3.1).

State of the forest. Set of data and information that describe the forest, such as total area of Managed Forest Land; as well as stratum-specific variables, e.g. area, increment, biomass, age-related information.

Stratum, strata. In the context of this guidance document, a stratum (in plural: strata) is a part of forest (distinguished geographically or grouped across different geographic locations) homogeneous for all the criteria applied to the stratification process (tree species, forest type, management system, ownership, etc.). Each stratum differs from other strata by at least one of the criteria of stratification.

Sustainable forest management (practice). The preamble of the LULUCF Regulation (recital 16) refers to the principles of sustainable forest management as adopted in the Ministerial Conferences on the Protection of Forests in Europe ('Forest Europe'). The Helsinki Resolution H1 (1993) of Forest Europe defines "sustainable management" as: "*the stewardship and use of forests and forest lands in a way, and at a rate, that maintains their biodiversity, productivity, regeneration capacity, vitality and their potential to fulfil, now and in the future, relevant ecological, economic and social functions, at local, national, and global levels, and that does not cause damage to other ecosystems*".[7] Furthermore, Annex IV A.(f) of the LULUCF Regulation states that "*the reference level should be consistent with the objective of contributing to the conservation of biodiversity and the sustainable use of natural resources, as set out in the EU forest strategy, Member States' national forest policies, and the EU biodiversity strategy*".

7 http://www.foresteurope.org/docs/MC/MC_helsinki_resolutionH1.pdf

ACRONYMS

BAWS	Biomass Available for Wood Supply
C	Carbon
CH_4	Methane
cm	Centimetre
CO_2	Carbon dioxide
CP	Compliance period
CSC	Carbon stock change
CSCF	Carbon stock chance factors
DBH	Diameter at breast height
DG CLIMA	Directorate General for Climate Action
DOM	Dead organic matter
EFI	European Forest Institute
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FMRL	Forest Management Reference Level
FMP	Forest management practice
FRL	Forest Reference Level
GHG	Greenhouse gas
GHGI	Greenhouse gas inventories
HFM	Harvest Fraction of Management
HP	Historical Period
HWP	Harvested wood product(s)
IIASA	International Institute for Applied Systems Analysis
IPCC	Intergovernmental Panel on Climate Change
IPCC GL	IPCC Guidelines
JRC	Joint Research Centre of the European Commission
KP	Kyoto Protocol
LULUCF	Land Use, Land Use Change and Forestry
MFL	Managed Forest Land
Mm^3	Mega cubic metres (million cubic metres)
ND	Natural Disturbances
NFAP	National Forestry Accounting Plan
NFI	National forest inventory
NIR	National inventory report
N_2O	Nitrous oxide
PP	Projection period
RCP	Representative Concentration Pathways
RP	Reference period
SOM	Soil organic matter
SSP	Shared Socioeconomic Pathways
TBA	Total Biomass Available
t	Tonne
T1, T2, T3	Tier 1, Tier 2, Tier 3
UNFCCC	United Nations Framework Convention on Climate Change
YR	Year

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SECTION 1

1 INTRODUCTION

1.1 What is this Guidance Document for?

In 2018, a new Regulation of the European Parliament and of the Council came into force, setting in place the accounting rules on the inclusion of greenhouse gas (GHG) emissions and removals from land use, land use change and forestry (LULUCF) in the 2030 climate and energy framework. The aim of this document is to provide guidance to EU Member States on the establishment of forest reference levels (FRLs) and national forestry accounting plans (NFAPs) in the context of the *Regulation (EU) 2018/841 of the European Parliament and of the Council of 30 May 2018 on the inclusion of greenhouse gas emissions and removals from land use, land use change and forestry in the 2030 climate and energy framework, and amending Regulation (EU) No 525/2013 and Decision No 529/2013/EU (Text with EEA relevance)* (hereafter referred to as the 'LULUCF Regulation'). This guidance document seeks to provide the best possible advice on interpreting the LULUCF Regulation, and developing the FRL and NFAP in compliance with the LULUCF Regulation. This is not a binding document and it is at the discretion of each Member State to use, or not use the document when establishing their national FRL and NFAP.

In the LULUCF Regulation, GHG emissions and removals from managed forest land (MFL) in each EU Member State are accounted against a FRL, a country-specific projected baseline of expected forest emissions and removals for the Compliance period (CP) 2021-2030. The NFAPs, including a proposed FRL, shall be submitted to the Commission by 31 December 2018 for the period from 2021 to 2025, and by 30 June 2023 for the period from 2026 to 2030 (Article 8.3). As defined in the LULUCF Regulation, the FRL "*shall be based on the continuation of sustainable forest management practice, as documented in the period from 2000 to 2009 with regard to dynamic age-related forest characteristics in national forests, using the best available data*" (Article 8(5)).

This Guidance Document provides advice and examples on how to prepare the FRL and NFAP, and gives guidance on how to ensure comprehensive and transparent reporting. Given that the forest characteristics, forest management practices (FMPs), as well as data and models availability vary substantially among the Member States, specific attention has been given on including a variety of different alternative methods to accommodate for different national circumstances. The goal is that this document helps each Member State to identify the set of historical management activities implemented in the Reference Period (RP), and to project the forest characteristics in the accounting period by simulating the continuation of historical FMPs over the CP.

This guidance document is structured as follows:

- Section 1: Overview of the principles for GHG accounting in forestry, the current state of reporting, and an overview of the legislative text.
- Section 2: Guidance to possible approaches to develop the FRLs, and advice on how to ensure transparent reporting. Under this Section, also hands-on examples on different calculation steps and possible methods are elaborated.
- Section 3: Detailed analysis of the criteria for the FRL set out in the Annex IV of the LULUCF Regulation, to clarify details and provide help to understand the requirements of the LULUCF Regulation. This section also illustrates an example table of contents for the submission of the NFAP, in accordance with the requirements of the Annex IV of the LULUCF Regulation.
- Further details are given in the Annexes I-IV:
  - Annex I: Provides a check list of information to be documented in the NFAPs.
  - Annex II: Handbook for establishing FRLs.
  - Annex III: Provides filled in examples of reporting tables as suggested in Section 2.
  - Annex IV: Overview of the EU Member States' reporting of LULUCF under Kyoto Protocol.

This document does not provide an exhaustive collection of all possible approaches to prepare the FRLs and NFAPs. Instead, the authors have sought to survey and analyse a wide array of possible approaches to develop and report FRLs and NFAPs. Based on this information, this document has been structured to give an overview of possible approaches for the Member States to develop their FRLs and NFAPs. In addition, the document highlights and explains important parts of the LULUCF Regulation so that the Member States can be confident in that their reporting complies with the requirements as set out in the legislative act.

1.2 Introduction to LULUCF in the context of climate change

1.2.1 Background

To limit the increase of the global average temperature, reducing g anthropogenic (human-induced) net emissions of GHGs is essential. In the Paris Agreement[8] adopted under the United Nations Framework Convention on Climate Change (UNFCCC), the parties, including the EU, agreed to commit to a long-term goal of keeping the global temperature increase well below 2°C above pre-industrial levels; and to pursue efforts to keep it from exceeding 1.5°C above pre-industrial levels. The Paris Agreement replaces the approach taken under the 1997 Kyoto Protocol (KP)[9], which will not be continued beyond 2020.

The main anthropogenic driver of the global temperature increase is the accumulation of GHGs in the atmosphere. Processes that release GHGs into the atmosphere, such as combustion of fuels, are referred to as 'sources'. Processes that remove GHGs from the atmosphere are called 'sinks'. The most important sinks are absorption of carbon in the oceans and by biomass on land. The sum of the sources and sinks is referred to as 'net emissions'. Critical anthropogenic GHGs include carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). In the LULUCF Regulation, all GHGs are expressed in terms of CO_2

8 https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement
9 https://unfccc.int/process/the-kyoto-protocol

equivalent (the effect of an equivalent mass of CO_2 in the atmosphere on solar radiative forcing).

The Paris Agreement also calls for a balance between anthropogenic emissions by sources and removals by sinks of GHGs in the second half of the century. This asks for net-zero emissions, where the amount of carbon absorbed by the sinks equals the amount of carbon released by the sources. Assuming that the use of fossil fuels will not end completely in the next decades, it will be necessary to achieve and enhance uptake of carbon by sinks whenever possible. This is where the LULUCF sector comes into play.

1.2.2 Specific characteristics of the LULUCF sector

LULUCF sector differs from other sectors (e.g. energy and transport) in that human actions on the LULUCF sector can at the same time contribute to both emitting and removing GHGs from the atmosphere. The forests remove and store carbon from the atmosphere when they grow, and the carbon is also stored in wood-based products. On the other hand, carbon is emitted to the atmosphere when wood decays to dead organic matter, when it is burnt, or when the wood-based products decay over their life-times. In addition, forest-related activities may lead to emissions of other GHGs: for example, drainage of wetlands is associated with CH_4 emissions, and nitrogen fertilization may increase N_2O emissions. Consequently, LULUCF can at the same time act as a source and a sink; therefore, determining the final net balance requires a careful assessment of the emissions and removals of GHGs within the sector.

In the context of the Paris Agreement and the sharing of efforts between countries, it is key to distinguish between anthropogenic emissions and removals, and those caused by natural processes. Within the LULUCF sector, and particularly within forestry, separation of the natural component in the carbon cycle from that associated with the impact of human activities is not always straightforward. Natural disturbances such as wildfires, windthrow, or insect outbreaks may lead to large emissions or reductions in the forest sinks, and their impact may be reduced or amplified through forest management practices.

Furthermore, the impact of activities or disturbances on forest land does not occur fully within the same year as the occurrence takes place. Forest harvesting reduces the carbon sinks temporarily, but may over the long term lead to improved growth of forests and consequently, larger sinks. Moreover, because of the long time-span of forest cycles, different management decisions over the course of the forest rotation time may affect the removals and emissions for decades or even centuries after the actual operation, such as planting or thinning, took place. Similarly, emissions from the decay of organic matter are seen still years after the disturbance creating the dead organic matter. This extension of impact over time is referred to as ‘legacy effect’. In other words, the future emissions and removals in forests are impacted by the long-term legacy effects associated with age-class dynamics, determined by past activities and natural disturbances. Unlike other sectors, in LULUCF and specifically in forestry it is typical that these legacy effects occur repeatedly over time in a cyclical fashion.

1.2.3 Overview of the LULUCF accounting principles

The GHG emission reduction target of the EU to reduce the GHG emissions by at least 40% by 2030 is set economy-wide, i.e. across sectors. To ensure reliable and efficient policies and comparison between different sectors, the reporting and accounting of the emissions and removals for each sector need to be reliable, robust, and transparent.

‘Reporting’ refers to the emission and removal estimates prepared by the countries. In the context of mitigation targets, ‘accounting’ refers to the comparison of emissions and removals with the target. On the LULUCF sector, the accounting is done through policy-agreed accounting rules, which filter the reported estimates with the aim to better

quantify better the results of mitigation actions (e.g. Cowie et al. 2007, Schlamadinger et al. 2007, Grassi et al. 2018). The LULUCF accounting then produces 'debits' or 'credits' (i.e. extra emissions or extra emission reductions, respectively) that count toward the target. Through the debit and credit system, the aim is to provide incentives for beneficial actions and policies, or disincentives for detrimental actions.

There are different approaches for establishing the counterfactual value, or the base value, for accounting the mitigation effects by carbon sinks and sources:

- In **gross-net accounting**, the counterfactual value is set at zero. This means that the net total ('net') of all ('gross') emissions and removals occurred in the compliance period are accounted. This approach is used in the LULUCF Regulation within Article 6, where the emissions and removals resulting from afforested land and deforested land shall be accounted for "*as being the total emissions and total removals for each of the years in the periods from 2021 to 2025 and from 2026 to 2030*".
- In **net-net accounting**, the counterfactual value is set as the emissions of the base year or level (net), and is compared with the emissions of the compliance period (net). This is the accounting principle in the LULUCF Regulation for managed cropland, managed grassland and managed wetland (Article 7), where the emissions and removals from these land use classes shall be compared to the base period from 2005 to 2009.

  Another example of net-net accounting is when the actual emissions and removals in a given year are compared against a projected **reference level**. This approach is used in the LULUCF Regulation for the accounting of MFL (Article 8).

The use of different accounting approaches reflects how the activities implemented in different land uses affect the development of carbon sinks and sources within the LULUCF sector. The gross-net accounting used for land use change emphasizes the more profound change of the characteristics of that land for the future, which can also be linked to a relatively specific point in time. Gross-net accounting aims to give full incentive to reduce emissions or enhance the sinks, while assuming that all the emissions and removals are a direct consequence of human actions. In net-net accounting, the choice of the RP is emphasized. For land uses where the annual emissions and removals change relatively little from year to year (such as cropland or grassland, where the annual biomass production is relatively similar from year to year), the use of a historical base year is justified since it allows to account for efforts made for enhancing net removals of GHG emissions over time.

For MFL, the accounting against a reference level provides a means of considering the long time-horizon and legacy effects of past management practices associated with forestry. This approach was applied under KP reporting for the second commitment period, and now adopted in the LULUCF Regulation. Note that the requirements and scope of the FRL in the LULUCF Regulation differ partly from the KP; see chapter "*LULUCF Regulation"* for more details. The FRL for MFL as regulated by the LULUCF Regulation ties the FRL to "*continuation of sustainable forest management practice, as documented in the period from 2000 to 2009*" (Article 8(5)). This aims to provide a baseline to show how the forest would develop if no changes to policies or practices were put in place (i.e. the counterfactual value), compared to the RP. The impact of this approach compared to net-net accounting against a base year is especially prominent in a situation where the age structure of a forest is skewed: if the forests had a relatively large share of trees in a certain age class, the total harvest would fluctuate over time purely because there are different amounts of trees reaching the harvest age during different periods in time. The use of FRL attempts to make a complete account of the impacts of changes in forest management practices, relative to the practice under a historical reference period, and to eliminate the differences that result purely from the age-related dynamics.

In the land use sector it is generally simpler and more accurate to measure the change in 'carbon stock', instead of the fluxes of emissions and removals. Carbon stock refers to "*the mass of carbon stored in a carbon pool*", measured at a given time. For example, the net emissions caused by land use change can be estimated through comparing the stock of carbon per area unit before and after the land was converted (the so called 'stock-difference' method). It is important to note that the mere presence of carbon stocks will not mitigate climate change, if emissions from other sectors continue increasing. Instead, the net carbon sinks need to be maintained and ideally enhanced. This means that the total amount of atmospheric carbon needs to be reduced, and more carbon sequestered in lands and oceans. It follows that in order for the land use to contribute positively to combating global temperature increase, it is necessary that the future land-based carbon stock will be larger than the current carbon stock, and that the net carbon sinks are enhanced.

The GHG emissions and removals are estimated from different 'carbon pools'. A carbon pool means "*the whole or part of a biochemical feature or system within the territory of a Member State and within which carbon, any precursor to a greenhouse gas containing carbon or any greenhouse gas containing carbon is stored*". In the LULUCF sector, and in forest land, the carbon pools considered include living biomass (above- and below ground), dead organic matter (litter and dead wood, DOW), soil organic matter (SOM), and harvested wood products (HWP).

In the context of the LULUCF Regulation, the following six pools are considered within the Member States (Annex 1.B):

- Above-ground biomass;
- Below-ground biomass;
- Litter;
- Dead wood;
- Soil organic carbon;
- Harvested wood products.

In line with the Paris Agreement, accounting of GHGs within the LULUCF Regulation refers to anthropogenic emissions by sources and removals by sinks. This means that natural disturbances may be excluded from the accounting. On the other hand, since HWP is an anthropogenic pool, it is included in the LULUCF Regulation. This is in line with UNFCCC reporting: HWP is reported under the KP as a separate carbon pool in afforested land and in land under forest management, respectively.

The accounting of HWP under LULUCF recognizes the fact that when forest is harvested and the wood used for material products, the carbon stored in the biomass is not released into the atmosphere immediately. Instead, the carbon continues to be stored in the products that have different lifetimes before eventually decaying or being burnt for energy production. In the LULUCF Regulation, the HWP that are specifically accounted for are paper, wood panels, and sawn wood (Article 9). For each of these products, specific half-life values are defined, reflecting the number of years it takes to lose one-half of the material currently in the pool, and eventually be released into the atmosphere[10]. This accounting attempts to promote enhanced use of wood products with long life-cycles, compared to short-lived products or the combustion of virgin wood directly to energy. The accounting is based on a 'production approach', which means that the HWP is accounted by the producing country, while "*imported [HWP], irrespective of their origin, shall not be accounted by the importing Member State*". These rules prevent double-

10 2006 IPCC Guidelines for National Greenhouse Gas Inventories, available online at: https://www.ipcc-nggip.iges.or.jp/public/2006gl/

counting of the internationally traded HWP. In addition to the modelling of the decay of HWP over time, the LULUCF Regulation requires also a comparison with instantaneous oxidation (which assumes that the carbon stored in the wood biomass is not stored but instead released into atmosphere directly after harvest). This comparison serves to evaluate the extent and importance of the HWP pool in relation with the whole LULUCF pool.

1.3 Previous reporting and accounting under the Kyoto Protocol

1.3.1 Overview

The 1997 Kyoto Protocol (KP)[11] established a set of accounting and reporting rules for assessing the emissions and removals from different sectors. It will not be continued beyond 2020. The LULUCF Regulation is part of the EU efforts towards the climate change mitigation targets of the Paris Agreement, which will replace KP after 2020. Here, we give an overview of the KP system and previous experiences with it, and highlight differences between the reporting under KP and the LULUCF Regulation.

The KP accounting system was designed with the aim to accurately reflect the atmospheric impacts of additional human actions during an established time period. The impacts of the additional actions have been generally addressed through the so-called net-net accounting approach that uses a reference year or level as a comparison point. This method excludes all emissions and removals that would occur in absence of the additional actions from being credited/debited (i.e. the counterfactual value).

To achieve such a goal, the accounting rules under the KP deals with:

- Legacy effect of pre-KP activities;
- Impact of natural disturbances;
- Symmetry of processes, as removals and subsequent emissions, and vice versa, from the same C pool, or as tree cover gains and tree cover losses, and vice versa in the same land;
- Non-permanence of CO_2 emissions and removals. That is, the CO_2 removals and subsequent CO_2 emissions, and vice versa, are accounted when they actually occur.

Further, in case of inaccuracy due to lack of adequate data, KP allows for conservative accounting; that is, it attempts to zero out the likelihood of overestimating net benefits.

1.3.2 Accounting of forest emissions and removals under the KP

The general assumption in the KP approach is that the reference level corresponds to the GHG emissions and removals of a historical base year, i.e., generally 1990. This means that the countries are considered accountable of all emissions and removals after this date. Consequently, any deviation with a positive-sign compared to the level of the base year (i.e. more emissions/less removals) will be debited, and any negative-sign deviation (i.e. less emissions/more removals) will be credited. However, in the woody biomass pool, previous actions or historical disturbances cause significant variation to the rate of carbon stock change through time, even in absence of subsequent actions or disturbances. This legacy effect means that a historical level of carbon stock change is not an appropriate counterfactual level for the accounting of emissions and removals related to the use of woody biomass.

11 https://unfccc.int/process/the-kyoto-protocol

For reasons such as these, all activities where the woody biomass carbon stock is negligible, or otherwise insignificant, use the base year GHG emissions and removals as their reference level[12], while:

- Afforestation sets its reference level at 0 (zero), so that all CO_2 removals are counted as an additional contribution compared to a scenario without such forest (i.e. gross-net accounting). Further, to ensure that following CO_2 emissions (e.g. associated with harvesting) are also accounted when they actually occur, land under afforestation cannot transit to an activity with a different reference level. Accounting all CO_2 removals and all subsequent CO_2 emissions the 0-reference level allows to account for the actual change in the long-term average C-stock, which is also in line with what the impacts of the afforestation activity are on the atmosphere.
- For symmetry, deforestation applies same reference level and accounting rules applied to afforestation; although, deforested land cannot transit to afforestation.
- Forest management applies a projected reference level (forest management reference level, FMRL) in order to zero out the contribution of CO_2 removals (and emissions) resulting from pre-KP actions or disturbances. Further, in order to exclude the impact of the inter-annual variability of natural disturbances[13], the contribution of disturbances to the reference level is set as the average occurred during the historical period 1990-2009 (or later).

1.3.3 Lessons learned under the KP, and expectations for the new FRLs

The concept of a reference level was used within the second commitment period (2013-2020) of the Kyoto Protocol, during which the Annex I parties were required establish a reference level referred to as FMRL. A total of 38 parties submitted their FMRLs under the KP, including all EU countries. There was a wide variety of approaches used to produce the FMRL, ranging from using the emission estimate from base year 1990, or a value of zero, to model-based projections[14]. Most countries applied projected FMRLs (including all EU countries), typically using the data from NFI combined with scenario analysis or demand projections with partial equilibrium models to estimate the future net emissions from forest management. Several EU countries projected FMRL following a common approach coordinated by the JRC and modelled by teams from IIASA and EFI (based on harvest demand projections). An overview of the LULUCF reporting by the EU Member States under KP commitment period 2 appears in Annex IV. A more thorough analysis on the lessons learned under the KP may be found in Grassi et al. (2018).

For the development of this guidance document, an electronic survey was sent to all Member States in February 2018. The aim of the survey was to get a better understanding of the experiences from the FMRLs and the modelling capacities and data availabilities that the Member States have available now for the FRLs. The response rate was excellent, with 27 Member States providing at least partial answers within the given time of two weeks. The responses provided an overview of lessons learned under the past FMRL process and expectations for the FRL development, as well as more detailed questions and comments regarding the technical or conceptual understanding of the LULUCF Regulation. These questions and comments have been taken into account and addressed throughout this guidance document.

The survey results show clearly that at the time of the development of the FMRLs, Member States had varying institutional capacities and varying resources available to

12 i.e. cropland management, grazing land management, revegetation, wetlands drainage and rewetting.
13 Identified as outliers in the normal distribution of emissions from disturbances
14 See Chapter 2, Box 2.7.3 of the 2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol for more detail. Available online at: https://www.ipcc-nggip.iges.or.jp/public/kpsg/pdf/KP_Supplement_Entire_Report.pdf

develop their own national projections. Since then, the capacity within the Member States has improved and a majority of Member States feel that they are able to apply national approaches to the development of their FRL.

Past experience with the FMRL was seen to have brought insight into what the process of setting a reference level entails, including the projections, technical corrections, as well as the review process. The FMRL development under the KP also gave better understanding of the availability and characteristics of models, data, and personnel needed nationally to deliver the reference levels. A frequently occurring comment was the difficulty to estimate future policies appropriately in the FMRL under the KP, as these estimations were experienced to be difficult to define and were perceived to include a high level of uncertainty. As the expectations of future policies will not be part of the LULUCF Regulation, this specific problem will be avoided for the FRL.

Past challenges that are expected to prevail for the FRL development include lack of data and inconsistencies between different data sets and data sources. Estimation of natural disturbances, accounting for HWP, and lack of FMP documentation were frequently mentioned issues where the Member States expected to face challenges for the FRL estimation. The survey answers brought also clearly forward the different natural conditions in different countries: the forests within the EU include a wide variety of tree species and forest structures that are managed in a variety of ways for different purposes. Within the EU, the forests range from subtropical Mediterranean forests to boreal tundra, and the forestry focus varies, from highly industrial use of timber to household firewood collection. Furthermore, often the management of forests is multifunctional, considering simultaneously several objectives such as water protection, recreation, biodiversity protection, and timber production. In this setting, it is obvious that a single system to categorize and model the forests and their importance in carbon accounting may not be meaningful. Instead, there should be flexibility to accommodate the national differences in the modelling of the FRL and LULUCF sector, while ensuring that the reporting is transparent and complete, and based on as consistent, comparable and accurate information as possible.

1.4 LULUCF Regulation

1.4.1 Background, structure and important dates

The LULUCF Regulation adopted in 2018 was published in all EU Member States' languages in the Official Journal of the European Union[15]. Here, we give an overview of its structure and the most important aspects with respect to developing the FRLs and NFAPs.

Figure 2 sets the LULUCF Regulation into context with respect to other agreements and regulations, both internationally and within the EU. The linkages between different processes and the background for the LULUCF Regulation are also described in the preamble of the LULUCF Regulation.

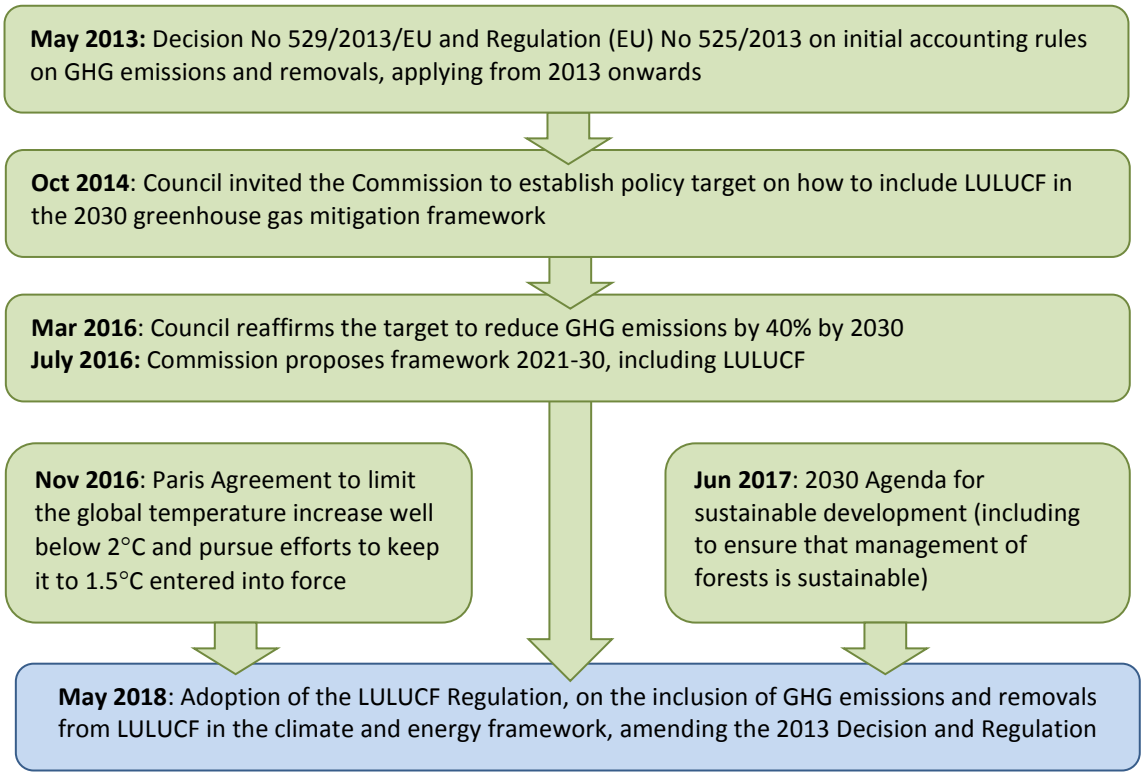


Figure 2. Overview of the context of the LULUCF Regulation and a selection of agreements that are closely related to it.

The structure of the LULUCF Regulation follows the practice and presentation of a publication in the Official Journal of the EU, consisting of a preamble, enacting terms, and annexes. Box 1 gives an overview of the contents of each part in the LULUCF Regulation. Figure 3 outlines the important dates related to the submissions and possible technical corrections as stated in the LULUCF Regulation. The LULUCF Regulation requires the Member States to submit to the Commission their NFAPs, including a proposed FRL, by 31 December 2018 for the period from 2021 to 2025 and by 30 June 2023 for the period from 2026 to 2030.

15 Available online at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2018.156.01.0001.01.ENG&toc=OJ:L:2018:156:TOC

Box 1. Structure of the LULUCF Regulation

The LULUCF Regulation has three parts: the preamble, the enacting terms of the Regulation, and annexes. The following gives an overview of the contents of the three parts.

1. ***Preamble***
   - Title and reference to the adopting institution/body.
   - Citations, indicating the legal basis and preparatory acts for the Regulation
     - These parts start with 'Having regard…', 'After transmission…' or 'Acting in accordance…'
   - Recitals, setting out the reasons for the contents of articles of the Regulation
     - The recitals are introduced by the word 'Whereas:'. In the LULUCF Regulation, there are 36 numbered recitals that explain the context, background, and main concepts for the Regulation.

2. ***Enacting terms***
   - This part constitutes the normative part of the LULUCF Regulation. It is divided into 20 Articles, which are further subdivided into paragraphs. The LULUCF Regulation constitutes of the following:
   - Articles 1-3 describe the subject matter, scope, and definitions used in the Regulation
   - Article 4 states the commitments for the Members States
   - Articles 5-9 state the accounting rules for the different land uses as well as for HWP
   - Article 10 describes the accounting rules for natural disturbances
   - Articles 11-13 describe the flexibilities available for the Member States
   - Article 14 details the requirements for a compliance check
   - Articles 15 and 16 describe the registry and exercise of delegation by the European Commission
   - Article 17 gives an overview of the review process of the submissions
   - Articles 18 and 19 detail the amendments to Regulation (EU) No 525/2013 and Decision No 529/2013/EU that this new LULUCF Regulation imposes
   - The final article 20 specifies the entry date and binding nature of the Regulation, as directly applicable in all Member States.

3. ***Annexes***
   - The LULUCF Regulation is accompanied by seven annexes, specifying the greenhouse gases and carbon pools addressed by the Regulation (Annex I), as well as Member State-specific thresholds of forest parameters to be considered for Forest Land (Annex II), base years (Annex III) and compensation under Managed Forest Land (MFL) flexibility (Annex VII). The annexes also give more detailed instructions on the contents and what to include in the national forestry accounting plan (Annex IV), HWP accounting (Annex V), and natural disturbances (Annex VI).

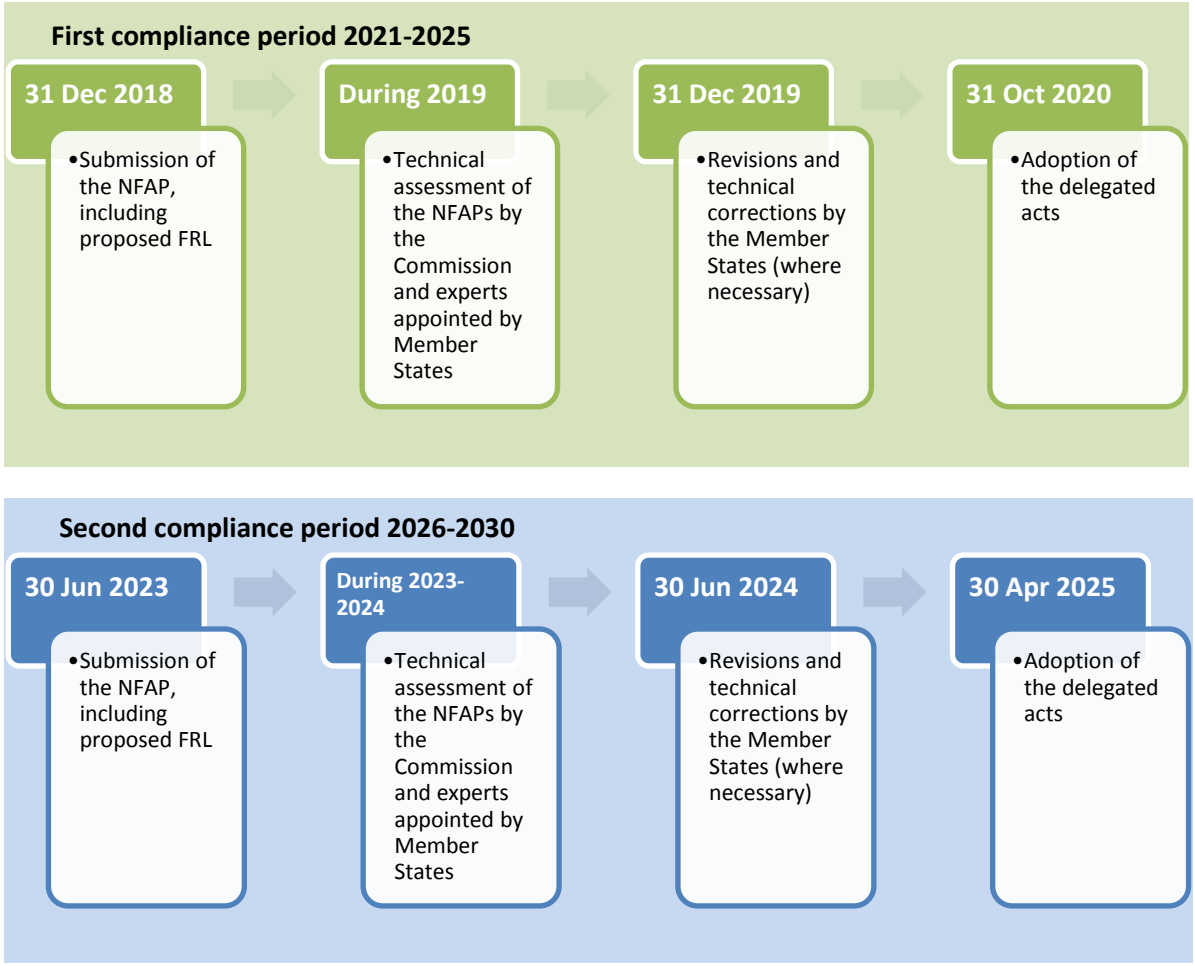


Figure 3. Timeline for the FRLs as defined in the LULUCF Regulation.

1.4.2 Key statements in the LULUCF Regulation concerning FRLs

According to the LULUCF Regulation, there are several requirements for the development of the FRL. In particular, related with the methodology, the FRL shall:

According to Article 8(5) of the LULUCF Regulation:

- "*be based on the continuation of sustainable forest management practice, as documented in the period from 2000 to 2009 with regard to dynamic age-related forest characteristics in national forests*"
- use the "*best available data*"
- "*take account of the future impact of dynamic age-related forest characteristics*"
- "*not unduly constrain forest management intensity as a core element of sustainable forest management practice, with the aim of maintaining or strengthening long-term carbon sinks*"

According to Annex IV of the LULUCF Regulation:

- "*be consistent with the goal of achieving a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century, including enhancing the potential removals by ageing forest stocks that may otherwise show progressively declining sinks*"
- "*ensure that the mere presence of carbon stocks is excluded from accounting*"
- "*ensure a robust and credible accounting system that ensures that emissions and removals resulting from biomass use are properly accounted for*"
- "*include the carbon pool of harvested wood products*"
- assume *"a constant ratio between solid and energy use of forest biomass as documented in the period from 2000 to 2009*"
- "*be consistent with the national projections of anthropogenic greenhouse gas emissions by sources and removals by sinks reported under Regulation (EU) No 525/2013*"
- "*be consistent with greenhouse gas inventories and relevant historical data*"
- "*be based on transparent, complete, consistent, comparable and accurate information*"
- "*be able to reproduce historical data from the National Greenhouse Gas Inventory*"

1.4.3 Description of key differences between FRL and FMRL

Both of the projected reference levels, the FMRL under the KP and the FRL under the LULUCF Regulation, are set to provide a baseline against which the future net forest emission can be compared for accounting proposes. The key difference between the two methods is that the FMRL included future effects of policies adopted and implemented by 2009 in the business-as-usual scenario[16], however the FRL, as detailed in the LULUCF Regulation, **does not include any reference to a future scenario.** It thereby, **excludes assumptions of forest management development or expectations on future demand for wood or land use**. Instead, the FRL "*shall be based on the continuation of sustainable forest management practice, as documented in the period from 2000 to 2009 with regard to dynamic age-related forest characteristics in national forests, using the best available data.*" (Article 8(5)). This aims to make the accounting of forest-sector mitigation more transparent, as the FRL is based on documented historical information instead of assumptions for the future. This approach is also more similar to the accounting of GHGs on other sectors (Grassi et al. 2018).

The FMRL under the KP was requested in the Decision 2/CMP.6 of the Cancun Agreements on Land use, land-use change and forestry in 2010[17], and further refined in the Decision 2/CMP.7 by the Conference of the Parties in Durban in 2011[18]. In the footnote 1 to paragraph 4 of the Decision 1/CMP.6[17], the FMRL was stated to be set transparently, taking into account the following:

> *"(a) removals or emissions from forest management as shown in greenhouse gas inventories and relevant historical data;*
>
> *(b) age-class structure;*
>
> *(c) forest management activities already undertaken;*
>
> *(d) projected forest management activities under a 'business as usual' scenario;*
>
> *(e) continuity with the treatment of forest management in the first commitment period;*
>
> *(f) the need to exclude removals from accounting in accordance with decision 16/CMP.1, paragraph 1.*
>
> *Points (c), (d) and (e) above were applied where relevant. The forest management reference levels also took into account the need for consistency with the inclusion of carbon pools. Reference levels including and excluding 'force majeure' should be provided."*

The LULUCF Regulation does not provide a similar concise list for aspects to be taken into account in the FRL. In order to compare the list provided under the KP to requirements set out in the LULUCF Regulation, we compare the two processes in Table 1. Note that here we cover only the aspects related to forest management; other aspects such as the considerations to area under forest management, calculation of different carbon pools, or consideration of natural disturbances, are covered in detail under Section 2 in this guidance document.

16 Appendix II of the Decision 2/CMP.6, available online at: https://unfccc.int/resource/docs/2010/cmp6/eng/12a01.pdf
17 FCCC/KP/CMP/2010/12/Add.1, available online at: https://unfccc.int/resource/docs/2010/cmp6/eng/12a01.pdf
18 FCCC/KP/CMP/2011/10/Add.1, available online at: https://unfccc.int/resource/docs/2011/cmp7/eng/10a01.pdf

Table 1. Comparison between the scope of the FMRL under the KP, and FRL as described in the LULUCF Regulation in terms of forest management. The points (e) and (f) in the KP referred to internal consistency within the KP, and are hence not included in this comparison with the LULUCF Regulation.

FMRL under the Kyoto Protocol[17]:	FRL as described in the LULUCF Regulation
The scope of the FMRL is to account for changes in emissions and removals associated with Forest Management (FM) only, i.e. excluding impact of legacy and of natural disturbances	The scope of the FRL is to account for *"emissions and removals resulting from managed forest land"* (Article 8(1))
"removals or emissions from forest management as shown in greenhouse gas inventories and relevant historical data"	*"Member States shall demonstrate consistency between the methods and data used to determine the proposed forest reference level in the national forestry accounting plan and those used in the reporting for managed forest land."* (Article 8(5)) *"the reference level shall be consistent with greenhouse gas inventories and relevant historical data and shall be based on transparent, complete, consistent, comparable and accurate information. In particular, the model used to construct the reference level shall be able to reproduce historical data from the National Greenhouse Gas Inventory"* (Annex IV.A(h))
"age-class structure"	*"The forest reference level shall be based on the continuation of sustainable forest management practice, as documented in the period from 2000 to 2009 with regard to dynamic age-related forest characteristics in national forests, using the best available data."* (Article 8(5)) *"Forest reference levels - - shall take account of the future impact of dynamic age-related forest characteristics in order not to unduly constrain forest management intensity as a core element of sustainable forest management practice, with the aim of maintaining or strengthening long-term carbon sinks"* (Article 8(5))
"forest management activities already undertaken"	*"The forest reference level shall be based on the continuation of sustainable forest management practice, as documented in the period from 2000 to 2009 with regard to dynamic age-related forest characteristics in national forests, using the best available data."* (Article 8(5))
"projected forest management activities under 'business as usual' scenario"	**NOTE:** no mention of a "scenario" projection in the LULUCF Regulation. Instead, the FRL is to be projected assuming continuation of the FMPs as in the RP.

1.4.4 General concepts about the FRL projections

This section is aimed to clarify some general aspects about the FRL projections in line with the LULUCF Regulation.

The use of the FRL should aim to allow to reflect fully in the accounts the impact of changes in FMP relative to a historical reference period. This allows the accounting of forest mitigation to be comparable to other GHG sectors, because all sectors implicitly reflect the impact of policy or management changes relative to a base year or period. Therefore, the use of a FRL allows comparability of forest credits with other sectors (Grassi et al. 2018).

The projection behind the FRL aims to represent what would occur on the MFL if the historical management regime was continued. Therefore, the assumed future impact of policies and markets are not to be included in the FRL estimation, since in all other GHG sectors such impacts are accounted for as credits[19] or debits[20]. The same management practices of the RP, without any rate of variation, are applied during the compliance period. This ensures that the FRL is an accurate estimate of the counterfactual value of emissions and removals that would have occurred in the absence of the impacts of policies and measures already in place, and of any variation of such policies and measures or of any new policy and measure put in place after the RP.

However, the FRL has to include the expected natural dynamics in forest carbon stocks in the country, through the combination of the expected changes in forest characteristics (e.g. biomass available for wood supply, net increment, etc.) and the "*continuation of forest management practice*" (Article 8(5)) in the RP.

Additionally, a pool that is not a source (demonstrated as the net balance of all GHG from the pool) can be excluded from the FRL. However, that option shall not apply in relation to the carbon pools of above-ground biomass, dead wood and HWP, in the land accounting category of MFL.

Even though, according to Article 8(5), the FRL shall not "*unduly constrain forest management intensity*", the FRL estimation cannot contradict the first paragraph of Article 8(5) "*The forest reference level (FRL) shall be based on the continuation of sustainable forest management practice, as documented in the period from 2000 to 2009*". This part of the LULUCF Regulation can be understood to reflect the need to model the development of age-related characteristics of the forests over time, instead of fixing those on the level of the RP. Section 2.3 of this document provides more detailed guidance on how to take this into account in the estimations of the FRL.

It is important to understand that the FRL is not a constraint on future management, and does not place a limit or threshold that should be met or improved upon[21]. Instead, the Member States are free to pursue and evolve sustainable management practices as they see fit. The purpose of the FRL is to allow the consequences to be accounted for in a transparent and reliable manner.

19 For instance, impacts of a policy in the energy sector leading to credits are those associated to a set of fiscal incentives for the production of renewable energy that determine a growth of the renewable energy market, which triggers a decrease in the cost of renewable energy production and consequently a progressive increase in the installation of renewable energy plants and in the associated carbon emissions.
20 For instance, impacts of a policy in the energy sector leading to debits are those associated with the removal of subsidies to fossil fuels that has the largest impact in the year in which is applied and a degressive impact in the following years according to the decreasing use of fossil fuels.
21 See e.g. Matthews and Henshall 2018. Presentation at JRC Workshop on LULUCF, Arona, 17 May 2018. Material available at: http://forest.jrc.ec.europa.eu/activities/lulucf/workshops/workshop-2018/

SECTION 2

2 POSSIBLE WAYS TO IMPLEMENT THE FRL REQUIREMENTS IN LINE WITH THE LULUCF REGULATION REQUIREMENTS

This section provides guidance to Member States on how to estimate the FRLs requested in Article 8 of the LULUCF Regulation. A step-by-step approach for projecting emissions by sources and removals by sinks from MFL is proposed, and each sequential step and possible methods to implement it are described in detail. An overview of key concepts for the development of the FRL is recalled below in Box 2. In addition, an overview of the suggested step-wise approach is presented below in Box 3. The steps proposed in this section have been organized in a structure that can be used to properly include the reporting of the FRL in the NFAP.

The aim of this section is to provide general guidance on the development of the FRL estimations for the CP, including descriptions of some of the decisions and choices that a Member State will need to consider when establishing the FRL. Also, this section provides practical suggestions on how to establish the FRL and provides guidance on how to report the FRL. The section also includes some approaches and examples of good practices, as well as several warnings about 'not in line' approaches. Nevertheless, the ultimate choice of the method to calculate the FRL will depend on the national circumstances, including data availability and modelling capacity.

Box 2: Key concepts for the implementation of the FRL

Compliance period (CP). The period 2021-2030, to which the LULUCF Regulation sets out the commitments of the Member States for LULUCF, and the rules for the accounting of emissions and removals from LULUCF and for checking the compliance of Member States with those commitments (Article 1 of the LULUCF Regulation).

Dynamic age-related forest characteristics. The LULUCF Regulation refers to "*dynamic age-related forest characteristics*" (Article 8(5)). In this guidance document, age-related characteristics are understood to refer to the state of 'maturity' of the forest, which can be characterized e.g. with mean age of a stand, its biomass density, and age or diameter class distribution. "Dynamic" is understood to refer to the development of these characteristics over time, such as the movement of a stand from one age or diameter class to another over time.

Forest Management Practice (FMP). Refers to a set of activities being carried out at different phases of the stand development. FMP can thus be seen as a set of activities carried out and aimed at fulfilling specific functions assigned to a forest (production, protection, etc.), including, e.g., the regeneration modality, the species planted, the schedule and intensity of thinning and final cut. Examples of activities are soil preparation and thinning, and many of the activities can be used in many FMPs.

State of the forest. Set of data and information that describe the forest, such as total area of Managed Forest Land; as well as stratum-specific variables, e.g. area, increment, biomass, age-related information.

Stratum. A part of forest (distinguished geographically or grouped across different geographic locations) homogeneous for all the criteria applied to the stratification process (tree species, forest type, management system, ownership, etc.). Each stratum differs from other strata by the value of at least one of the criteria of stratification.

Reference period (RP). The period from 2000 to 2009.

Box 3. Overview of the suggested step-wise approach to implement FRLs and figure highlighting how the steps are suggested to be carried out sequentially

Step 1: Stratify the area of MFL, according to country-defined criteria, and apply the stratification in a consistent manner over time, including the RP 2000-2009.

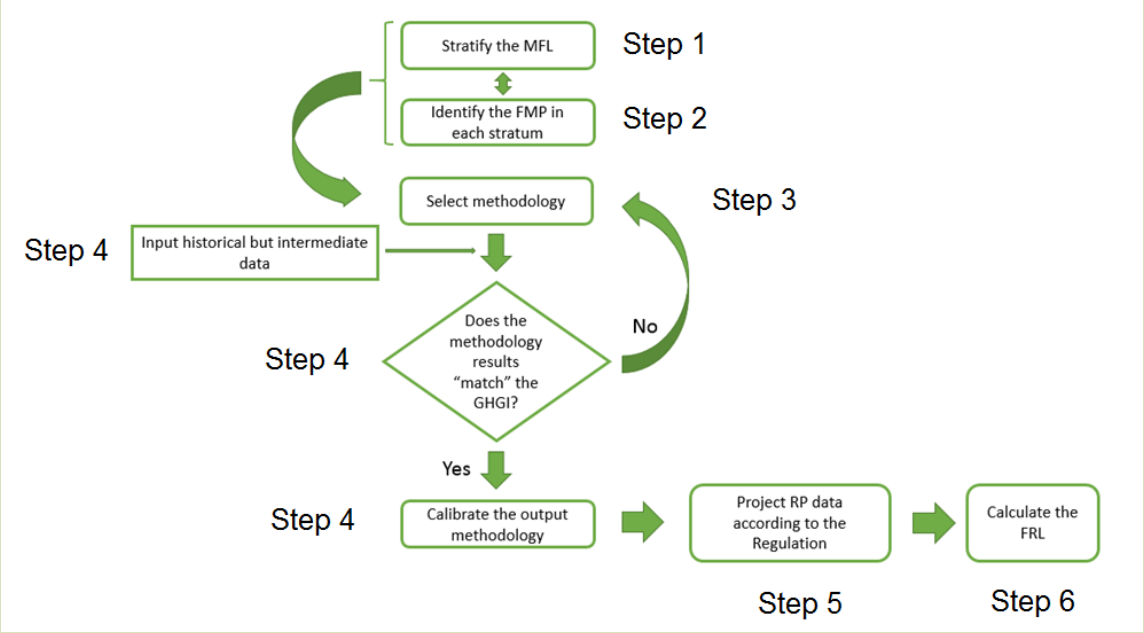
Step 2: Identify and document the FMPs in each strata for the 2000-2009 period, based on country-defined and quantifiable operational criteria.

Step 3: Select the appropriate methodology to project the development of carbon pools based on available data (including strata and management practices described in Steps 1 and 2) and national circumstances.

Step 4: Calibrate the selected methodology based on real observed data and show that the methodology is able to reproduce the GHG Inventory estimates.

Step 5: Project the future development of anthropogenic forest greenhouse gas emissions by sources and removals by sinks for the CP.

Step 6: Calculate the FRLs as average of emissions and removals during 2021-2025 and 2026-2030.



2.1 Stratification

Step 1: Stratify managed forest land

Stratify the area of managed forest land, according to country-defined criteria, and apply the stratification in a consistent manner over time, including the Reference Period 2000-2009.

This subchapter is structured as follows:

2.1.1 Introduction

In this guidance document, we propose to start the preparation of the FRL with stratification, in other words dividing the MFL into classes. The strata defined in the first step will then be used as a basis for defining the FMPs in Step 2.

A **Stratum** (in the context of this guidance document) is a part of forest (distinguished geographically or grouped across different geographic locations) homogeneous for all the criteria applied to the stratification process (tree species, forest type, management system, ownership, etc.). Each stratum differs from other strata by at least one of the criteria of stratification.

Stratification is not an explicit requirement in the LULUCF Regulation. On the other hand, the FRL "*shall be based on transparent, complete, consistent, comparable and accurate information*" (Annex IV.A(h) of the LULUCF Regulation). Clear documentation of the stratification (division of the MFL into classes) helps to make the description of the forests more structured and thus more transparent and easier for reviewing.

Stratification also serves to enhance the reporting and make it easier to understand also for those not familiar with the specific national circumstances: the Member States are hence advised to use stratification principles that best fit to describe the forests and FMPs in the respective countries, instead of adopting a general rule set for stratification. The purpose of the stratification in Step 1 is to document clearly the basis for the allocation of the FMPs on the MFL.

The basis and level of detail for the stratification is likely to depend strongly on the national circumstances and the FMPs applied in the country. FMPs applied in forests primarily used for wood production differ from the practices applied in forests primarily serving for other purposes, such as water protection or recreation. The FMPs may differ in forests on plains and steep slopes, for different tree species mixtures, growing conditions, etc. State and private forest owners may have different FMPs in forests that are similar by the other characteristics. With stratification, such differences can be taken into account by the Member State. In other words, stratification of the MFL serves to provide a basis for distinguishing different types of FMPs.

The LULUCF Regulation also explicitly requests the Member States to "*demonstrate consistency between the methods and data used to determine the proposed forest reference level in the national forestry accounting plan and those used in the reporting for managed forest land.*" (Article 8(5)). This means that where applicable, it is good

practice to use the same principles for the stratification as those used in the GHG inventory (GHGI) or NFI (if the NFI forms the basis for reporting for managed forest land). However, if deemed appropriate and justifiable, the stratification for the FRL may differ from the stratification used in e.g. NFI and may sometimes be partly already implemented in the forest model.

2.1.2 Possible criteria for stratification

Countries may use different **criteria to stratify MFL**, typically including some of the following:

- **Bio-physical context**
  - Geographic part of the country (e.g. North and South)
  - Topography (e.g. plain and mountainous, flat terrain and slope)
  - Bio-geophysical site conditions (e.g. site index)
- **Administrative / legal context**
  - Administrative boundaries (region, province, municipality, etc.)
  - Ownership (private, public)
- **Function and characteristics of forest stands**
  - Functions/objective assigned to forest (timber production, water quality protection, maintenance of habitats, recreation, conservation etc.)
  - Forest Management/ Silvicultural system (coppice forest vs. high forest, clearcut vs shelterwood, etc.)
  - Tree species composition/mixture (forest categories and types, prevailing tree species, mixtures, etc.)
  - Quality of timber produced (sawlogs, pulpwood, firewood)
  - Vulnerability to external disturbances (fire, windstorms, insect outbreaks, etc.)
  - Accessibility (e.g. roads, remote forests)

Examples of possible (but not limited to) **stratification of MFL** in some Member States are presented in the boxes below. Note that these are examples presented previously in the literature, and do not necessarily represent the approach that will be selected by the Member States for the preparation of the FRL.

Box 4: Example of stratification for Finland

For the GHG estimations in the National Inventory Report (NIR), Finland has used stratification by region (south/north), soil (mineral/organic) and species (pine, spruce, deciduous). To cover the peculiarities of forest management in the country in more detail (Yrjölä, 2002), stratification is also possible along the following criteria:

- Southern Finland and Northern Finland
- Different tree species (pine, spruce, silver birch, downy birch, larch, aspen)
- Site classes (OMT - rich, MT - medium, VT - rather poor and CT - poor forest site types and peat soil)
- Main function of forests (timber production, reindeer husbandry, protection, recreation)
- Forest owner

Box 5: Example of stratification for Sweden

In earlier analysis of the forests in Sweden, the following criteria have been used to distinguish the area used for different FMPs (Skogsstyrelsen, 2015):

- Geographic region (a total of 12 regions are being used, each covering a set of counties)
- Forest ownership (non-industrial private owners, other owners (including government, municipalities, church, forest companies))
- Main function of forest (production forest, voluntarily set-aside forests, formally protected nature reserves)
- Forest type, characterized by tree species (Scots pine, Norway spruce, Lodgepole pine, Birch, Other), soil moisture and site index

Box 6: Example of stratification for Croatia

According to description of forests and forest management in Croatia (Law on forests, 2014; Ordinance on forest management, 2015; NIR, 2017) managed forest area in the country can be stratified by the following criteria:

- Main function of forests (commercial, protective, special purpose)
- MFL category (high forests, plantations, forest cultures, plantations, coppices, maquia, shrub, garigue, scrub)
- Management type (e.g. even aged or uneven aged)
- Tree species
- Terrain topography
- Level of fire vulnerability
- Forest owner

Box 7: Example of stratification for France

In France, the following criteria have been used to stratify the forests in order to distinguish the area used for different FMPs (Colin et al. 2016):

- Cultivated poplar stands, other stands
  - Further stratification for cultivated poplar stands based on:
    - Clone group
    - Region
  - Further stratification for other stands based on:
    - Forest cover type
    - tree species
    - Ownership category
    - Biogeographical region

An example of stratification based on the criteria listed in Box 5 for Sweden is presented in Figure 4.

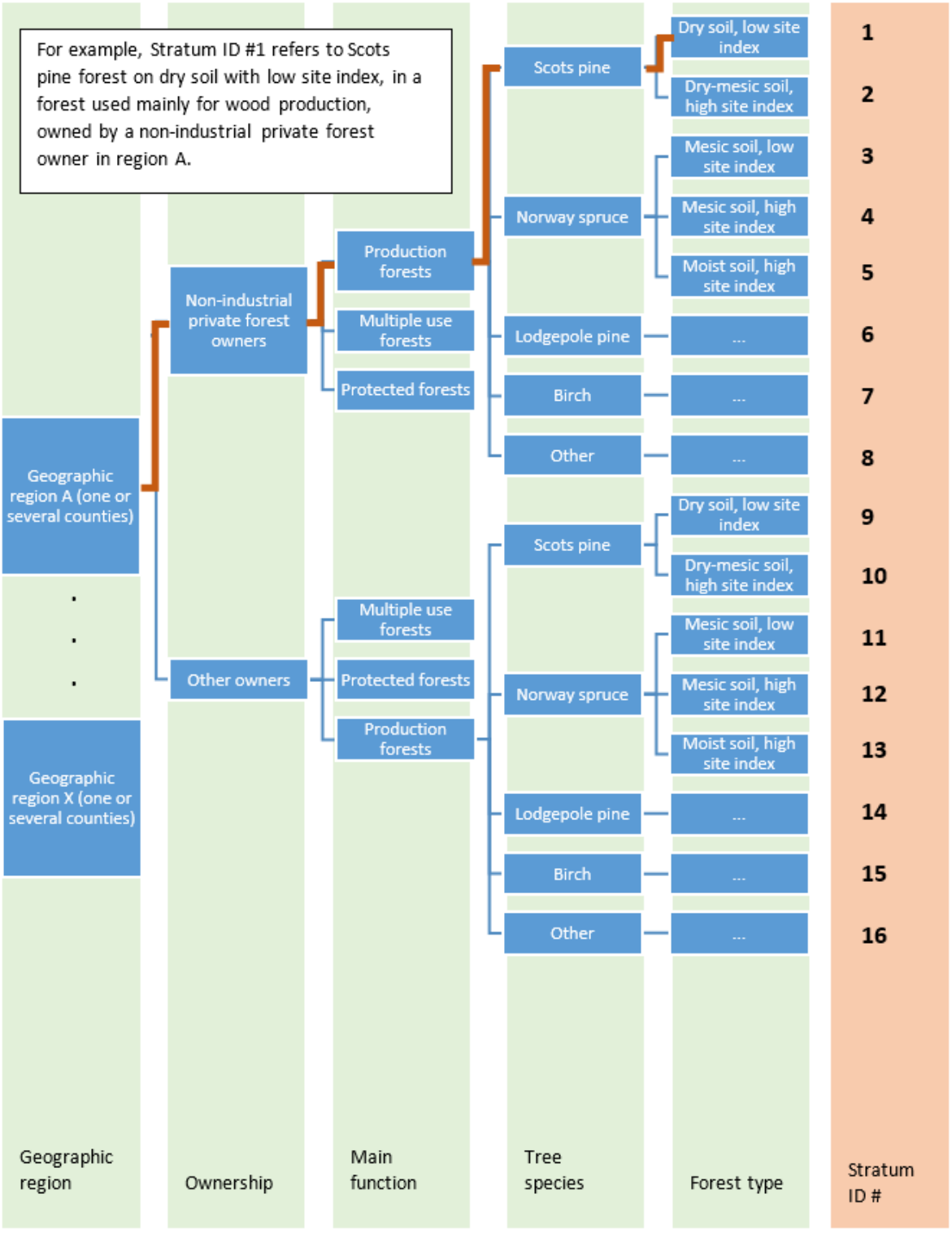


Figure 4. An example of stratification following the criteria presented in Box 5.

2.1.3 Consistency requirements for stratification criteria

The criteria used for stratification are to remain the same in the modelling of historical and projected emission and removals. The number of strata is constrained by available data and method (model) requirements used for estimation of FRL.

We suggest to prepare a list of data necessary for the method chosen for FRL estimation, then check which detailing of stratification still can satisfy the data demand. The level of detail needed for the stratification depends on the method chosen for the FRL estimation, as well as on the available data.

According to Article 8(5) of the LULUCF Regulation, "*The forest reference level shall be based on the continuation of sustainable forest management practice, as documented in the period from 2000 to 2009*". This implies that the FRL is based on the continuation of (documented) sustainable FMPs in the historical RP, and the FMPs considered in the FRL are not projected to change during the CP. Similarly, once the strata are defined and FMPs associated to each stratum, they are expected to not change over CP.

Thus, a stratum is a coherent unit within which no systematic change is expected over time. Hence, it is not good practice to stratify the MFL by criteria that may change relatively fast over time (e.g. age class or harvest volume). The FRL is based on the continuation of (documented) sustainable FMPs as in the period 2000-2009. This in turn means that once the strata are defined and created, and FMPs associated to each stratum, these are expected to not change over the CP. However, the forest within each stratum can be divided further into units for modelling purposes (e.g. the model may be based on age classes). The modelling assumptions are discussed in detail in Step 3 (see chapter 2.3) and assumptions to be taken for the projection of the FRL are further discussed in Step 5 (see chapter 2.5).

It is good practice that the construction of FRL reflects as close as possible any stratification already used in the national GHG inventory or the NFI. This facilitates demonstrating that the model used to construct the FRL is able to reproduce historical data from GHG inventory. It is recommended that any deviation from this good practice is documented and justified by the Member State.

It is also good practice to provide a description of the forest definition used for the construction of FRL and explain whether it differs from that used in the national GHG inventory.

2.1.4 Documenting the strata

It is good practice to document the following information for each stratum:

- Area during the RP 2000-2009.
- Development of age-related forest characteristics during the RP (e.g., area of forest stands in each age class, average above-ground and below-ground biomass in each age class, average diameter in each age class, increments in each age class etc.; for uneven-aged forest the respective information concerns the whole forest instead of age classes) depending on data requirements of the method used for FRL estimation.
- The forest age-related characteristics for the year which is the closest to the starting year of modelling, i.e., 2009, or is representative for the starting year of modelling.
- Species composition.
- Additional forest characteristics relevant to the criteria of the stratification and method used for FRL estimation.

It is important to quantitatively define those forest characteristics which are used in the method selected by a Member State for FRL estimation. The purpose of the documentation is to comply with the requirement of "*transparent, complete, consistent, comparable and accurate information*" (Annex IV.A(h)) and to allow for proper reviewing of the FRL estimation by designated experts. The forest characteristics can be presented in a table or a set of tables. Sources of information used for description of the forest

characteristics are also to be documented. An example of possible table for documenting information sources used for determining forest characteristics in each stratum is Table 2 (a filled in example of Table 2 is presented in Annex III of this document).

Table 2: Example of a table in which Member States may document data sources used as a basis for stratification of MFL. See Annex III of this document for an example of how the table can be filled in.

Forest characteristics	Data references	Stratum ID where the characteristics and reference are relevant
Aboveground biomass		
Belowground biomass		
Area		
Species composition, species X, …n		
etc.		

2.1.5 Additional data

If a Member State does not have all data necessary for documenting the forest characteristics (e.g., based on NFI or other research and monitoring), other published data may be used. Box 8 gives an overview of possible data sources that may be considered. Furthermore, some of the data, e.g. forest age related increments can be approximated with a limited accuracy using forest growth models (e.g. Schelhaas et al., 2018).

Box 8: Examples of possible data sources for complementing national data

- Forest cover maps (JRC; Hansen et al., 2013),
- Maps of forest biomass (Barredo et al., 2012; Gallaun et al., 2010; Kindermann et al., 2008; Thurner et al., 2014),
- Maps of tree species (Brus et al., 2011; JRC; Mauri et al., 2017),
- Maps of wood production (Verkerk et al., 2015),
- Spatial data on logging residues (Di Fulvio et al., 2016),
- Biomass expansion factors (Zianis et al. 2005).

2.2 Forest management practices

Step 2: Description of forest management practices

Identify and describe the forest management practices in each strata for 2000-2009 based on country-defined operational criteria and quantifiable data.

This subchapter is structured as follows:

2.2.1 Introduction

In this Step, the FMPs applied in the period from 2000 to 2009 are described for each stratum (see Step 1) through country-defined and quantifiable operational criteria. Both the qualitative and quantitative aspects of each FMPs are to be documented. In addition, it should be demonstrated how these definitions have been implemented and applied consistently over time for the estimation of the FRL.

The justification for this Step stems from Article 8(5) of the LULUCF Regulation, which states that the FRL "*shall be based on the continuation of sustainable forest management practice, as documented in the period from 2000 to 2009*". As the continuation of sustainable management practice forms the basis for the FRL, it is important that Member States provide a transparent documentation of the FMPs that were applied in the period from 2000 to 2009.

Although Article 8(5) refers to "*practice*" in singular, it is interpreted that depending on the understanding and justification of this term provided by the Member State, the overall FMP within the Member State can also be considered to consist of several different practices, depending on e.g. the stratification of forests to accommodate national circumstances. Nevertheless, the documentation needs to use quantitative criteria, to show that the FRL is "*based on transparent, complete, consistent, comparable and accurate information*", as required by Annex IV.A(h) of the LULUCF Regulation.

It is good practice to describe how large a share of the national forests was covered by a given FMP in the period from 2000 to 2009. It is also good practice that Member States document explicitly the data sources which have been used to identify and specify each FMP.

2.2.2 What is a forest management practice?

In the context of this document, a **forest management practice** refers to a set of management activities (i.e. silvicultural/forestry operations) being carried out at different phases of the stand development.

A FMP can thus be referred to a set of management activities carried out and aimed at fulfilling specific functions assigned to a forest (production, protection, etc.), including,

e.g., the regeneration modality, the species planted, the schedule and intensity of thinning and final cut. Examples of activities are soil preparation and thinning, and more than one activity can be used in different FMPs. If there is a forest management plan adopted by the owner of a stand, then the practices foreseen for each management unit defines the FMPs.

Through these activities, the FMP describes the management throughout the full cycle of the stand development in qualitative and quantitative terms. An FMP describes the origin and development of a forest stand and includes specification of, for example:

- The origin (by seed or vegetative, such as suckers or coppice) of the stand.
- The first activity being carried out (i.e. soil preparation) to the last activity of the cycle (i.e. final cut).
- When trees are harvested (e.g. specific age or dimension).
- Description of the main methods of removing trees. Are all trees removed in one final harvest (e.g. a clearcut), or are trees harvested through selective cutting?
- Description if stumps are being harvested or not.

The outcomes of FMPs are dependent on the environment, the growing conditions and tree species (hence, FMPs are linked to specific strata to reflect how the forest is being managed and the outcome of such managements). A qualitatively similar practice used in one part of the EU can in quantitative terms be different in another environment.

One way to think of a FMP is a comparison to a toolbox: it includes many tools (activities), used in different phases of the stand development. These tools or activities are not unique to a single FMP and they can be used in many FMPs, even in different stages of development (e.g. an activity example is clearcut that could be done in FMP 1 at 50 years and in FMP 2 at 120 years).

2.2.3 Description of forest management practices

It is good practice that the Member States describe in detail the FMPs applied in the MFL in the period from 2000 to 2009. It is good practice to describe the following two aspects for each FMP:

- **Qualitative aspects**: The qualitative information concerning the FMP describes **what** is being done: which activities or operations are carried out for that specific FMP at different phases of the stand development.
- **Quantitative aspects**: The quantitative information concerning each FMP describes **when** and **how** each activity or operation is carried out.

It is good practice to provide the qualitative documentation of each FMP so that it describes the management activities throughout the full cycle of the stand development, starting from the first activity being carried out (e.g. soil preparation) to the last activity of the cycle (e.g. end-of-rotation cutting).

To the extent possible, it is good practice to define when each management activity is being carried out (i.e. the quantitative aspects of the FMP) based on age-related characteristics of a stand. This term can also be understood as the state of 'maturity' of the forest. This links the description of the practices to the requirement in the LULUCF Regulation to "*take account of the future impact of dynamic age-related forest characteristics*" (Article 8(5)), and contributes to providing a transparent basis on showing that the FMP projected for the future is truly "*continuation of sustainable forest management practice*" (Article 8(5)) as documented in the RP, and not a change in FMP. The definition of when each activity is being carried may also be linked to variables describing the state of the forest (see Box 9).

Box 9: Examples of variables that may be used to define when and how each activity or operation is carried out.

Examples of variables describing the state of the forest:

- Total area of MFL
- Stratum-specific variables:
  - Area of stratum
  - Mean age
  - Mean biomass volume
  - Number of seedlings/trees
  - Basal area
  - Crown cover
  - Mean diameter
  - Volume class of the growing stock
  - Stocking level

Examples of age-related characteristics that describe the maturity of the stand:

- Mean age of the stand
- Mean diameter of the stand
- Mean volume of growing stock

Examples of operations characterizing forest management practice, linking the state of the forest and the timing of the operation:

- Pre-commercial thinning when the stand is 10-15 years old
- Pre-commercial thinning when trees reach the diameter class (Dbh) of 10-15 cm
- Thinning when the basal area exceeds 18 m^2/ha and the age exceeds 30 years

It is not good practice to define when each activity is being carried out based on assumptions or projected sources of information such as future wood price development, interest rates, net present value estimates, or expected demand for wood for energy and material purposes. See Figure 5 for an overview of good practice and not-good practice examples of criteria that may be used to define when each activity is being carried out.

When documenting the FMPs, it is good practice to describe as closely as possible the **management practices that actually took place during RP**, and not the management that was expected, what was legally allowed during the RP, or the best possible management of the forest would have been. The aim is indeed to describe as accurately and precisely as the management practices that were actually carried out during the RP. This information will then be the basis to model the continuation of management practices documented in the RP in the period from 2021 to 2030.

When documenting the FMPs in a Member State, it is not good practice to distinguish different FMPs (or management activities) only based on a criteria that has a large annual variability (i.e. rotation). As an example, it is not considered good practice to define one FMP (FMP 1) for which the final cut takes place when the trees are 81 to 82 years old, a second practice (FMP 2) for which the final cut takes place when the trees are 83 to 84 years old, a third practice (FMP 3) for which the final cut takes place when the trees are 85 to 86 years old, and so forth. A single FMP may instead cover a wider range of criteria for it to encompass and cover such annual fluctuations.

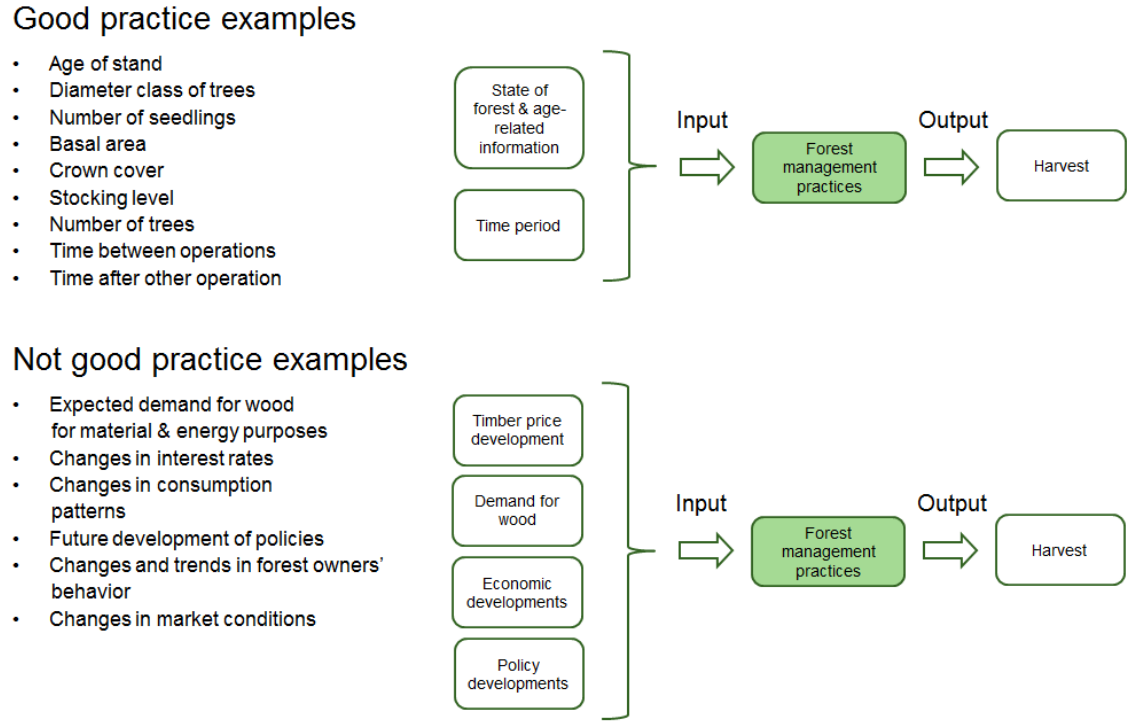


Figure 5: 'Good practice' and 'not good practice' example of criteria's that may be used to define when a management activity within a FMP is being carried out.

2.2.4 Documentation of forest management practices

Since the documentation of current FMPs should reflect the country's circumstances appropriately, a large degree of flexibility can be applied to the documentation, as long as (i) the criteria/values (or similar indicators) used are transparently documented and their rationale illustrated, and (ii) the same FMPs are applied consistently when projecting the FRL (see Step 5).

Here, we give two alternative examples on how to document FMPs: describing the FMPs through forestry activities (Alternative 1), and describing the FMPs by biomass removal percentage within an age or diameter class (Alternative 2).

2.2.4.1 Alternative 1: Describe FMPs by management activities

As a first step, it is suggested to provide a qualitative description of the FMPs as applied during the RP. In this step, the aim is to describe each FMP in terms of the associated set of management activities (i.e. silvicultural/forestry operations) to be carried out. One alternative approach to document the qualitative information of the management practices is shown in Table 3.

It should be noted that Table 3 is only an example of how the qualitative aspects of the FMPs can be documented and Member States are free to adopt the table as they see fit to fully reflect the country's circumstances.

Table 3: Example of how Member States may describe the qualitative aspects of the FMPs as applied in the Member State during the RP. See Annex III of this document for an example of how the table can be filled in.

Forest Management Practice			
Index	**Name of Practice**	**Short Description of Practice**	**Data source for practice**
FMP 1	Pine clearcutting	Even aged pine forest with long rotation and regenerated by clearcut	NFI
FMP 2	Spruce clearcutting	Even aged spruce forest regenerated by clearcutting	NFI
FMP 3	Pine uniform shelterwood	Even aged pine forest regenerated with consecutive cuttings applied on the whole area	NFI
FMP 4	Close to Nature Forest	Forest with close to nature management and minimal intervention	NFI
...	...	...	...

After the qualitative description of each FMP has been defined, it is good practice to document the specific characteristics of each FMP. In such tables, it is good practice to provide quantitative information about each FMP, thereby defining when each activity is being carried out.

It good practice that the description documents: (i) how is each activity performed, and (ii) when is each activity being carried out. It is good practice to document the characteristics of each management practice as precise as possible to facilitate the modelling of the management practices and to clarify the difference between the management practices. It is important that Member States also provide quantitative information for each activity criteria so that they can be modelled and applied to estimate the projection of the FRL.

One alternative approach to document the quantitative information of the management practices is shown in Table 4 and Table 5. These two tables show an example of how the FMPs can be documented according to two broad categories of management: the management practices based on clear-felling (even-aged forest) (see Table 4), and the management practices without clear-felling (uneven-aged forest) (see Table 5). Member States should note that Table 4 and Table 5 are only examples of how Member States may document the quantitative aspects of the FMPs. Member States are free to adapt Table 4 and Table 5 as they see fit to fully reflect country specific circumstances.

Table 4: Example of how to quantify each FMP in terms of its management activities (silvicultural/forestry operations). In this table only the FMPs that include a final harvest of the forest is described. The same Index and name of FMPs as set out in in Table 3 are applied. Each activity (i.e. silvicultural/forestry operation) should be defined and reported in terms of two aspects: I) the criteria for when the operation is carried out (e.g. at a specific minimum age, time interval, or a specific diameter class (Dbh)); II) the percentage of living biomass removed. See Annex III of this document for a detailed example of how the table can be filled in.

Forest Management Practice		Silvicultural operations with final harvesting							
		Pre-commercial thinning		First commercial thinning		Second commercial thinning		Final cutting	
Index	Name of Practice	Age (yrs) or Dbh (cm.)	% biomass harvest	Age (yrs) or Dbh (cm.)	% biomass removals	Age (yrs) or Dbh (cm.)	% biomass removals	Age (yrs) or Dbh (cm.)	% biomass removals
FMP 1	Pine clearcutting long	>10	15%	>20	15%	N.A.	N.A.	120 - 140	95%
FMP 2	Spruce clearcutting	>10	15%	>20	15%	N.A.	N.A.	80-100	95%
FMP 3	Pine uniform shelter wood	N.A.	N.A.	>20	15%	>30	15%	80-120	95%
...	...	...	...	...	...	...	...	...	...

Table 5: Example of how to quantify each national FMP in terms of its description of its management activities (silvicultural/forestry operations). In this table, only the FMPs without final harvesting of the forest is described. The same Index and name of FMPs as set out in in Table 3 are applied. See Annex III of this document for a detailed example of how the table can be filled in.

Forest Management Practice		Silvicultural operations without final harvesting	
Index	Name of Practice	Years between two subsequent operations (yrs.)	% biomass removals
FMP 4	Single tree selection	15-20	15%
...	...	...	...

After the qualitative and quantitative aspects of each FMPs have been documented, it is good practice to document the use of FMPs according to the stratification of the forest land, as developed in Step 1.

One example of how this can be documented is shown in Table 6. The main aim of documenting the use of management practices in different strata is to clarify in which stratum the management practices are being implemented and to provide clear indications about the difference between strata in term of how they are being managed.

Table 6: Example of how to document the percentage distribution of FMPs for each stratum of the country. Member States are encouraged to amend the table according to the number of strata defined in Step 1, and the number of FMPs as defined in Table 3. For each stratum, the sum over the percentage distribution of FMPs should sum up to 100% and should be indicated in the row called Sum Total (%). See Annex III of this document for a detailed example of how the table can be filled in.

Stratification of MFL			% distribution of FMPs					Sum Total (%)
Strata categorization level I	Strata categorization level II	...	FMP Index 1	FMP Index 2	FMP Index 3	FMP Index 4	...	
Type I (e.g. Private commercial forest owners)	Type I (e.g. Pine)		85%	0%	0%	15%		100%
			75%	0%	0%	25%		100%
	Type II (e.g. Spruce)		0%	100%	0%	0%		100%
			0%	82%	0%	0%		100%
	Type III (e.g. Birch)		...	...	...	...	...	...
	Type IV (e.g. Aspen)							
Type II (e.g. State owned forest)	Type I (e.g. Pine)							
	Type II (e.g. Spruce)							
	Type III (e.g. Birch)							
	Type IV (e.g. Aspen)							

2.2.4.2 Alternative 2: Describe FMPs by biomass removals in forest age or diameter classes

A second alternative to describe the FMPs is to define the biomass removal as a function of the age and state of the forest (e.g. age class, diameter class). This is slightly different from Alternative 1, in which the FMP are mainly documented according to the biomass removal for each specific management activity. In Alternative 2, the biomass removal (e.g. the % removal of the growing stock) is not defined according to each specific activity, but directly as a function of the age and state of the forest. As such, the difference between Alternative 1 and Alternative 2 is only in terms of how the FMPs are documented.

Similarly to Alternative 1, it is good practice to document both the qualitative and the quantitative information of the each FMP. Alternative 2 is largely based on well-established and available references of the descriptions of the FMPs, while Alternative 1 may be better suited for situations where earlier documentation is poor or does not exist.

Table 10 gives a possible example of how to document the qualitative description of the FMPs. Compared to Alternative 1, this example relies heavily on other documentation, and only provides overall principles of the FMPs. To ensure transparent documentation of the practices, careful and complete references to published documentation are here essential.

Table 7: Example of a qualitative description of FMP, following Alternative 2.

Forest management practice		
Index	**Short description of practice**	**Determination of the actual biomass removal rates**
FMP_{spruce}	FMP_{spruce} consists of soil preparation through scarification, planting of seedlings, pre-commercial thinning of young stands, one to three thinnings over the rotation period, and a final harvest through clearcutting. The harvest schedule and biomass removals in harvests are regulated by Forest Law (please provide reference here), and guidelines for good FMP.	The biomass removals used in the FRL are based on observations of actual harvests in the period 2000-2009. The biomass removal as a % of growing stock is determined through calculating harvest probability for a given age class using the method described in (please provide reference here).
…	…	…

Table 8 provides an example of the quantitative details to document the FMPs within Alternative 2. The rationale behind this description of FMPs is to identify as accurately as possible the characteristics of FMPs that affect the emissions and removals of GHGs from the forests. In this respect, it is good practice that the stratification of the forests (see Step 1) includes at the minimum differentiation between tree species or species groups, and geographic regions in cases where it has a clear impact on forest growth. Given that the FRL shall "*take account of the future impact of dynamic age-related forest characteristics*" (Article 8(5)), it is good practice to define the harvest removals or removal probabilities based on age-related characteristics such as age or diameter classes, seeking to provide as accurate and complete information on the FMPs as possible.

Table 8: Example of how to quantify each national FMP in terms of the percentage of biomass removal of the total growing stock in a certain age or diameter class, following Alternative 2.

	Biomass removal as a % of growing stock within each age or diameter class					
Age (or Dbh) class **Index**	**0-20**	**21-40**	**41-60**	**61-80**	**81-100**	**…**
FMP_{spruce}	50%	20%	35%	0%	45%	…
…	…	…	…	…	…	…

2.2.5 Implementation of forest management practices

Some models used for the projection of the FRL may require that each management activity takes place at a specific timing of a criteria (i.e. final clearcutting takes place when the stand is 85 years old) instead of a range for a criteria (e.g. final clearcutting takes place when the stand is 80-100 years old). As such, the timing of when an activity is to be carried out may have to be set according to a single static value (or a criteria).

If such a static value is selected, it is good practice that Member States do so based on the range during which the activity was implemented during the RP.

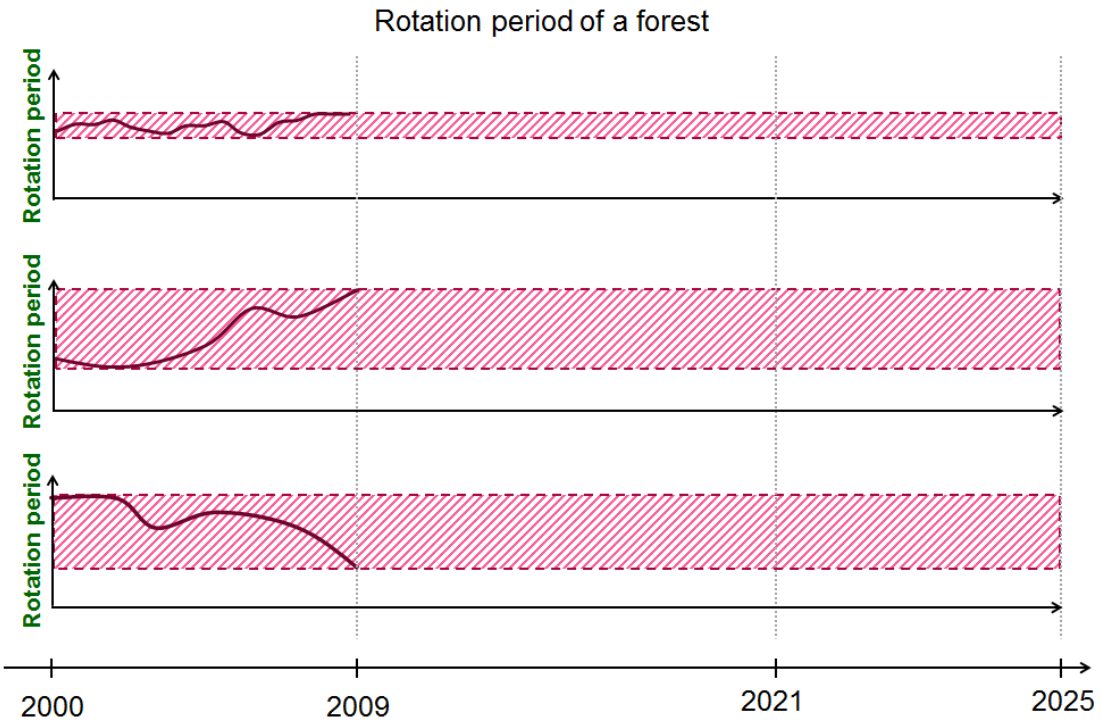


Figure 6. Three examples of historical trends in the timing of a management activity for an FMP. The solid line shows the historical values as documented for the period from 2000 to 2009. Shaded area shows the minimal and maximal range of the operation criteria as observed for the period from 2000 to 2009.

When deciding upon the definition of the exact criteria for when an activity is to be carried out, **it is good practice that the minimum and maximum values of when the activity was carried out during the RP sets the boundary conditions for when the activity is to be carried out during the CP**.

In other words, the static value for when the management activity (silvicultural/forestry operation) does take place is to be selected by the Member State, but is not to deviate from the values observed during the RP.

This implies that even if a trend in when an activity is carried could be observed and documented during the period from 2000 to 2009 (e.g. that the final clearcutting is taking place earlier in 2009 than in 2000), **it is good practice that such trends are not projected to continue during the CP and to confirm this in the documentation**.

Because of the inter-annual variability, it is deemed to be good practice to define the FMPs based on data across a period of time, instead from a single year as for other GHG categories. That is, if a quantifiable variable used to describing when a FMP is carried out (for example rotation period) varies within a specific range during the RP and no clear trend can be established, then the average value for the RP can used to quantify the FMP (see top example in Figure 6). However, if the quantifiable variable does now follow a trend and varies or changes its value abruptly during the RP, then it can be justified that the latest value is applied to characterize the FMP (see middle and bottom examples in Figure 6).

Consequently, it is good practice that each FMP is quantified according to a single and static value (or criteria) that describe when it is carried out, not by a trend nor by a rate of change.

2.2.6 Possible data sources for documenting forest management practices

Numerous Member States have long time series of information concerning the state of their forest from the NFIs. NFI usually provides data concerning the state of the forest at a given time, and a comparison of NFI plots from two different points can be used to derive information on yields and removals. All such information may be already used for GHG reporting, and hence considered also as input data for the construction of the FRL. For example, information on the FMPs that were applied in the period from 2000 to 2009 can be derived through a comparison of permanent inventory plots between years.

NFI data commonly has the disadvantage that it does not provide information about the management purposes, but only that a specific management practice has taken place. For the purpose of defining the FMPs and filling in the Table 3 to Table 8, this is not a problem as the FMPs should be defined according to the management that took place. Other data sources than NFI may of course also be used to define the FMPs, such as forest laws and other legal documents, forest management guidelines, and forest management plans.

When documenting the FMPs, **it is good practice that Member States only use data sources from the period 2000 to 2009**, as required in the LULUCF Regulation. This is the case as the Article 8(5) states that "*The forest reference level shall be based on the continuation of sustainable forest management practice, as documented in the period from 2000 to 2009*".

A challenge when applying NFI data to document the FMPs may be that the inventory period may not match with the requirement of using data that was documented in the period from 2000 to 2009. In many EU Member States, the inventories take place over several years, and the inventory periods may not be compatible with the RP of 2000 to 2009. For instance, as illustrated in Figure 7, a Member State may perform the forest inventories based on a five-year cycle, meaning that each year 1/5 of the sample plots are measured. Furthermore, in this example, the total estimates as reported in the year 2005 are based on the inventories carried out during the period 2003 to 2007.

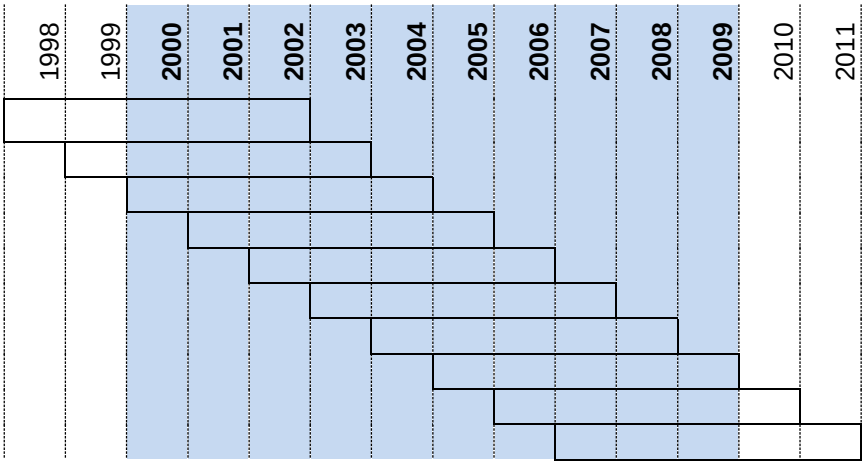


Figure 7. Example of an NFI where the inventory follows a running five-year average, reported in year X. In this example, the NFI as reported in the year 2000 is based on inventories carried out during the period 1998 to 2002.

In this example, it would be good practice that only the sample plots measured in the time period from 2000 to 2009 (shaded in blue) would be used for the documentation of the FMPs. In other words, it would be the reported total estimates for the period of 2002 to 2007 that would be used for documenting the FMPs.

However, it is likely that most Member States do not have such detailed inventory information available of their forests, and in some cases the NFI period may be completely outside the RP. If data sources outside the period from 2000 to 2009 are used, it is good practice to document and justify this deviation. Also, if this is the case, it is good practice to document an assessment of the impact of this deviation on the FRL.

The use of all available data sources on FMPs to construct the time series of management practices is certainly good practice as it integrates all available information. It is good practice to document which data sources have been used to specify the FMPs and justify why these sources have been used.

In the worst case, no information may be available or suitable for the description of specific FMPs. In such cases, expert judgement may be carried out on the basis of knowledge gained concerning country specific FMPs that are being carried out. While the judgement by experienced experts may be essentially of good quality, it is difficult to verify. This is why expert judgement should be the last alternative as an approach. If expert judgement is carried out, it is highly recommended that the "elicitation protocol" from the IPCC Guidelines for expert judgment is being followed.[22]

2.2.7 Sustainability of forest management practices

According to the LULUCF Regulation, the FRL "*shall be based on the continuation of sustainable forest management practice, as documented in the period from 2000 to 2009*" (Article 8(5)). Concerning sustainability, it can be noted that the preamble (recital 16) of the LULUCF Regulation refers to the principles of sustainable forest management as adopted in the Ministerial Conferences on the Protection of Forests in Europe ('Forest Europe'). According to Forest Europe, a forest management is defined sustainable if it maintains "*(forest) biodiversity, productivity, regeneration capacity, vitality and (forest) potential to fulfil, now and in the future, relevant ecological, economic and social functions, at local, national, and global levels, and does not cause damage to other ecosystems*".

It is good practice that Member States documents in a transparent manner how the principles of sustainable forest management practice are being applied within their country. It is good practice to provide a short documentation that clarifies highlights what is defined as a sustainable forest management practice and how such principles are being enforced through means such as national regulations, forest certification and endorsements of specific criteria's and principles.

If a forest management practice that was implemented during the RP is deemed by a Member State not to fulfill the criteria of being a sustainable forest management practice, it is good practice that the Member States:

- Document the previous forest management practice (see Step 2.2.4) as deemed to be a non-sustainable forest management practice.
- Document and justify why the previous forest management practice is deemed as a non-sustainable forest management practice. Such documentation should include a description of what principle(s) of sustainable forest management practice that the previous practice disregards or is in violation of.
- Document the new forest management practice (see Step 2.2.4) that is assumed to replace the previous non-sustainable forest management practice.
- Document and justify why the new forest management practice provides an improvement in terms of sustainability and why it is a sustainable forest management practice.

22 See IPCC, 2006; Volume 1, Annex 2.1 for further guidance. Available online at: https://www.ipcc-nggip.iges.or.jp/public/2006gl/

Only when all the above mentioned aspects have been transparently documented and justified can the new forest management practice be considered for the projection of the FRL.

2.2.8 Adaptation of forest management practices to statistical harvest levels

To complement NFI data and to acquire missing information (e.g. thresholds for operational criteria as defined in Table 4 and Table 5) modelling exercises may also be employed. As it is good practice to describe the FMPs as closely as possible to the management practices that actually took place during RP, such approaches may also be used to refine the quantitative aspects of the FMPs have been defined and documented.

A first example of such an approach is to derive the average threshold (or distribution function) for when a management activity is carried out (e.g. age to perform the final cutting) through combining the historical harvest levels with the age structure[23]. Through combining such data sources, information can be derived to assist the specification of the specific criteria of each FMP.

A second example of such an approach is based on obtaining harvest rates by stratum and age[24] during the RP and compares those to the outcome of the FMPs. The harvest of each stratum based on 2000-2009 data should reflect the harvest as a result from implementing the FMP during the same years. If only total harvest (or aggregated harvest) is available, it is suggested to disaggregating that data by stratum and age based on bibliographical information describing the FMP regarding theoretical harvest by area for each stratum and age.

Using this information and the areas in the RP, a theoretical harvest can be estimated and compared with the statistical harvest. This ratio between the estimated and the statistical harvest can be used improve upon the parameterization of the FMPs.

The suggested procedure is as follows:

1. Obtain the total statistical harvest for each year of the RP (TSH_{RP}).
2. Using the FMPs as defined and documented in Step 2, estimate a theoretical harvest by area for each stratum and age ($THbA_{RP}$).
3. Multiply the area of each stratum in the RP (A_{RP}) by the theoretical harvest by area ($THbA_{RP}$) to obtain a theoretical total harvest (TTH_{RP}).
4. Verify the difference between the theoretical total harvest (TTH_{RP}) and the statistical harvest (TSH_{RP}).
5. Adapt the parameterization of the FMPs so that the theoretical total harvest (TTH_{RP}) matches the statistical harvest (TSH_{RP}).

23 An example of such an approach is described in: http://publications.jrc.ec.europa.eu/repository/handle/JRC106814
24 Age should be understood as 'maturity' parameter. In case of uneven forest, it can be replaced by the volume classes of growing stock or the mean diameter.

2.3 Methodology

Step 3: Selection of appropriate methodology

Select the appropriate methodology to project future development of anthropogenic forest GHG emissions by sources and removals by sinks based on available data and national circumstances.

This subchapter is structured as follows:

2.3.1 Introduction

This part of the guidance document provides information on how to select the appropriate methodology to project the development of carbon stocks in the carbon pools in the CP based on the continuation of the sustainable FMPs of the RP regarding dynamic age-related forest characteristics in national forests, using the best available data.

The objective is to estimate future development of the MFL carbon pools in the CP in line with the stratification developed in the Steps 1 and the FMPs as defined in Step 2. It is important to point out that the set of strata and FMPs must consider all the variables needed in the methodology for the estimation of the FRL projections selected in this Step 3.

Finally, it is important to point out that despite a unique methodology could be used for all strata and FMP, a Member State may use different methodologies to project the different strata and FMP, so they can take into account the differences in management practices and forest composition. For example, a forest model could be used for the commercial forest whilst other strata (e.g. protected national parks) could be estimated based on a completely different methodology. As changes between strata/FMP are not allowed (see next section), the use of different methodologies presents no further problems, meanwhile the methodologies results are consistent with the ones presented in the GHG inventories (see Step 4 below).

It should be mentioned that the natural disturbances estimation requires special consideration, and detailed information on the possible approaches to include the natural disturbances in the FRL estimation is included in his section (see 2.3.6). Additionally, further information on the treatment of the HWP pool is included also provided in this section (see 2.3.5).

For the estimation of the FRL, two sets of input data are foreseen to be required by a model for projecting the FRL for the CP:

a) Data describing the **state of the forest** for each stratum (e.g. area, increment, biomass volume…).
b) Description of the **FMPs** in 2000-2009 for each stratum.

According to the LULUCF Regulation, the methodology used for projecting the FRL needs to model "*continuation of sustainable forest management practice […] with regard to dynamic age-related forest characteristics*" (Article 8(5)). To comply with this, in most cases, the methodology will need to take into account the stratification previously introduced in Step 1, the FMPs introduced in Step 2, and the age-structure development of the forest.

2.3.2 What is fixed and not fixed?

The LULUCF Regulation lays out rules and criteria that need to be taken into account when choosing methodology and data for the estimation of the FRL. Most importantly, the projections need to be made with attention to the terms used in Article 8(5): "*continuation of sustainable forest management practice*", which implies that variables and parameters describing the FMPs need to be fixed to the RP level in the projections over the CP, while "*regard to dynamic age-related forest characteristics*" implies that the age structure of the forest should not be fixed over the CP.

For this reason, all variables and parameters directly related to the description of the FMP (e.g. which management activities are included in an FMP, when and how each activity is carried out) and the criteria used to stratify the MFL (e.g. geographic part of the country, ownership, tree species) need to remain constant throughout the CP. A change in these aspects would indicate a change in the FMP during the CP, and is not to be included in the FRL.

In other words, **it is good practice that all information and descriptions regarding the FMPs remains unchanged throughout the CP**. It is important to note that only the FMPs that were implemented in the period from 2000 to 2009 are to be applied in CP for the estimation of the FRL.

Additionally, it is good practice that the area of land allocated to each stratum and FMP remains constant from the **starting year of the projection** onwards (thereby not extrapolating any possible trends observed historically into the future).[25] Any deviation in terms of area allocation would be considered as a change in management, and is as such not good practice to include in the projection of the FRL.

On the other hand, **it is good practice that the dynamic age-related characteristics[26] of the forest do not remain fixed throughout the CP**, meaning that the age structure of the forest is modelled to develop over time. This allows to "*not unduly constrain forest management intensity as a core element of sustainable forest management practice*" (Article 8(5)). For example, the total annual area of clearcuts may vary between years and also differ between the RP and CP. As a consequence, the total harvest volume may vary between years in the CP (i.e. it is dynamic), and may also differ from the total harvest volume during the RP.

Therefore, it is good practice that the selected model takes into account the age ('maturity') distribution within each stratum (usually age or diameter class distribution) in a way that allows for age structure to change over time. Here, with 'age structure' we mean the area of forest in each age class. This means that while the total area of land allocated to a certain stratum-FMP combination remains fixed, area of each age class within a stratum-FMP combination may change over time (i.e. forest hectares will move from one to another age class, while the stratum-FMP description does not change).

25 with the possible only exception of conversions to/from forest (See Section 2.5.3).
26 It is important to point out that the references to age, age class, age structure should be understood as the state of 'maturity' of the forest. In the case of even-aged forest, the age of the stratum could be used. However, in case of uneven-aged forest, it will correspond to the current average "size" of the forest, and it is described by parameters different than age (e.g. dbh, mean diameter, volume classes of growing stock, etc.).

However, the parametrization of the model with regards to the characteristic of each combination of stratum, FMP and age class (e.g. growth or mortality functions) should not be changed in the projections.

Therefore, all parameters related with the amount of wood harvest by performing a specific management activity within a FMP (i.e. implementing an option covered by an FMP) are to remain constant throughout the CP[27]. That is, the outcome of performing a specific management activity is fixed for each specific combination of stratum, FMP and age class. However, as the age structure of the forest may change over time (to take into account the age dynamic characteristics), the total volume of wood harvested is not fixed in the CP.

Table 9 summarizes the main variables and parameters needed for the modelling of the GHG emissions and removals, and indicates which are to be fixed over the CP, and which are allowed to be dynamic over time.

Table 9. Types of data according to the methodology.

Input data	Data fixed in the CP	Dynamic data in the CP	Final output
FMP	**FMP**		
Silvicultural/forestry operations	Silvicultural/forestry operations		
Harvest (% of biomass)	Harvest (% of biomass)		
How each operation is carried out	How each operation is carried out		
		Area harvested	
Stratum-FMP combination			
Total area of the stratum-FMP	Total area of the stratum/FMP		
Age structure within a stratum-FMP		Age structure within a stratum/FMP	
State of forest	State of forest		
		Total volume of wood harvested	
			Variations in living biomass, soil organic carbon and dead organic matter pools

27 With the possible only exception for models that account for climate change (see Step 5).

2.3.3 Requirements for the selected methodology

The methodology as selected by the Member State needs to be able to:

- Not allow changes in the fixed variables.
- Estimate the evolution of the dynamic variables.
- Estimate the C pool variations.
- Estimate the changes in the HWP pool.

So, it is good practice that the methodology is able to estimate the dynamic data, based on input data:

- The age structure.
- The total wood harvested.

Finally, based on fixed and dynamic data, it is good practice that the methodology also is be able to estimate:

- The C pool variations.
- The changes in the HWP pool.

Hereafter, we provide a proposal for a subdivision of the previous estimation procedure in what we will be refer to as 'modules':

- **Age structure module**: models the dynamic of areas within a stratum/FMP;
- **Harvest module**: models the total volume of wood harvested;
- **C pool variation module**: would use the outputs of the previous models (dynamic variables) and the fixed variables to estimate the variations in the carbon pools.
- **HWP module**: would use the total volume of wood harvested to estimate the variations in the HWP pool

The following figure shows the structure of the FRL methodology:

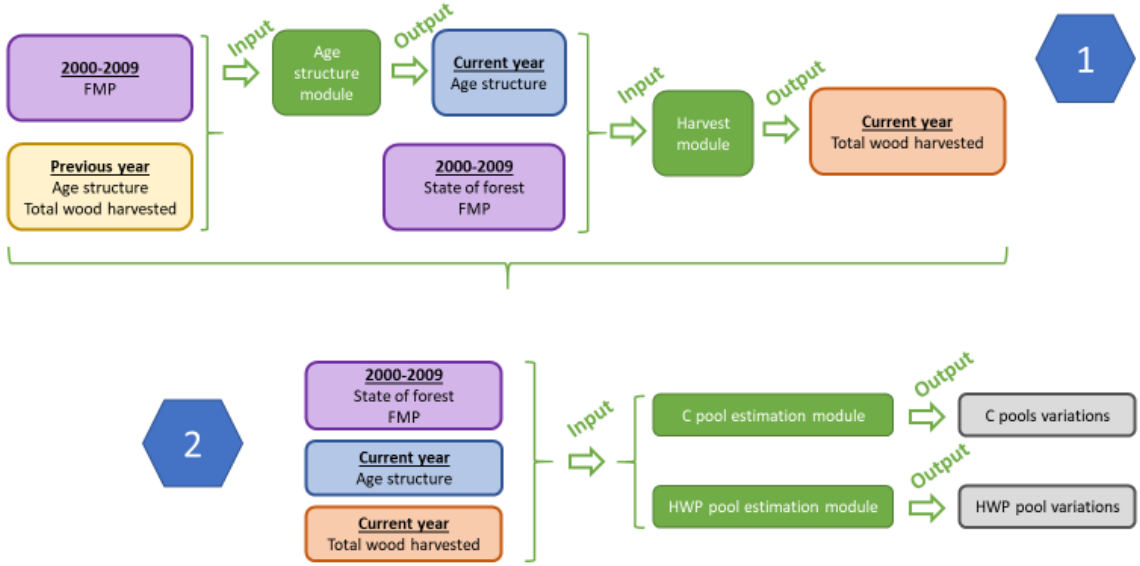


Figure 8: Methodology structure.

2.3.4 Modelling carbon pools in forest

As explained in the previous section, the methodology could use three modules for estimating the dynamic variables and, therefore, the variations in the C pools of the forest. The characteristics of each of these modules will not be described in more detail in this section.

2.3.4.1 Age-structure module

This module is aimed to predict the next year age-structure of forest, based on the information of the current year age-structure and FMPs.

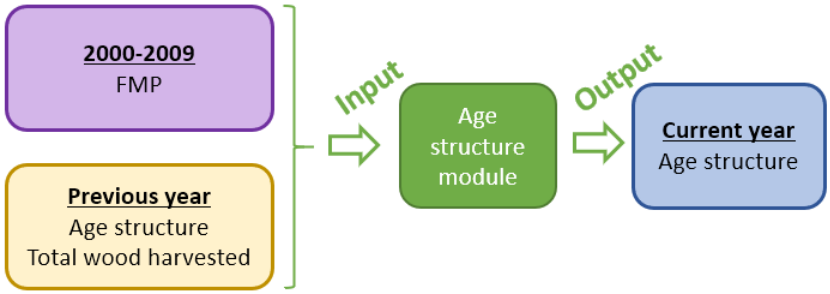


Figure 9: Age-structure module description.

For age-classes based on years, the module only needs to move forward in time the areas from one each class to another based on the number of years projected and the possible losses. In case that the age distribution within each age class is not known, it is good practice to assume that the distribution is uniform (i.e. the area of forest is the same for all ages included in the age-class, e.g. if 40 kha are allocated in the age class “21-40 y”, then it is assumed that 2 kha are 21 years, 2 kha are 22 kha…).

However, if the age classes are based on volumes or dbh, the age-structure model has to be able to estimate the yearly amount of increase of those variables to model the changes between age classes over the years.

In order to model these changes of area, the Member State could use a forest management probability matrix that matches the development of volume in each age class during the RP, thereby describing the forest management as was applied during the RP. As already explained, this forest management probability matrix has to be develop for each stratum-FMPs combination, as defined in Steps 1 and 2.

The basic idea behind this approach is that a country would use inventory data and the matrix approach to calibrate historical harvest to the management actually taking place in the inventory plots. Once calibrated, this same parametrization could be applied to the CP.

Box 10. Examples of changes in the age structure distribution estimated by the age-structure module.

Year i areas by strata/FMP/age class

Strata/FMP	Age classes/Area (kha)				
Pine commercial/FMP1	**0-20 y**	**20-40 y**	**40-60 y**	**>60 y**	**Total**
	60	50	80	20	210
Pine conservation/FMP2	**0-30 y**	**30-70 y**	**70-100 y**	**>100 y**	**Total**
	10	30	60	20	120
Mixed Forest centre/FMP3	**0-50 m3/ha**	**50-150 m3/ha**	**150-250 m3/ha**	**>250 m3/ha**	**Total**
	30	30	25	20	105
Mixed forest south/FMP4	**0-50 m3/ha**	**50-100 m3/ha**	**100-200 m3/ha**	**>200 m3/ha**	**Total**
	60	50	40	20	170
Eucalyptus plantation/FMP5	**0-10 y**	**10-20 y**			**Total**
	20	30			50

Combined with the activities of the FMP by strata/FMP/age class

Strata/FMP	Age classes			
Pine commercial/FMP1	**0-20 y**	**20-40 y**	**40-60 y**	**>60 y**
	No cut	No cut	No cut	Cut (30%)
Pine conservation/FMP2	**0-30 y**	**30-70 y**	**70-100 y**	**>100 y**
	No cut	No cut	No cut	No cut
Mixed Forest centre/FMP3	**0-50 m3/ha**	**50-150 m3/ha**	**150-250 m3/ha**	**>250 m3/ha**
	No cut	No cut	Thinning (10%)	Thinning (20%)
Mixed forest south/FMP4	**0-50 m3/ha**	**50-100 m3/ha**	**100-200 m3/ha**	**>200 m3/ha**
	No cut	No cut	Thinning (5%)	Thinning (15%)
Eucalyptus plantation/FMP5	**0-10 y**	**10-20 y**		
	No cut	Cut (at 20y)		

Note: *More detailed information in the activities composing a FMP has to be given (this only focus on harvest, but it is not the only variable)*

Produce the Year i+1 areas by strata/FMP/age class

Strata/FMP	Age classes/Area (kha)				
Pine commercial/FMP1	**0-20 y**	**20-40 y**	**40-60 y**	**>60 y**	**Total**
	62	51	76	21	210
Pine conservation/FMP2	**0-30 y**	**30-70 y**	**70-100 y**	**>100 y**	**Total**
	5	30	60	25	120
Mixed Forest centre/FMP3	**0-50 m3/ha**	**50-150 m3/ha**	**150-250 m3/ha**	**>250 m3/ha**	**Total**
	28	29	27	21	105
Mixed forest south/FMP4	**0-50 m3/ha**	**50-100 m3/ha**	**100-200 m3/ha**	**>200 m3/ha**	**Total**
	55	52	42	21	170
Eucalyptus plantation/FMP5	**0-10 y**	**10-20 y**			**Total**
	22	28			50

2.3.4.2 Harvest module:

The aim of this module is to estimate the total volume of wood harvested, based on the current year age-structure (dynamic) and the FMP (fixed). It has to take into account all kinds of harvesting practices in the country as documented in Step 2, including both clearcutting and thinning.

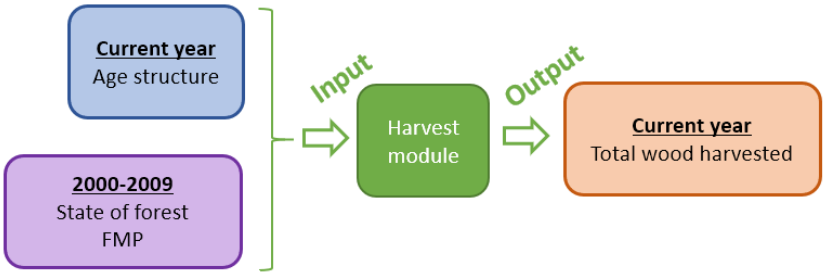


Figure 10: Harvest module description.

According to Article 8(5), the FRL shall not "unduly constrain future forest management intensity".

There are several alternatives for the implementation of this concept as shown in Box 11.

Box 11. Alternatives for the harvest module.

Alternative 1: Maintain the harvest ratio to the wood available for cutting

This alternative, included as part of the JRC approach[28], is based on maintaining constant over time the ratio between the harvest and the amount of biomass available for wood supply in MFL (for both final felling and thinning).

- Step a: Calculate the 'biomass available for wood supply' in the RP ($BAWS_{RP}$, e.g. biomass within 80 and 140 years if clear-cutting or 20% of total biomass for silvicultural operations without final harvesting).
- Step b: Document the harvest amount during the RP (H_{RP}).
- Step c: Estimate the Harvest Fraction of Management (HFM_{RP}) during RP as: $HFM_{RP} = H_{RP} / BAWS_{RP}$. HFM_{RP} is a proxy that expresses the impact of all constraints on the harvest during RP.
- Step d: Estimate the future biomass available for wood supply ($BAWS_{CP}$) by applying the same FMP of the RP to the expected age-related evolution of forest characteristics (e.g., biomass and increment).
- Step e: Set future harvest (H_{CP}) as: $HFM_{RP} \times BAWS_{CP}$.

This approach may help overcoming the situation where no precise information on specific FMP are available during the RP.

Alternative 2: Maintain the harvest ratio to the total wood available

This is a more general alternative based on the previous Alternative 1. It uses the same step-by-step method but replacing the biomass available for wood supply ($BAWS_{RP}$ and $BAWS_{CP}$) by the total biomass available in MFL (TBA_{RP} and TBA_{CP})[29].

Alternative 3: Maintain the harvest amount

This alternative is to be considered as a last resource in case of lack of modelling capability to assess the relation between harvest and wood available. The procedure is to document the harvest amount during the RP (HRP) and use it for the CP (HCP). It is important to point out that this alternative does not consider any information on the evolution of the forest and just assume the continuation of the current harvest and, therefore, is not in line with the LULUCF Regulation.

28 Grassi and Pilli (2017) Projecting forest GHG emissions and removals based on the "continuation of current forest management": the JRC method. EUR 28623 EN. Luxembourg (Luxembourg): Publications Office of the European Union; 2017. doi:10.2760/844243.
See also Grassi at el. 2018

29 A further generalization of this approach based on areas instead of wood available will not be in line with the LULUCF Regulation as it would not take into account the age-structure dynamics. So, it is not a good practice to base the estimations in areas in this harvest module.

2.3.4.3 Carbon pool variation module

The aim of this module is to estimate the variation in all C forest pools (above-ground biomass, below-ground biomass, dead wood, litter and soil organic carbon) based on the fixed data and the information estimated by the previous modules (dynamic data).

Figure 11: C pools variation module description.

The results of this module have to be consistent with the estimations in the GHG inventory. Additionally, the input data is similar to the one used in the GHG inventory. So, this module would probably use a methodology similar to the one used in the national GHG inventory.

Box 12. Alternative of modelling for countries using stock-difference method.

This modelling takes into account jointly the effect of harvest and the C pool variations at stratum/FMP/age class level. Nevertheless, a model for the age-structure is still needed to complement this approach.

This approach is focus on the EU Member States that apply the Stock-Difference Method (usually known as carbon stock change method, CSC) of the 2006 IPCC Guidelines in the estimation of their national GHG Inventories. This method to assess carbon stock changes is applied where carbon stocks in relevant pools are measured at two points in time (e.g. measurements of the NFIs).

If based in NFI measurement, and if the NFI is reliable, this method is able, usually with low uncertainty to estimate the net change of carbon in a pool. However, it does not provide information on potential gains and the amount and type of the losses, which are key for the developing of sound projections. In addition, the information of these gains and losses could not exist in the country, which impairs the use of other approaches based on gains and losses.

The aim of this approach is to estimate the projected FRL based on the information currently used in the GHG Inventory in a simple way that it is able both to be perfectly consistent with the GHG results and take into consideration the FMP of 2000-2009 and the variations in the forest structure.

The NFI inventory data, eventually combined with other data, may deliver activity data (usually the areas) and carbon stock change factors (CSCF)[30] for different forest classes (temporal and spatial as well as for other characteristics). A forest inventory can thereby provide data on the areas of forests classified by a number of parameters (i.e. it can provide information by stratum).

At GHG Inventory level, it is normally used a single country specific CSCF (or a small set of CSCFs) based on repeatedly measured NFI data for a historical year or time period. However, using the raw data of the NFI, it is also possible to derive different CSCFs by forest stratum and age class using the same approach[31]. The CSCF per area unit for a single stratum and age reflects the impact of the forest management on this stratum regarding net emissions or removals per unit of area.

So, the CSCFs of each stratum based on 2000-2009 data should reflect the FMP in those years. These CSCFs could be combined with the best available data for describing the areas and their combination will provide the C pool variations in the CP.

The procedure will be:

1. *Calculate the areas evolution using the age-structure module.*
2. *Calculate the CSCFs for each stratum/FMP/age class based on the NFI information that was used for the GHG Inventory using RP (2000-2009) data.*
3. *Estimate the projections multiplying the RP CSCFs by the projected areas.*

2.3.4.4 The 'fall-back' approach

This is a really simplified approach aimed to provide an estimation method in the lack of data to properly model the FRL. It can only be applied if the Member State can clearly demonstrate and document the complete lack of the minimum data needed to model the forest dynamics. It is important to point out that here we refer to the lack of input data, not of a model or a modelling framework. If a country has no model available, but has available data, this approach is not an option and it is deemed good practice to either develop or obtain a suitable model for estimating the FRL (see Section 2.3.7 for an overview of existing modelling frameworks that may be utilised).

30 By CSCF, in this context, we refer to C variations in each pool by unit (usually ha).
31 Strata in the FRL estimations and the categorization used in the GHG Inventory could differ (e.g. forest types vs. regions). However, as both classifications are based on the NFI data, the aggregated results should be equal.

For the carbon pool that the approach is selected to be applied for (i.e. above-below ground biomass, litter, dead-organic matter, or soil organic carbon), the approach would assume the continuation of historical GHG emissions and removals as observed in the RP. Therefore, the FRL will be calculated as the average of emissions and removals for the pool in the RP as included in the most up-to-date GHG Inventory (i.e. the 2018 submission).

2.3.5 Modelling the development of the harvested wood products

This section provides information on how to implement the calculation framework for estimating emissions and removals of CO_2 from HWP on the basis of changes of the carbon pool and contains some background information on the assumption of instantaneous oxidation.

Box 13. Overview of key steps for estimating the carbon pool in HWP

Phase I: Collect time series of HWP activity data comprising the defined HWP default categories "sawnwood", "wood-based panels" and "paper and paperboard" as well as harvest data to allocate HWP to domestic forests

Phase II: Calculate HWP originating from the domestic forest land category Forest Land remaining Forest Land"

a) Estimate the share of HWP originating from domestic forests by means of relevant feedstock categories

b) Allocate HWP from domestic forests to the land use category "Forest Land remaining Forest Land" (FLrFL)

c) Calculate the annual carbon inflow to the HWP pool

Phase III: Implement the HWP estimation method in line with the requirements (cf. Figure 12)

2.3.5.1 Estimating the carbon pool in HWP

In order to implement the requirements for estimating emissions and removals associated with HWP as set out in the LULUCF Regulation and in line with the requirements of the relevant IPCC guidelines, countries need to fulfil the following three phases.

I. Collect activity data for the defined HWP categories from relevant production and trade statistics reflecting the national and assort data time series for further data processing accordingly, e.g. in a spreadsheet programme. Following elements need to be considered in relation to the collection of the required activity data:

I.1. HWP categories

I.1.1. Activity data that could be used with the default method to estimate HWP contribution (i.e. first order decay function) as defined in Annex V of the LULUCF Regulation.

These estimates on the basis of the change of the carbon pool in HWP shall include (a) paper (b) wood panels and (c) sawnwood. The FAO and IPCC guidelines provide internationally agreed definitions of these aggregated wood product commodities and further specify their included subcategories. Detailed guidance can be found in Section 2.8.1.1 of IPCC (2014). For calculating the carbon content of those commodities, the relevant carbon conversion factors are provided in Table 2.8.1 of Section 2.8.3.1 IPCC (2014)[32].

In the case that countries want to apply country-specific activity data, Section 2.8.4.1 of IPCC (2014) further specifies the possible sets of data or sources which would be in line also with the LULUCF Regulation.

These data comprise HWP item data following the international HS nomenclature and classification system (i.e. the categories 'sawnwood', 'wood-based panels' and 'paper and paperboard').

"*These data could be available from country-specific statistics containing further disaggregated items of the subcategories as specified in Table 2.8.2. Examples would be coated particle board, fibreboard with specific density or surface, or coniferous sawnwood made from specific tree species (e.g. larch). Introducing disaggregated item data using appropriate carbon conversion factors e.g. based on information on wood densities can contribute to considerably improve the accuracy of the HWP estimations.*" (IPCC 2014).

The type of activity data that could be combined with the default first order decay function (Annex V of the LULUCF Regulation) could be derived from either

- National statistical offices in the case of the above mentioned country-specific HWP item data following the international HS nomenclature, or
- International statistics, e.g. FAOSTAT (which supposed to be consistent with data from national sources)

I.1.2. Activity data that would require also country-specific methods to estimate the emissions and removals of CO_2 from HWP

Other country-specific activity data which do not follow the international HS nomenclature and classification system could be either

- Finished HWP that are further processed from the above mentioned categories, or
- Data on buildings with different wooden construction components (made of those defined commodities).

Both type of data would require the application of also country-specific methodologies as set out in Section 2.8.4.2 of IPCC (2014) and could not be combined with the first order decay function as referred to in Annex V of the LULUCF Regulation.

I.2. Data for allocating HWP to 'Forest Land remaining Forest Land' (FLrFL)

In order to allocate the HWP to the originating forest land category 'Forest Land remaining Forest Land' as set out in the LULUCF Regulation, further data on

32 The same information is expected to be included in Table 12.2 of Section 12.5.2 of the IPCC 2019 Refinement.

harvest amounts originating from those lands is needed to estimate the share of HWP removed thereof. Following IPCC (2014) this includes the feedstock commodities 'industrial roundwood' and 'wood pulp'. It is suggested to also including 'recovered paper' as feedstock commodity for the HWP category 'paper and paperboard' when estimating emissions and removals from HWP applying the 'production' approach.[32]

I.3. Time series

To fulfil the requirements of IPCC for estimating the initial carbon stock both in the annual reporting as well as in calculating the HWP contribution to the projected FRL, the activity data time series needs to comprise the years starting in 1990. Further information is provided in Section 2.8.3 of IPCC (2014).

II. Calculate the annual carbon inflow to the HWP pool following the 'production' approach as set out in the LULUCF Regulation

According to the LULUCF Regulation, only carbon in HWP originating from domestic forests ('Forest Land remaining Forest Land') is to be considered in the FRL estimates[33]. In consequence, the times series of data reflecting the annual production of HWP commodities as described in I.1 need to be allocated to the relevant domestic forest land category. This comprises three intermediate steps:

STEP a: Estimate the share of carbon in HWP coming from domestic forests. For this purpose, calculate the share of the relevant HWP feedstock categories 'industrial roundwood', 'wood pulp' and if applicable 'recovered paper' being used (i.e. consumed) for manufacturing the relevant HWP categories 'sawnwood', 'wood-based panels' and 'paper and paperboard' and at the same time originating from domestic forests.

STEP b: Estimate the annual fraction of feedstock for the HWP categories 'sawnwood', 'wood-based panels' and 'paper and paperboard' originating from the particular land category 'Forest Land remaining Forest Land'[33]. It is important to note, that in line with the requirements of the LULUCF Regulation, harvested wood originating from Deforested Land is to be treated on the basis of 'instantaneous oxidation'. In the case that the data used for this purpose (e.g. harvest amounts as considered for previous steps) deviate from harvest amounts as contained in production statistics such as FAOSTAT, please explain the differences and the relation between those sets of data.

STEP c: In order to obtain the annual fractions of HWP which originate from domestic harvest and the relevant land category to be considered in the FRL, combine the information obtained from Steps a and b.

Further methodological guidance with relevant equations is provided in Section 2.8.1.2 of IPCC (2014)[34].

III. Implementation of the default first order decay function

In a next step, the calculated annual carbon inflow is to be used for estimating the annual carbon stock and its changes over time by means of the first order decay function as set out in Annex V of the LULUCF Regulation. The following Figure 9 provides an example with relevant formulae on how to implement this equation consistent with IPCC (2014) in a spreadsheet model (e.g. Microsoft Excel)

33 NOTE: "In the case that it is not possible to differentiate between the harvest from Lands subject to Afforestation and the and FM, it is conservative and in line with good practice to assume that all HWP entering the accounting framework originate from FM." (IPCC 2014).
34 Similar information is expected to be included in Section 12.5.2.1 ("Compilation of activity data for the 'production' approach") of the IPCC 2019 Refinement.

	A	B	C	D
1		half-life (hl)	35	
2		decay constant *k*	=LN(2)/C1	
3		term 'e^{-k}' of Eq. 12.2	=EXP(-C2)	
4		term '$[(1 - e^{-k})/k]$' of Eq. 12.2	=(1-EXP(-C2))/C2	
5				
6	years	Inflow	*HWPj* carbon stock	stock-change
7	1990	100,00	=AVERAGE(B7:B11)/C2	=C8-C7
8	1991	101,00	=$C$3*C7+$C$4*B7	=C9-C8
9	1992	150,00	=$C$3*C8+$C$4*B8	=C10-C9
10	1993	103,00	=$C$3*C9+$C$4*B9	=C11-C10
11	1994	95,00	=$C$3*C10+$C$4*B10	=C12-C11
12	1995	105,00	=$C$3*C11+$C$4*B11	=C13-C12
13	1996	100,00	=$C$3*C12+$C$4*B12	=C14-C13
14	…	…	…	…

The initial carbon stock for the year 1990 is calculated in cell C7 as suggested in IPCC (2014). The FOD function used for calculating the carbon stock for the start of each subsequent year is implemented in cells C8:C13. Based on the development of the carbon stock of the particular HWP category, the stock-changes (i.e. carbon pool changes are calculated in the cells of column D).

Figure 12: Example for implementing the first order decay function in a spreadsheet (e.g. MS Excel).

2.3.5.2 Assuming 'instantaneous oxidation'

The criterion d) of Annex IV of the LULUCF Regulation for calculating emissions and removals of CO_2 from HWP as part of the FRL requires a comparison "*between assuming instantaneous oxidation and applying the first-order decay function*". Furthermore, Annex V of the LULUCF Regulation defines that also "*HWP from solid waste disposal sites and HWP that were harvested for energy purposes shall be accounted for on the basis of instantaneous oxidation*".

The assumption of 'instantaneous oxidation' is based on the notion that the carbon pool in HWP is stable (i.e. carbon inflow to the HWP pool equals carbon outflow from the HWP pool). In consequence, the assumption of 'instantaneous oxidation' corresponds to an estimate of no changes in HWP carbon stocks, with the result that emission and removals of CO_2 from HWP are zero (cf. also IPCC 2006). Mathematically, this equals the assumption that all carbon in the biomass harvested is oxidized in the removal year (i.e. year of harvest). It is important to note that the assumption of 'instantaneous oxidation' only relates to the HWP pool; carbon losses from the above ground biomass carbon pool in the forest (e.g. through harvest) are still included in the forest carbon pool estimates.

Following calculated example assuming a gain/loss method for implementing the forest carbon pool estimates illustrates the assumption of 'instantaneous oxidation' to be applied to the HWP pool only:

1. Forest C-pool above ground biomass

   C-pool Inflow (i.e. forest growth) = -100

   C-pool Outflow (i.e. harvest) = +90

   Emissions and removals from above ground biomass carbon pool = -10

2. HWP C-pool

   C-pool Inflow = -35 (example)

   C-pool Outflow = +35

   Emissions and removals from HWP carbon pool = 0

As a result of the assumption that all carbon in the biomass harvested is oxidized in the removal year (i.e. in the year of harvest) (cf. *inter alia* IPCC 1997), in the above example, no additional emissions and removals are to be added to the +90 (harvest).

In consequence of applying 'instantaneous oxidation', only emissions and removals associated with the use of harvested wood as material are to be estimated in the context of the LULUCF Regulation. Emissions associated with the use of wood for energy purposes are implicitly included in the forest carbon pool estimates.

Further detailed information on the assumption of instantaneous oxidation which is described consistently with relation to the carbon pool in HWP is provided in IPCC (1997) and IPCC (2014).

2.3.6 Modelling the development of natural disturbances

According to LULUCF Regulation, natural disturbances (ND) are defined as "*any non-anthropogenic events or circumstances that cause significant emissions in forests and the occurrence of which is beyond the control of the relevant Member State, and the effects of which the Member State is objectively unable to significantly limit, even after their occurrence, on emissions*" (article 3(1.9)).

According to Article 10 of the LULUCF Regulation, Member States may exclude (on voluntary basis) from their accounts for MFL the GHG emissions resulting from natural disturbances that exceed the average emissions caused by natural disturbances in the period from 2001 to 2020, excluding statistical outliers ('background level'). This approach is consistent with the principles and approaches described in the 2013 IPCC KP Supplement (section 2.3.9.6 "*Guidance on the development of the background level and margin*").

If a Member State uses this provision, the FRL projections must exclude the effect of ND in the RP and substitute them by the background level of emissions from natural disturbances. The background level is to be calculated in accordance with this Article 10 and Annex VI of the LULUCF Regulation, and should be calculated to avoid expectation of credits or debits from the natural disturbances.

Otherwise, if the Member State do not want to use the natural disturbances provision, the Member State have to take into account the effect of the natural disturbances directly in the FRL projection.

Box 14 shows three distinct alternatives proposed for dealing directly in the FRL projections with the natural disturbances in the CP.

Box 14. Alternatives for considering natural disturbances in the FRL

Alternative 1: Natural disturbances included in the model

For this alternative, the model that is being used to estimate the FRL directly takes into account the effect of the natural disturbances in its estimations. Therefore, the natural disturbances in the RP have to be included in the model inputs.

Alternative 2: Natural disturbances effect included in Step 4

For this alternative, the model selected does not explicitly estimate the effect of the natural disturbances in the CP or the country assumes no disturbances after the RP in the model estimations.

However, as its effects have to be taken into account, the country could address them during the step 4. The GHG Inventory results include the effect of the natural disturbances. Therefore, even if the model does not explicitly take into account the natural disturbances effect, during the calibration of the methodology, their effect would automatically incorporate in future projections the continuation of past level of GHG emissions produced by natural disturbances. This is the alternative followed by JRC.

Alternative 3: Zero effect of the natural disturbances in the CP

This alternative assumes that no natural disturbances are going to occur during the CP and no post-calibration is done to include them. This alternative could be used in combination with the use of a Background Level.

2.3.7 Existing modelling frameworks

A number of existing modelling frameworks may be used by countries to estimate the FRL. Box 15 provides some examples of modelling frameworks that are available and may be employed to project the development of forests. An overview of a number of these modelling frameworks can be found in Schelhaas et al. (2017).

Box 15. Examples of modelling frameworks to project the development of forests

- G4M – The Global Forest Model *(Kindermann et al. 2008; Gusti 2010)* *http://webarchive.iiasa.ac.at/Research/FOR/globiom/forestry.html*
- EFISCEN – The European Forest Information Scenario model (Verkerk et al. 2014) *http://www.efi.int/portal/*
- CBM-CFS3 - Carbon Budget Model of the Canadian Forest Sector (Pilli et al. 2013) *http://www.nrcan.gc.ca/forests/climate-change/carbon-accounting/13107*
- EFDM - The European Forest Dynamics Model (Packalen et al. 2014)
- YASSO model (for SOC) (Liski et al. 2005) *http://en.ilmatieteenlaitos.fi/yasso*
- FVS - Forest Vegetation Simulator *https://www.fs.fed.us/fvs/*

To increase reliability of the estimation, a Member State may use projections of more than one model, especially in case if Member State does not have country specific model (Boettcher et al., 2012).

A number of national forest system model also exist that may be utilized within the context of the FRL, such as CALDIS (Ledermann et al., 2017), FOHOW (Schwarzbauer

and Stern, 2010), CARBWARE (NIR Ireland, 2018), Heureka (Wikström et al. 2011), SF-GTM and MELA (FMRL Finland, 2011), and CARBINE and RECONCILE (NIR UK, 2018).

It is important to point out that these models are designed to provide the best estimates of the future development of the forest. However, FRL estimations are constrained by a number of mandatory requirements included in the LULUCF Regulation. Therefore, it is responsibility of the country to make sure that those constraints (e.g. FMP practices from 2000-2009, lack of changes in the total area of a stratum/FMP) are properly included in the model, so the results are in line with the LULUCF Regulation.

2.3.8 Documenting the methodology used

According to the LULUCF Regulation, the FRL "*shall be based on transparent, complete, consistent, comparable and accurate information*" (Annex IV.A(h)). It is good practice for Member States to extensively document the method that has been applied for the projection of the FRL in order to provide the needed transparency for the reviewing process.

2.4 Consistency with greenhouse gas inventories

Step 4: Calibration and consistency with greenhouse gas inventory estimates

Calibrate the selected methodology based on real observed data and show that the methodology is able to reproduce historical data from the National Greenhouse Gas Inventory.

This subchapter is structured as follows:

2.4.1 Introduction

In this step, it is shown that the methodology as selected in Step 3 is able to reproduce the existing and documented data as reported in the latest National Greenhouse Gas Inventory for MFL. It is suggested that Member States document that the methodology is able to reproduce historical data through the use of the set of Table 10.

The calibration step has two separate and concurrent goals:

1. to verify that the model is able to reproduce historical GHG estimates. This means that, given the set of equations and parameters that compose the model and the set of input data for FMPs, the model produces output-values of GHG estimates that are actually consistent with those reported for the historical time period.

   Differences between historical data and the model-outputs may be explained:

   i. as errors in the model formulation and/or parametrization ($Errors_{model/parameter}$) – e.g. the function for calculating the biomass increment does not calculate correctly the increment actually occurred in the HP – or

   ii. as inconsistencies between the input dataset and actual variables in the RP ($Errors_{management\_dataset}$) – e.g. forests of type X are assumed to be subject to a thinning at age 20 (with intensity Y) and 40 (with intensity Z) and a final harvest at age 60, although thinning actually occurs in average only once between age 20 and 40 (with intensity within the range Y-Z) and the final harvest not always occurs -and usually not exactly at the established age-;

   i.e. $Estimate_{modelled} = Estimate_{historical} + Errors_{model/parameter} + Errors_{management\_dataset}$

   To exclude the second source of errors, the calibration step needs also:

2. to verify that the set of management practices used as input into the model are consistent with those applied in the RP.

To achieve both goals a 4-phase serial procedure for the **calibration process** is hereafter proposed.

2.4.2 First phase: consistency of the management practices

In the **first phase**, the datasets of **actual management practices** in the RP (AMP_{RP}), as compiled at Step 2, **and average management practices** (MMP_{PP}) to be applied as input data in the Projection Period (PP) to project the FRL, as compiled at Step 2, are checked to verify their mutual consistency.

Such checking may be done just at the level of total harvest at country level, or at level of harvest allocated at each stratum.

The guidance in Box 16 applies to quantitative variables of management practices (e.g. harvested wood over the total wood available for harvest). However, non-quantitative variables, if any, impact the quantitative variables and therefore are indirectly checked (e.g. it is a management practice to salvage log all wood in all forests impacted by disturbances), the impact of such management practice can be identified in the variable "*harvested wood over the total wood available for harvest*" and accordingly verified.

Box 16: Description of the two proposed alternatives for verifying mutual consistency between the set of actual management practices (AMP_{RP}) and average management practices (MMP_{PP}).

Alternative A:

In case AMP_{RP} shows a variability in the management practices across RP (e.g. "*harvested wood over the total wood available for harvest"*) without a clear trend, the central value of the distribution of AMP_{RP} is used as MMP_{PP}, and the following conditions should be met:

- the MMP_{PP} should be either the mean or the median[35] value, or a value comprised between those two, of the distribution built. This aims at identifying the MMP_{PP} as the central value of AMP_{RP};
- the outliers in the distribution of actual management practices should have been excluded from the calculation of its central value.

Alternative B:

In case AMP_{RP} shows a variability in the management practices across RP (e.g. "*harvested wood over the total wood available for harvest*") with a clear trend, the latest value of the distribution of AMP_{RP} is used as MMP_{PP}, and the following conditions should be met:

- the MMP_{PP} is the latest value of AMP_{RP};
- the MMP_{PP} is not a rate of change observed between the latest value and any other value of the AMP_{RP}. Indeed, any change projected in the future implies a change in BAU conditions that have caused that change and therefore a deviation from historical BAU conditions, and such deviation is the subject of the accounting mechanism (which means that its impact on accounting cannot be zeroed through its inclusion in the FRL).

In both alternative cases, A and B, when verifying the ability of the model to reproduce historical GHG estimates (i.e. second phase), **the set of actual management practices across the RP (AMP_{RP}) is used instead of that one used for the FRL projection i.e. (MMP_{PP}).** For the state of forest & age-related information, the available information closest to the beginning of the RP is used.

Note that it may occur that data on actual management may not be suitable (robust) to ensure that the model may correctly reproduce historical estimates. However, any gap-

35 Being the RP a short period, the set of available data will likely be an incomplete distribution of values. In case of incomplete distributions, the median is a better estimator of the "typical" value of a variable than the mean since it is not skewed so much by extremely large or small values typical of incomplete distributions. Furthermore, the median always has equal probability to be either over or under the true value (although it does not necessary represent the value that minimizes the error).

filling of information should be done after the second phase is carried out with the information available (without any gap-filling).

2.4.3 Second phase: consistency of the emissions and removals estimates

The FRL is the projection of forest C stocks according to historical management practices. Where forest C stocks vary because of:

- the legacy effect of management activities and disturbances occurred before the first year of the time period for which the projection is made;
- the management practices and disturbances that will occur in the time period for which the projection is made, under the assumption that same management practices as those applied in the historical period will apply.

Because the verification of outputs may only be done for historical periods, the model used for projecting the FRL must produce estimates for the historical period. The historical data on forest area and C stocks (i.e. the state of forest & age-related information), as stratified according to relevant variables that determine the C stock gains and losses, used to project the FRL are the latest of the historical period 2000-2009 purely and the projection starts from 2010 onward[36], although a Member State can use more recent data if justified.

Verification consists in the comparison of model's outputs and actual data as reported in the National GHGI:

- Ideally, two variables are to be verified: gains and losses;
- Pools to be verified are all those for which a non-zero net change is included in the FRL. Ideally the Biomass pools are verified in isolation; although also other C pools i.e. dead organic matter, soil organic matter and HWP may be verified in isolation. In any case, the verification is also performed at level of total GHG emissions and removals;
- These will be verified at the level of aggregation at which they are projected (e.g. fuelwood vs industrial roundwood);
- Both the level and the trend need to be verified:
    - For verifying the level, the sum of the time series of historical data should be compared with the sum of model's outputs. The verification is positive if they are one within one standard deviation (i.e. the 68% confidence interval[37]) of the other, otherwise the model's outputs need to be refined.
        - Other statistical tests may be applied; to evaluate the similarity of the precisions of the two datasets (e.g. the Fisher's test) or the bias (as the Student's t-test, the Cochran t-test, the Anova test); although the shortness of time series may impair the validity of such tests.
    - For verifying the trend (this test is done before the impact of disturbances is replaced by its background level of emissions):
        - the inter-annual variability within the projected time series should not be larger than that reported in the GHGI;
        - the direction of the trend should be the same, i.e. same highs and lows, same trendline when applying moving averages[38].

36 This means that the legacy effect of activities implemented, and disturbances occurred, in forest land from 2010 till the year of projection are included in the accounting, as it occurs for any other sector.
37 This is consistent with the IPCC approach to define «likely» confidence in the likelihood of an outcome or result
38 E.g. 3 or 5 years rolling average.

If the model results for the verification do not match the above-listed requirements, it is recommended to:

- first assess if information on historical management can be gap-filled to enhance the consistency of model's outputs with historical estimates. In case such gap-filling does not enhance the quality of model's outputs making them matching the above-listed requirements,
- then revise the model applied or to use an alternative model.

A procedure of **gap-filling of information on the management practices applied in the RP** should:

- First provide the information needed for gap-filling. This could be done for similarities with management activities of the following period if information needed is available for the period following RP; or by using expert judgement.
- Second provide information to support the validity of the use of such information.
- Third describe the impact on the model's outputs for the historical period of the information applied for gap-filling.
- Fourth describe the impact on the model's outputs for the projected period of the information applied for gap-filling.

The verification is done with historical data of the period 2000-2009 and the adjustment applied to the projected period 2021-2030. In case a different, and justified year for the beginning of the projection is selected, the verification is done with historical data of the period 2000-20XX (where 20XX is the year before the beginning of the projection), and the adjustment applied to the projected period 2021-2030.

In any case, when verifying the ability of the model to reproduce historical GHG estimates, the set of actual management practices across the historical RP (AMP_{RP}) is used instead of that one used for the FRL projection i.e. (MMP_{PP}). For the state of forest & age-related information, the available information closest to the beginning of the projection (i.e. 2009 or, if justified, 20XX) is used; from such starting point the state of forest & age-related information is modelled according to the actual management practices. See Figure 13.

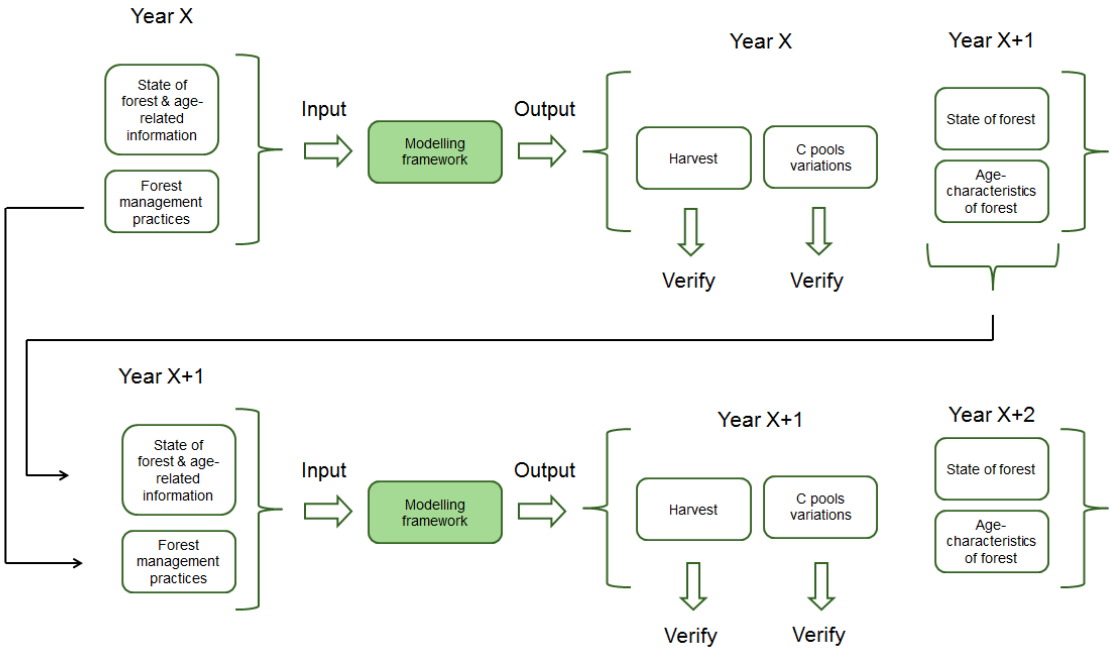


Figure 13: An overview of the process of reproducing the historical estimates as documented in the latest national GHG Inventories for MFL.

2.4.4 Third phase : consistency of the time series

This phase is applied to check if the entire time series of estimates -i.e. *historical estimates* + *projected estimates*- is consistent and where inconsistencies are found how to **adjust the projected estimates**.

An inconsistency in the time series is quantified as follows:

- **Step I**. calculate a new dataset of the interannual rate of change (e.g. ($Estimate_{2016}$ - $Estimate_{2015}$) / $Estimate_{2015}$);
- **Step II**. calculate the average value and the standard deviation of the new dataset;
- **Step III**. identify an inconsistency in the time series between the last historical year and the first projected year if the interannual rate of change is larger than the average value plus 2 the standard deviation;

In case no inconsistency is found, this phase does not apply.

In case an inconsistency is found, one of the techniques provided in section 5.3.3 of volume 1 of the 2006 IPCC Guidelines, should be applied to ensure time series consistency.

The aim of these techniques is to ensure that no any inconsistencies occur in the time series. That means that any differences between subsequent years should not be larger than the observed variability in the time series of historical data. Further, trends should have consistent behaviour across time.

In case the two trends show a consistent behaviour across time, an adjustment factor of the projected estimates can be calculated by comparing the overlap between a set of annual estimates composed by as much years as possible (this is because comparing

only one year likely lead to bias and it is not possible to evaluate trends). The following equation taken from Volume 1 of the 2006 IPCC Guidelines (equation 5.1) applies:

$$y_0 = x_0 * \left(\frac{1}{(n-m+1)} * \sum_{i=m}^{n} \frac{y_i}{x_i} \right)$$

Where:

y_0 = the recalculated emission or removal estimate computed using the overlap method;

x_0 = the estimate developed using the previously used method;

y_i and x_i are the estimates prepared using the new and previously used methods during the period of overlap, as denoted by years m through n.

Table 10: Suggested set of tables (one for the three variables: Biomass gains, Biomass losses, Net GHG emissions/removals) to document that model estimates for the CP are within the estimated range of variability of the GHG Inventory estimates.

Year	Model estimate of either - Biomass gains - Biomass losses - Net GHG emission/removals	GHG Inventory estimates for the same variable	68% confidence interval of GHG estimates
2000			
2001			
2002			
2003			
2004			
2005			
2006			
2007			
2008			
2009			
2010			
2011			
2012			
2013			
2014			
2015			
2016			

2.5 Projections

Step 5: Projection of emissions and removals

Project the future development of anthropogenic forest GHG emissions by sources and removals by sinks for the CP.

This subchapter is structured as follows:

2.5.1 Introduction

In this step, the methodology as selected in Step 3 and calibrated in Step 4 is used to project the future development of anthropogenic forest GHG emissions by sources and removals by sinks for the CP. That is, the modelling framework applied by a Member State is in this Step used to project the FRL for the periods 2021-2025 and 2026-2030 (see Figure 14).

In this part of the guidance document we will focus on key assumptions that need to be taken for carrying out this particular task.

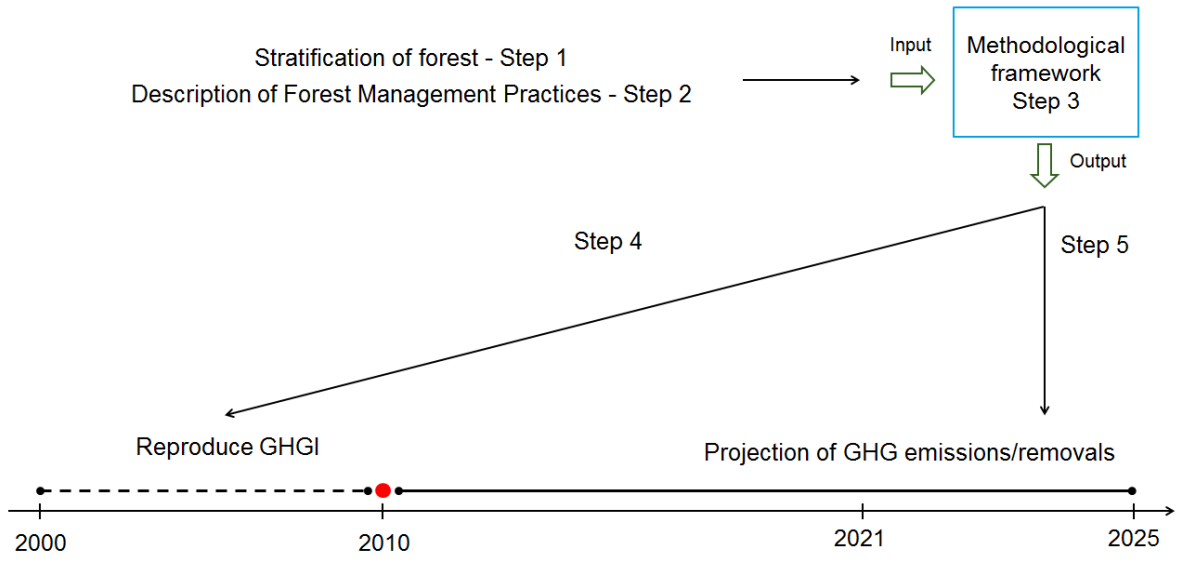


Figure 14: Overview of how the various steps fit together in relation to a timeline of the reference and CPs. In this figure, the red dot at 2010 illustrates the default starting years for the projections (See Section 2.5.4 for further details).

2.5.2 Assumptions concerning climate change

2.5.2.1 Overview

Estimates of the FRL may be affected by changes in future climatic conditions such as changes in precipitation, temperature, and CO_2 and nitrogen deposition feedbacks. These changes may have a direct impact on aspects such as forest growth, mortality and biomass decomposition rates, thereby influencing the projection of emissions by sources and removals by sinks from MFL.

Depending on the modelling framework as selected in Step 3, different assumptions may be made concerning future climatic conditions and the related carbon impacts for the projection of the FRL.

Box 17 shows two distinct alternatives proposed for dealing with climate change during the CP.

Box 17. Consideration of climate change during the CP.

Alternative 1: No consideration to future climate effects

For the projection of the FRL, use the same climatic conditions as for a historical time period (depending on data availability) for which the climatic conditions are known. If this alternative is selected and applied by a Member State, it is simply assumed that the climatic conditions will not change during the CP (i.e. constant over time).

It is good practice that a Member State selects to apply this alternative if the modelling framework selected in Step 3 to project the FRL is not able to account for changes in climatic conditions. This alternative may also be selected if the modelling framework selected in Step 3 is able to account for changes in climatic conditions, but the uncertainty associated with the climate change modelling is deemed too high.

Alternative 2: Projection of the future climatic conditions

This alternative is for Member States that consider the future climatic conditions while projecting the FRL. By this alternative, it is assumed that the future climatic conditions are known and the impacts of the related changes are accounted for in the projection of the FRL. If the methodology as selected in Step 3 is able to account for future changes in climatic conditions, a Member State may select to apply this alternative and account for such changes in the projection of the FRL.

For this alternative, country-specific climate projections may be applied, including downscaled climatic conditions for the SSP-RCP scenarios (Moss et al. 2010). National estimates of the historical trend in climatic conditions may also be applied to project the FRL. A simple example of such an approach would be to calculate geographically explicit historical trend in climatic conditions, and assume that the same trend will continue during CP.

2.5.2.2 Documentation and technical corrections

It is good practice that a Member State clearly specifies, documents and justifies which of the two alternatives is applied for climate change assumptions in the projection of FRL for the CP.

If Alternative 2 is selected by a Member State, it is good practice to document in detail which assumptions and projections for future climatic conditions are being applied, and where the data for the projection can be found. In addition, if Alternative 2 is selected to be applied, it is good practice that a Member State documents the potential impact on the FRL of selecting Alternative 2 instead of Alternative 1.

If a Member State selects to apply Alternative 2, it is good practice that Member States submit a technical correction to correct for any potential differences between the projected and actual climatic conditions during the CP. As long as methodological consistency is fulfilled, a technical correction may be applied by a Member State based on the climatic conditions that actually took place during the CP instead of the projected climatic conditions applied for the calculation of the FRL.

Estimating and applying when necessary such a technical correction would remove any erroneous estimates of carbon balance development simply caused by differences between the projected climatic conditions and the climatic conditions that actually occurred.

2.5.3 Assumptions concerning area development of managed forest land

2.5.3.1 Overview

The area of MFL may change during the CP due to two related processes:

- Afforestation, where 'land converted to forest land', as reported in the GHG inventories, has reached the end of the 20-year conversion period[39] and starts being reported as MFL.
- Deforestation, where MFL is converted other land uses and starts being reported as 'forest land converted to other land uses' (as reported in the GHG inventories).

Although in most cases the two dynamic processes will have relatively limited impact on the overall emissions and removals from MFL, assumptions need to be taken to project that area of MFL during the CP. There are two distinct alternatives proposed to project the area of MFL during the CP, shown in Box 18.

Box 18. Assumptions concerning the development of MFL area during the CP

Alternative 1: Assume constant area of managed forest land

For this alternative it is assumed that the area of MFL does not change during the CP and remains constant over time. In other words, it is assumed that the area of MFL will stay constant from the starting year of the projection and no yearly changes are considered nor accounted for in the projection of the FRL.

Alternative 2: Assume dynamic development of managed forest land

This alternative is based on the assumption that the area of MFL will change in the future and such changes are accounted for in the projection of the FRL.

For this alternative, it is good practice to estimate area gains (land entering to the MFL category) based on the historical and documented area of land classified as 'land converted to forest' as reported in the GHG inventories. Based on this data source and the default 20-years transition period, the area gains for a specific year can be calculated as the area of 'land converted to forest' that reached the end of the 20-year transition period. In other words, the area of land that entered into the category 'land converted to forest' in the year 2000 provides the estimate of area gains for the year 2020 (as this is when the 20-years transition period will end). The area gains may be allocated to stratums according to historical or geographic explicit data sources. To summarize, the area of land converted to 'land converted to forest' for the period of 2000 to 2010 and documented in the GHG inventories becomes the area gains for the period of 2020 to 2030.

To estimate area losses, it is good practice that a Member State uses the average historical and documented area of 'forest land converted to other land-uses' for the period from 2000 until 2016 as reported in the GHG Inventories. In other words, it is good practice that a Member State calculates the yearly average of 'forest land converted to other land-uses' for the period from 2000 to 2016, and apply this yearly average from the starting year of the projection of the FRL.

When applying this alternative, it is important to calculate the area of MFL for each individual year during the CP using the annual projection of area gains and area losses. In other words, the projected area of MFL should be calculated for each individual year by adding the estimated gains in area and subtracting the expected losses in area.

39 The conversion period is normally 20 years (Article 5(3)). However, as stated in Article 6(2), a 30-year conversion period may be used *"if duly justified based on the IPCC Guidelines"*.

2.5.3.2 Documentation and technical correction

It is good practice that Member States document and justify which of these alternatives that they apply for the projection of the MFL. As the two processes of afforestation and deforestation both affect the area of MFL and the carbon impacts, it is important that two processes are dealt with in a consistent manner. It is therefore not good practice that a Member State applies one of the above described alternatives for afforestation and a different alternative for deforestation.

As long as methodological consistency is fulfilled, a technical correction may be applied by a Member State based on the area development that actually took place during the CP instead of the area development initially applied for the calculation of the FRL.

If a Member State applies Alternative 2 for the development of the MFL, it is good practice that Member States applies a technical correction to correct for differences between the actual and projected area development during the CP. If a Member State applies Alternative 1 for the development of the MFL, the Member States may apply a technical correction to correct for differences between the actual and projected area development during the CP.

Estimating and applying when necessary such a technical correction would remove any erroneous estimates of carbon development simply caused by differences between the assumed area development and the area development that actually took place.

2.5.4 Starting year for the projection of the FRL

2.5.4.1 Overview

As a default, it is good practice that Member States start the projection of the FRL as of 2010 or earlier. Consequently, 2011 will be the first year that the modelling framework projects the development of the MFL (i.e. the state of the forest as of 2011 will be estimated and an output from the modelling framework).

It is good practice that the projection is started for a year as close as possible to 2010 for which all relevant data sources are available for the modelling framework and they together provide a consistent representation of the status of the MFL.

A Member State may select a different starting year for the projection of the FRL if this is deemed appropriate and justifiable. If the projection is selected to be started after 2010, it is good practice to clearly document and justify why this is done. In addition, it is good practice that the Member State shows that the modelling framework is able to reproduce historical data from the National GHG Inventory in the period from 2000 to the starting year of the projection of the FRL (e.g. 2017).

For the period after 2009, such an evaluation should be performed based on the real observed management of the forest (see Section 2.4.2) during that time period instead of a continuation of the FMPs in 2000-2009. In other words, it is good practice that a Member State shows that the selected modelling framework is able to reproduce the latest National GHG Inventory through the use of the latest available data.

2.5.4.2 Data sources to be used

In terms of data sources to be used for the projection of the FRL, the LULUCF Regulation states that the FRL shall be developed "*using the best available data*" (Article 8(5)) and shall be "*transparent, complete, consistent, comparable and accurate information*" (Annex IV.A(h) of the LULUCF Regulation). Therefore, the data sources used should be in line with the good practices of IPCC (2006 IPCC GL, volume 1, chapter 1, section 1.4).

Data describing the **state of the forest** (e.g. total area of MFL; information by stratum such as area, increment, biomass, age related information and area allocated to each FMP) have to be used for the projection of the FRL. Depending on the starting year of the projection, either earlier data from the RP (i.e. data up to 2009) or the latest available data (at the time of FRL setting, e.g. up to 2016) can be applied for the projection of the FRL.

It is good practice to use the best available data sources to define the state of the forest as of the starting year of the projection of the FRL. In other words, if 2010 is selected as the starting year of the projection, it is good practice to use data from the latest NFI or GHG Inventory (i.e. GHGI 2018) to define the state of the forest as of the starting year of the projection (2010) and not data that was available as of the starting year of the projection (i.e. GHGI 2010-2011).

2.5.4.3 Documentation and technical correction

In terms of documentation, it is good practice that Member States document for which year the projection of the FRL starts and which starting year is selected for the projection of the FRL.

If the projection is selected to be started after 2010, it is good practice that Member States justify why they have selected to use that specific year (e.g. why more recent data is considered more reliable and applied for the projection of the FRL).

It is of particular importance and good practice that a Member State transparently document what data sources are being applied to define the state of the forest as of the starting year of the projection of the FRL. Furthermore, independently of the starting year of the projections, it is good practice that a homogenous and consistent set of data sources are being applied to provide a logical and rational representation of the state of the forest for that year.

If the projection is selected to be started as of 2010, or earlier, it is not good practice that Member States applies a technical correction to alter the starting year of the projection of the FRL. However, if the projection is selected to be started after 2010, a technical correction may be applied if this allows for the consideration to best available data describing the state of the forest or the age-related forest characteristics of the forest.

Independently of the starting year of the projection, a technical correction may be applied by a Member State to correct for differences between the actual and projected state of the MFL until the start of the CP (i.e. 2021). As long as methodological consistency is fulfilled, a technical correction may be applied by a Member State based on the observed state of the MFL as of the start of the CP instead of the projected state of the forest as applied for the calculation of the FRL.

A technical correction thereby allows a Member State to utilize NFIs carried out after 2016/2017 to improve upon the description of the age-related forest characteristic as of the start of the CP.

2.5.5 Assumptions concerning the period from 2010 to 2020

2.5.5.1 Overview

For the projection of the FRL, assumptions have to be taken concerning the development of the MFL in the period from 2010 to 2020.

In terms of the stratification of MFL, **the approach for stratifying the area of MFL as developed in Step 1 should be consistently applied** for the RP 2000 to 2009, 2010 to 2020, and for the projection of the FRL for the period of 2021-2025 and 2026-2030.

It is important to note that it is good practice that the criteria used for the stratification is to remain constant in the modelling of historical and projected emissions by sources and removals by sinks. This means that the same approach for stratifying the area of MFL is to be applied independently of the selected starting year of the projection of the FRL and throughout the CP.

Furthermore, **it is good practice that the area of land allocated to each stratum remains constant from the starting year of the projection** (thereby not extrapolating into the future any possible trends observed during the RP).[40] In other words, the stratification of the MFL (and the area of land allocated to each stratum) as documented for the year of start of the projection is to remain constant throughout the CP.

This implies that during the CP, only the overall state of the forest will adapt to the implementation of the FMPs, which in turn will adapt to aspects such as the age dynamics of the forest.

In terms of the FMPs, **it is good practice that the described of the FMPs as defined and documented in Step 2 for the RP are consistently applied from the starting year of the projection onwards**. It is important to note that only the descriptions of the FMPs that were implemented in the period from 2000 to 2009 are to be applied for the estimation of the FRL.

Therefore, the country-defined operational criteria (i.e. the quantification of the FMPs) for the period of 2000-2009 are also to be applied to project the FRL. Independently of the starting year of the projection, the same FMPs should be enforced from the starting year of the projection of the FRL for the CP.

Given that the FRL shall be projected based on a continuation of FMP**, it is good practice that the areas allocated to the each FMP remain constant from the starting year of the projection of the FRL**. In other words, for each stratum, the area allocated to each FMP is to remain constant throughout the CP. Even if a trend could be observed and documented during the RP of area being converted from one FMP to another FMP, it is not good practice to continue such a trend during the CP.

This implies that if the stratification as documented in Step 1 and the FMP as documented in Step 2 are species specific, then including in the CP estimates a conversion from one tree species to another species (e.g. planting broadleaf trees after the final clearcutting of coniferous) would not be in line with the good practice guidance.

2.5.5.2 Documentation and technical correction

40 The only foreseen exemption from this good practice is if the area of MFL is assumed to develop over time (see Section 2.5.3). If this is the case, then it is good practice to allocate area gains and area losses to strata's as documented during the RP.

In terms of documentation, it is good practice that Member States document what assumptions are taken for the period 2010 to 2020.

Given that the FRL for the CP shall be based on "*the continuation of sustainable forest management practice, as documented in the period from 2000 to 2009 with regard to dynamic age-related forest characteristics in national forests*" (Article 8(5)), it is not good practice to perform a technical correction of the FRL, based on the FMPs that actually were carried out during the CP instead of the FMPs as documented in Step 2.

The definition of when each management activity is being carried out, as documented in the period from 2000 to 2009, is to be consistently applied throughout the CP. It is therefore not good practice to perform a technical correction of the operational criteria describing when an activity is being carried out.

As an example, if an management activity has been specified to be carried out at a specific age-related characteristics of the forest (i.e. the first pre-commercial thinning is carried out when the trees reach a the diameter class (Dbh) of 10-15 cm), this value cannot be changed through a technical correction (i.e. the first pre-commercial thinning is carried out when the trees reach a the diameter class (Dbh) of 5-9 cm).

Furthermore, it would not be good practice to perform a technical correction of the operational criteria describing when a management activity is being carried out based on updated information concerning aspects such as wood price development, interest rates, net present value estimates, and demand of wood for energy and material purposes.

This is the case as the operational criteria are to the extent possible be defined according to the age-related characteristics of the national forests, not to projected data sources.

2.5.6 Assumptions concerning harvested wood products

2.5.6.1 Overview

As set out in criterion e) of Annex IV.A of the LULUCF Regulation, for calculating the HWP contribution to the FRL, "*a constant ratio between solid and energy use of forest biomass as documented in the period from 2000 to 2009 shall be assumed*".

Independent from potentially available information on developments and/or changes in the consumption or production patterns of the relevant HWP commodities, the above criterion for setting the FRL implies that the proportion of harvest manufactured to the defined semi-finished wood products representing the material or solid use of HWP remain unchanged as well as the HWP composition of their production during the RP 2000-2009.

In order to implement the projection for HWP in the FRL, starting basis for the calculations are the projected harvest amounts that have been estimated following the methodology as set out in the previous steps (Steps 3 - Section 2.3.5 and Step 5 – Section 2.5.3 to 2.5.4). Similar to an example as described in Section 2.8.5 of IPCC (2014), the following steps need to be implemented for calculating the projected carbon Inflow to the HWP pool in line this requirement and consistent with the relevant IPCC guidance on HWP:

1. **STEP I**: Calculation of the rates of change of the projected harvest as compared to the average of the historic harvest within the period 2000 to 2009.

   Numeric example:

   (i) Average historic harvest for the years 2000-2009: 50 $Mm^3\ yr^{-1}$

   (ii) Projected harvest (in $Mm^3\ yr^{-1}$): in 2021=52, in 2022=53, in 2023=55…

   (iii) Rates of change as compared to historic average: in 2021=4%, in 2022=6%, in 2023=10%

2. **STEP II**: Application of these annual change rates to the same time period average (i.e. 2000-2009) of historic carbon inflow to the HWP pool, which has been calculated from HWP production, in order to project the future carbon inflow to the HWP pool (reflecting the material or solid wood use).

   Numeric example:

   (i) Average production of sawnwood for the years 2000-2009: 10 $Mm^3\ yr^{-1}$

   (ii) Projected production of sawnwood (in $Mm^3\ yr^{-1}$): in 2021=10.4, in 2022=10.6, in 2023=11 …

   As a result, it is assumed that the same average proportion of harvested timber used as feedstock for the subsequent production of the defined HWP categories (i.e. sawnwood, wood-based panels and paper and paperboard, reflecting in the solid wood use) in the defined time period 2000-2009 will also apply in the projection period.

3. **STEP III**: Estimate future emissions and removals from HWP applying the methods as set out earlier in Step 3 (See section 2.3.5).

   In the case that additional information on timber assortments and their respective use for the subsequent manufacture of the defined HWP default categories (i.e. semi-finished wood products) is being used for an alternative approach, countries need to ensure consistency with the requirement to maintain the same proportion of harvest manufactured to the defined semi-finished wood products in their projection as in the

period 2000 – 2009. It is furthermore good practice that Member States document the applied methods and justify why such an alternative has been applied.

For projecting the future development of emissions and removals, the annual carbon inflow to the HWP pool is calculated from 1990 onwards including the latest activity data derived from the relevant statistics (not later than from 2020). This is to be implemented independent from selected starting year of the projection (see Section 2.5.4), as the carbon stock in the HWP pool is to be estimated on the basis of separate activity data (see Section 2.3.5). Subsequent to available statistical data, the projected production of the relevant HWP commodities as derived from Step II are to be used to continually estimate the future carbon inflow to the HWP pool.

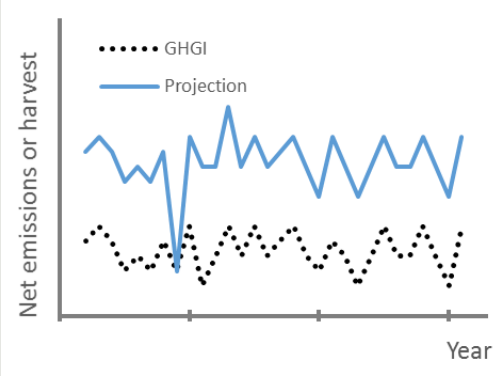
2.5.6.2 Documentation and technical correction

In terms of documentation, it is good practice to document how the projected emissions and removals from the Harvested Wood Products pool have been implemented. This includes a description of what data sources both for HWP activity data (default categories) and projected harvest amounts for implementing the Steps described above have been applied as well as a description on how the described Steps above have been implemented. In the case that a technical correction following the descriptions under Section 2.5.2-2.5.5 is conducted with a subsequent change of the projected harvest amounts as modelled following the methodological guidance provided under Section 2.3.5, it is good practice to also recalculate the projected emissions and removals from the Harvested Wood Products pool as part of the FRL.

2.5.7 Possible problems with the projections and how to address them

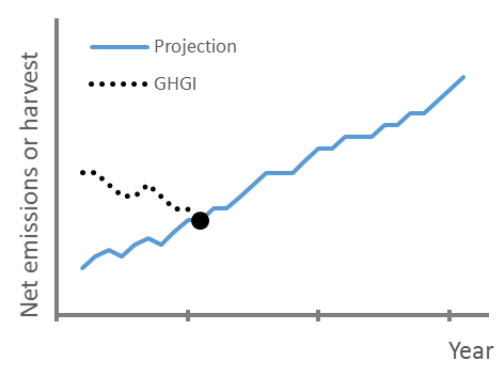
Box 19. gives an overview of possible problems that the Member States may encounter when projecting the FRL, and proposes solutions for addressing them.

Box 19: Possible problems with the FRL projections and how to address them.



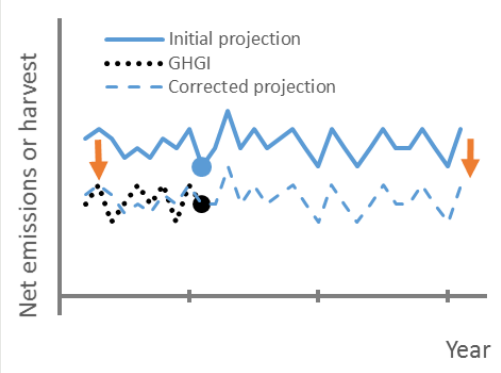
Problem: The projection only matches a single time point in the GHGI, not the overall GHGI

Solution: Calibrate the projection ignoring outliers (see also Section 2.4.3).



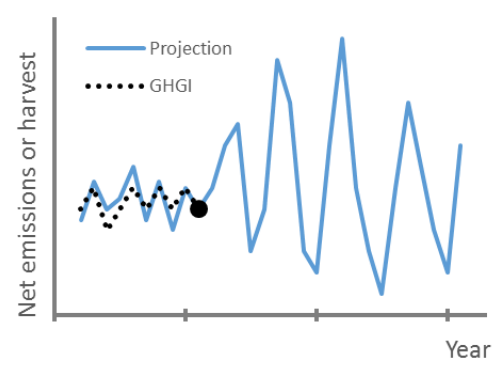
Problem: The trend of the GHGI is not consistent with the trend of the projection

Solution: Refine the model (see also Section 2.4.3).



Problem: The initial projection is on a different overall level than the GHGI

Solution: Calibrate the projection to be in line with the overall level of the GHGI (shown with dashed line). See also Section 2.4.4.



Problem: The projected inter-annual variability is much larger than the inter-annual-variability in the GHGI

Solution: Refine the model. See also Section 2.5.

2.6 Calculate the forest reference level

Step 6: Calculate the forest reference level

Calculate the FRLs as average of emissions and removals during 2021-2025 and 2026-2030.

Once the GHG emissions and removals have been calculated, the 5-year average of projected values is taken as FRL values for the periods 2012-2025 and 2026-2030. Once the FRL has been calculated it cannot be modified. However, technical corrections to the FRL may subsequently be applied, to ensure methodological consistency with the estimates of actual GHG emissions and removals.

In particular:

- Biomass C stock gains (and proportionally C stock gains in other pools inferred from biomass C stocks) need to be corrected in case of the increment is calculated by using:
    - Climate-related variables; in such a case the same set of climate data -i.e. those during the accounting period- will be applied to the estimates of actual increment and to recalculate the projected increment.
    - Direct measurements (e.g. NFI); in such a case relations increments-other variable[41] needs to be recalculated with the new data collected during the accounting period and applied to recalculate the FRL.
    - Empiric relations (e.g. yield curves) that are recalculated (new data, better model fitting) during the accounting period; same considerations as for point ii apply.
- Biomass C stock losses, need to be corrected only if parameters (e.g. biomass expansion factors, allometric functions) applied are recalculated. No technical corrections is applied for any change in activity data, as roundwood harvested, fuelwood collected, losses due to other disturbances;
- C stocks inputs and outputs (as well as GHG emissions) from non-biomass pools need to be corrected in case any parameters or empirical or functional relations that has been applied for calculating the FRL is subsequently revised (e.g. decay factors):

Once a technical correction has been calculated and applied, the calibration of the corrected FRL needs to be performed again, as it was done for the FRL, to ensure that no inconsistencies in the time series originated from the recalculation.

If a technical correction is to be applied, it is good practice to justify and transparently document the updates as implemented.

41 Likely age (or biomass density) dependent increment curves

SECTION 3

3 CRITERIA FOR THE FOREST REFERENCE LEVEL AND THE CONTENTS OF THE NATIONAL FORESTRY ACCOUNTING PLAN

3.1 Description of Annex IV criteria for constructing FRLs

As described in Section 1, the LULUCF Regulation consists of a preamble describing the context and background, enacting terms with the different articles of the Regulation, and seven annexes that give further detail as to how to comply with the LULUCF Regulation.

Annex IV.A of the LULUCF Regulation defines criteria for determining the FRL. Here, we present these criteria as stated in the LULUCF Regulation, and give guidance on how to interpret or address the different criteria.

As stated Annex IV.A of the LULUCF Regulation, a "*Member State's forest reference level shall be determined in accordance with the following criteria*":

"(a) the reference level shall be consistent with the goal of achieving a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century, including enhancing the potential removals by ageing forest stocks that may otherwise show progressively declining sinks;"

This notion links the LULUCF Regulation to the Paris Agreement that the EU and Member States have ratified, and encourages the Member States to reflect on the long-term development of the forest sinks, also beyond the CP. This criterion can be understood to imply that a momentary change in harvest volume because of forest age structure can be justified, if it leads to enhancing potential removals by forest increment in the long term. Note, however, that the above cannot contradict the first paragraph of Article 8(5) "*The forest reference level (FRL) shall be based on the continuation of sustainable forest management practice, as documented in the period from 2000 to 2009*". It is good practice to discuss the long-term implications of the FMPs estimated in the FRL in qualitative (and if possible, quantitative) terms, in relation to the objective of enhancing the long-term LULUCF sinks.

This criterion thereby refers also to Article 13 of the LULUCF Regulation (Managed forest land flexibility), which details the conditions on which a Member State may compensate emissions from the LULUCF sector that incur during the CP, including long term strategy.

"(b) the reference level shall ensure that the mere presence of carbon stocks is excluded from accounting;"

This criterion is compatible with the KP Decision 16/CMP.1[42], where this same principle was affirmed. It reflects the objective of enhancing the carbon stocks and the net carbon sinks where possible, instead of only preserving existing carbon stocks. It is understood that a pre-existing carbon stock in terrestrial vegetation such as a forest on a given area of land does not contribute towards the reduction of atmospheric carbon. Therefore, it is appropriate for the FRL to support accounting for net changes in forest carbon stocks, rather than accounting for total existing carbon stocks in forests.

42 FCCC/KP/CMP/2005/8/Add.3. Available online at: https://unfccc.int/resource/docs/2005/cmp1/eng/08a03.pdf

"(c) the reference level should ensure a robust and credible accounting system that ensures that emissions and removals resulting from biomass use are properly accounted for;"

This criterion reflects the need to provide trustworthy accounting. Note also that combustion of wood is excluded from the energy sector accounting on the basis that it is instead accounted for in the LULUCF sector, hence underlining the needs to properly account for biomass used within the LULUCF.

"(d) the reference level shall include the carbon pool of harvested wood products, thereby providing a comparison between assuming instantaneous oxidation and applying the first-order decay function and half-life values;"

This criterion asks to provide explicitly an assessment of the size of the HWP carbon pool. This would in most Member States result in two different FRL estimates provided by the Member State: one assuming instantaneous oxidation (where no carbon is stored in HWP, and that pool is essentially zero), and an FRL where carbon storage within HWP is accounted for.

It is good practice to explicitly state the difference between the estimates, for example:

"The forest reference level for [country] is XX tons CO_2 eq, in which the HWP pool constitutes of xy tons CO_2 eq. If instantaneous oxidation of HWP was assumed, the FRL would be YY tons CO_2 eq."[43]

See more guidance on how to fulfil this criterion under Section 2.3.5 of this document, and Annex V of the LULUCF Regulation.

"(e) a constant ratio between solid and energy use of forest biomass as documented in the period from 2000 to 2009 shall be assumed;"

See more guidance on how to fulfil this criterion under Section 2.5.6 of this document.

"(f) the reference level should be consistent with the objective of contributing to the conservation of biodiversity and the sustainable use of natural resources, as set out in the EU forest strategy, Member States' national forest policies, and the EU biodiversity strategy;"

This criterion ties the FRL projections to the concept of sustainable use of natural resources. That is, the FRL should be based on the continuation of sustainable FMP in 2000-2009 (Article 8(5)). It is good practice to confirm that the FMPs upon which the FRL is constructed are consistent with the objective of contributing to the conservation of biodiversity and other criteria for sustainable use of natural resources, as set out in the EU forest strategy, Member States' national forest policies, and the EU biodiversity strategy.

It is recognised that the conservation or enhancement of forest carbon stocks and net carbon sinks comprise just one objective of sustainable forest management. The pursuit of wider sustainable management objectives may have positive and/or negative consequences for the development of forest carbon stocks and net carbon sinks that may vary over time.

The Member States are encouraged to provide commentary on how sustainable forest management policies and practices are evolving, where relevant, and to describe how these have been taken into account in the modelling of the FRL. In this way, the

43 The relation between the FRL and HWP pools will be: YY + xy = XX.

consistency between the modelling of the FRL and historical and evolving sustainable FMPs may be demonstrated.

"(g) the reference level shall be consistent with the national projections of anthropogenic greenhouse gas emissions by sources and removals by sinks reported under Regulation (EU) No 525/2013;"

This criterion ties the FRL submitted within the LULUCF Regulation (EU) 2018/841 to the overall policies and requirements as set out earlier in Regulation (EU) No 525/2013, See Section 2.4 for how to ensure consistency with the GHG inventories.

"(h) the reference level shall be consistent with greenhouse gas inventories and relevant historical data and shall be based on transparent, complete, consistent, comparable and accurate information. In particular, the model used to construct the reference level shall be able to reproduce historical data from the National Greenhouse Gas Inventory."

This criterion is addressed in detail under Section 2, Step 4 of this document.

3.2 Common table of contents for the NFAP

Annex IV B. of the LULUCF Regulation sets out the key elements that the national forestry accounting plans shall contain. Based on the elements (a) to (e), it is suggested that Member States develop their NFAP according to the following common table of contents. This table has been developed to accommodate the need to document each Step of the suggested approach to implement the FRL requirements in line with the LULUCF Regulation.

Chapter 1: General Introduction

1.1: General description of the forest reference level for [the Member State]

1.2: Consideration to the criteria as set in Annex IV of the LULUCF Regulation

Chapter 2: Preamble for the forest reference level

2.1: Carbon pools and greenhouse gases included in the forest reference level

2.2: Demonstration of consistency between the carbon pools included in the forest reference level

2.3: Description of the long-term forest strategy

2.3.1: Overall description of the forests and forest management in [the Member State] and the adopted national policies

2.3.2: Description of future harvesting rates under different policy scenarios

Chapter 3: Description of the modelling approach

3.1: Description of the general approach as applied for estimating the forest reference level

3.2: Documentation of data sources as applied for estimating the forest reference level

3.2.1: Documentation of stratification of the managed forest land

3.2.2: Documentation of sustainable forest management practices as applied in the estimation of the forest reference level

3.3: Detailed description of the modelling framework as applied in the estimation of the forest reference level

Chapter 4: Forest reference level

4.1: Forest reference level and detailed description of the development of the carbon pools

4.2: Consistency between the forest reference level and the latest national inventory report

4.4: Calculated carbon pools and greenhouse gases for the forest reference level

References

ANNEXES

ANNEX I

Check list of information to be document in the NFAPS

In this annex we provide a series of check lists of information to be included in the NFAP under the LULUCF Regulation. The check lists as detailed below follows the suggested stepwise approach for estimating the FRL and for each Step, a list of key items to be document and specified is provided.

Step 1: Stratify the area of MFL, according to country-defined criteria, and apply the stratification in a consistent manner over time, including the RP 2000-2009.	
Document how the area of Managed Forest Land is considered in the determination of the forest reference level (Annex IV B.) of the LULUCF Regulation)	☐
Document how large a share of the national forests was covered by a given FMP in the period from 2000 to 2009	☐
Document each criteria used for the stratification of the MFL.	☐
Document data sources used to perform the stratification.	☐
Document and justify any deviation between the stratification for the FRL and any stratification already used in the GHG inventory or NFI.	☐
Document the sources of information used to determine the forest characteristics for each stratum (see Table 2 for an example of this can be documented).	☐
Document the forest definition used for the construction of FRL and explain whether it differs from that used in the national GHG inventory.	☐

Step 2: Identify and document the FMPs in each strata for 2000-2009 based on country-defined operational criteria and quantifiable data.	
Document the sources of information used to identify and specify the FMPs.	☐
Describe in qualitative terms each FMP as applied during the RP (see Table 3 for an example of how this can be documented).	☐
Describe in quantitative terms each FMP as applied during the RP (see Table 4 and Table 5 for examples of how this can be documented).	☐
Document the use of FMPs according to the stratification of the forest land (see Table 6 for an example of how this can be documented).	☐
Verify that the documentation of the FMPs include specifications about: (i) how each management activity is performed, and (ii) when is each management activity being carried out.	☐
Check that the above descriptions of FMPs and forest characteristics include a description of the following forest characteristics (Annex IV B.): - dynamic age-related forest characteristics - increments - rotation length - other information on forest management activities	 ☐ ☐ ☐ ☐
Confirm that any trends in when an management activity is carried as observed during the period from 2000 to 2009 are not projected to continue during the CP	☐
Document and confirm that only data sources from the period 2000 to 2009 are being used to define the FMPs. If data sources outside the period from 2000 to 2009 are used, document and justify this deviation. Also, document an assessment of the impact of this deviation on the FRL.	☐ ☐ ☐
Document how the principles of sustainable forest management practice are being applied within the country.	☐
Document the use of the FMPs in each strata of the MFL (see Table 6 for an example of this can be documented).	☐

Step 3: Select the appropriate methodology to project the development of carbon pools based on available data and national circumstances.	
Document the methodology as selected to project to the development of carbon pools.	☐
Document the 'Age structure module'	☐
Document the 'Harvest module'	☐
Document the 'C pool variation module'	☐
Document how natural disturbances have been estimated in the projection of the FRL, including data sources as applied.	☐
Document how the harvested wood products pool has been estimated in the projection of the FRL, including data sources as applied.	☐

Step 4: Calibrate the selected methodology based on real observed data and show that the methodology is able to reproduce the GHG Inventory estimates.	
Document the model estimates of Biomass gains, Biomass losses, and Net GHG emissions/removals from the year 2000 until the starting year of the projection of the FRL.	☐
Document the emissions and removals from forests and harvested wood products as shown in GHG inventories and relevant historical data (Annex IV (B)), from the year 2000 until the starting year of the projection of the FRL.	☐

Step 5: Select the appropriate methodology to project the development of carbon pools based on available data and national circumstances.	
Specify the assumptions taken concerning climate change and documentation of data sources applied.	☐
If a projection of future climate conditions are used (Alternative 2 in Box 17), document: - Assumptions and projections for future climatic conditions as applied - Document the potential impact on the FRL by not consideration to future climate effect (i.e. applying Alternative 1 instead of Alternative 2 (see Box 17))	☐ ☐
Specify and justify the assumptions taken concerning the area development of MFL and documentation of data sources as applied.	☐
Specify the assumptions taken concerning the area development of MFL and documentation of data sources as applied.	☐
Document and justify the selected starting year for the projection of the FRL.	☐
Document and justify the assumptions taken concerning the period from 2010 to 2020.	☐
Specify the data sources used to describe the State of the forest as of the starting year of the projection of the FRL.	☐
Confirm that area of land allocated to each stratum remains constant from the starting year of the projection	☐
Confirm that described of the FMPs as defined and documented in Step 2 for the RP are consistently applied from the starting year of the projection onwards.	☐
Describe the historical and future harvesting rates disaggregated between energy and non-energy uses. (Annex IV B.)	☐

Step 6: Calculate the FRLs as average of emissions and removals during 2021-2025 and 2026-2030.	
Document the 5-year average of projected values for the periods 2021-2025 and 2026-2030.	☐

ANNEX II

Handbook for establishing Forest Reference Levels

A total of six steps are envisioned to be taken for the implementations of the FRLs. The sequence in which these steps are expected to be implemented and performed is visualized in Figure 15. It is important to note that while some of these steps are to be performed sequentially (i.e. Step 5 is only to be performed after Step 4), there are also some steps that can be performed at the same time. As an example, Step 1 and Step 2 may very well be performed simultaneously as the selection of the stratification is highly interlinked to the identification of the FMPs.

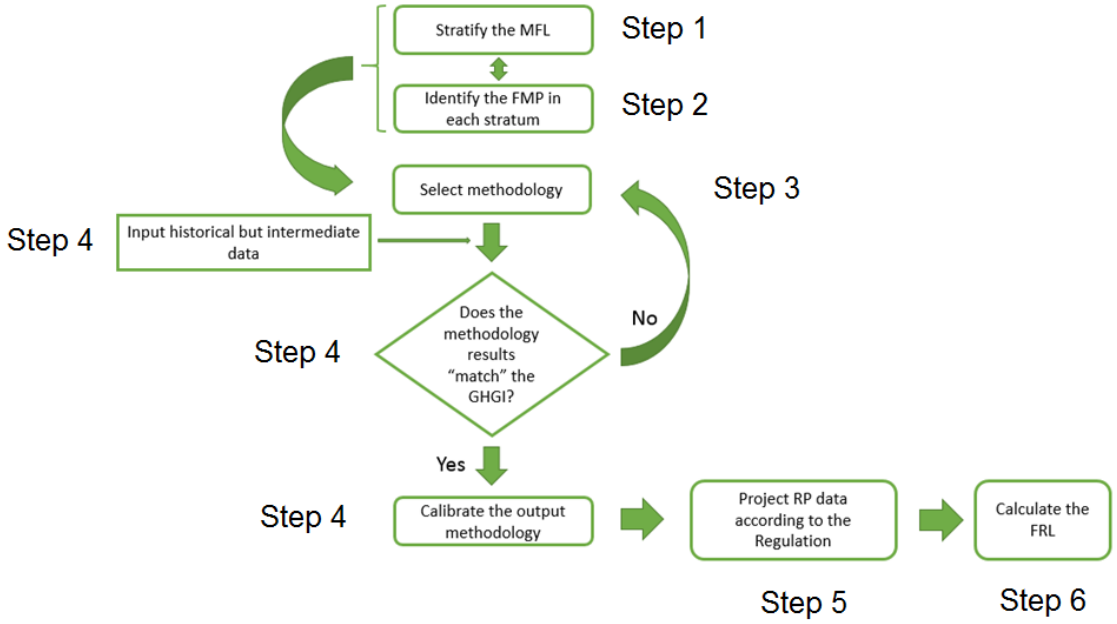


Figure 15: An overview of the step by step process that is envisioned to be taken to establish the FRL and how the steps are suggested to be carried out sequentially.

In this handbook we highlight and list the key aspects to consider during the implementation of each of these steps. The main aim of this description it to provide additional information concerning how these steps fit together and the flow of information that follows. For detailed description about each step we refer to Section 2 of this document.

Step 1: Stratification

- Main aim of this Step is to define and document the stratification of MFL.
- The stratification of forest land serves to distinguish different types of FMPs.
- It is important that the stratification covers the entire area of MFL.
- It is good practice that the criteria used for the stratification remains constant in the modelling of historical and projected emissions by sources and removals by sinks.
- The number of strata and their definition are to be selected in consideration of available data and methodological (model) requirements for estimating the FRL.

Step 2: Description of forest management practices

- In this Step, the FMPs that were applied in the period from 2000 to 2009 are to be documented through country-defined and quantifiable operational criteria.
- For each stratum identified in Step 1, the FMPs that took place in the stratum are to be documented.
- The focus is to closely document and describe the management practices that actually took place during the RP, i.e. not the management practices that were expected to take place or that were legally allowed to take place
- The information collected and document in this Step will serve as input to the methodology developed to project the FRL in Step number 3, thereby forming the basis to model the continuation of FMPs during the CP.

Step 3: Select the appropriate methodology

- In this Step, the methodology used to estimate the FRL would be selected, calibrated and documented.
- The objective is to select a method that can estimate future development of the MFL carbon pools in the CP, in line with the stratification as selected in Step 1 and the Forest Management Practices documented in Step 2.
- It is important to note that the Member States can use different methods for different strata, to take into account differences in management practices, forest composition, and tree species.

Step 4: Calibration and consistency with greenhouse gas inventory estimates

- In this Step, the methodology as selected in Step 3 is calibrated based on the real observed data, including the data concerning each strata and FMP as collected in Step 1 and 2.
- It should be shown that the methodology as selected in Step 3 is able to reproduce the existing and documented data as reported in the latest national GHG Inventories for MFL.
- It should be shown that the modelling framework is able to reproduce historical GHGI estimates from the year 2000 until the starting year of the projection of the FRL. Figure 16 provides an illustration of how this can be done sequentially for each year that is being assessed.

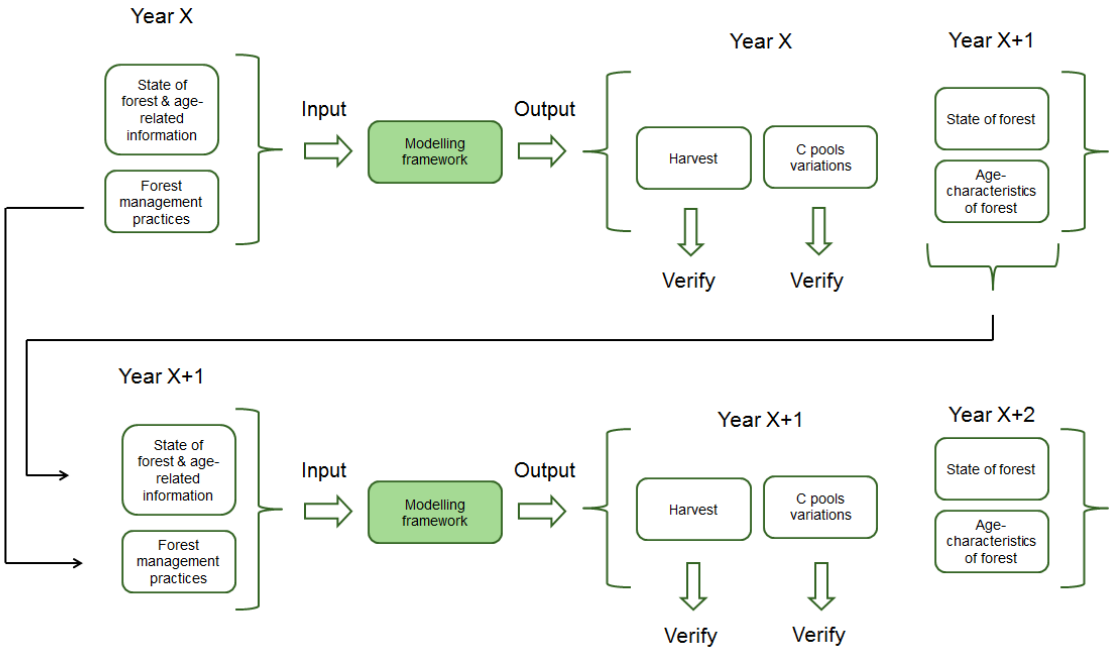


Figure 16: An overview of the process of reproducing the historical estimates as documented in the latest National Greenhouse Gas Inventory for MFL.

Step 5: Projection of emissions and removals

- In this Step, the methodology as selected and calibrated in Step 4 would be used to project the future development of anthropogenic forest GHG emissions by sources and removals by sinks for the CP.
- Key input to the methodological framework includes the data concerning each strata and FMP as collected in Step 1 and 2.
- Key output from the methodological framework is the projection of emissions by sources and removals by sinks from the starting year of the projections until 2025.

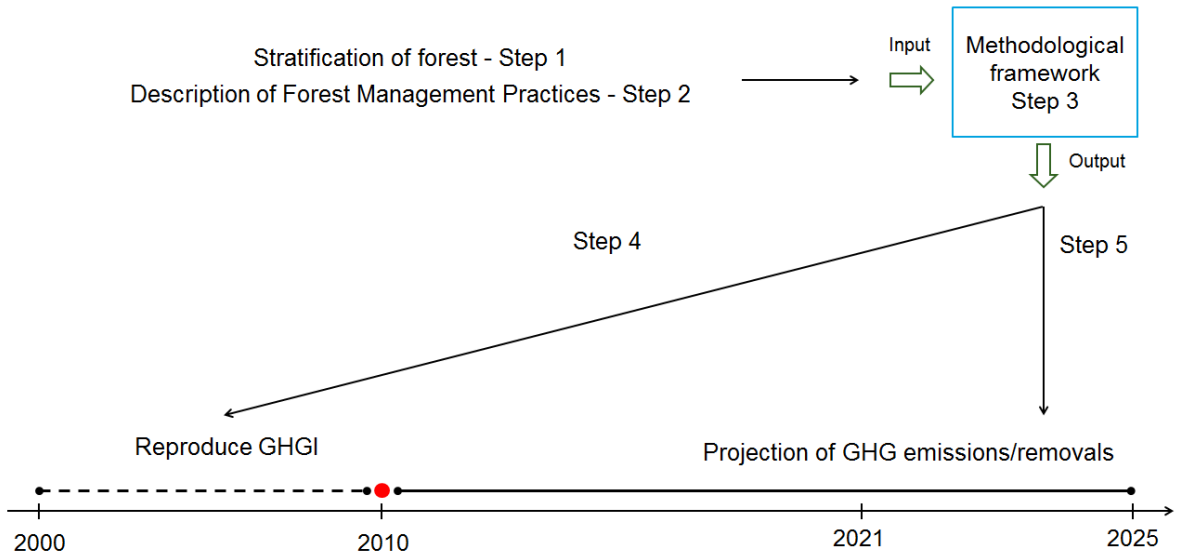
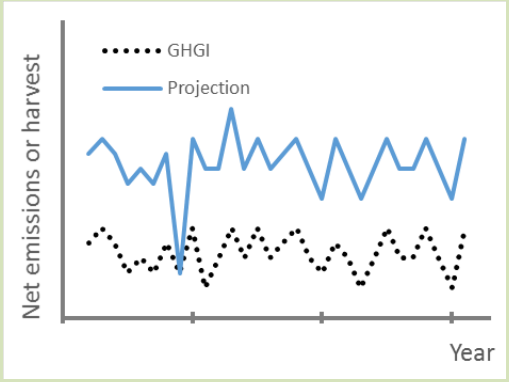


Figure 17: Overview of how the various Steps that are to be implemented fit together in terms of a timeline. In this figure, the red dots at 2010 illustrate the preferred staring years for the projections.

Step 6: Calculate the forest reference level

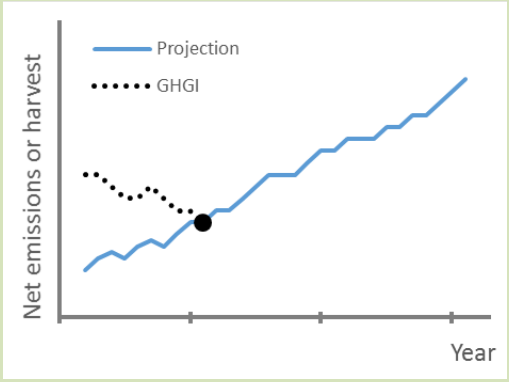
- Based on the yearly estimates of GHG emissions and removals for MFL has been developed in Step 5, the 5-year average of projected values can be calculated based on the FRL values for the periods 2021 - 2025 and 2026 - 2030.
- The calculations of the average estimates should be fully performed based on the estimates as developed within Step 5.

Possible problems with the projection and how to address them



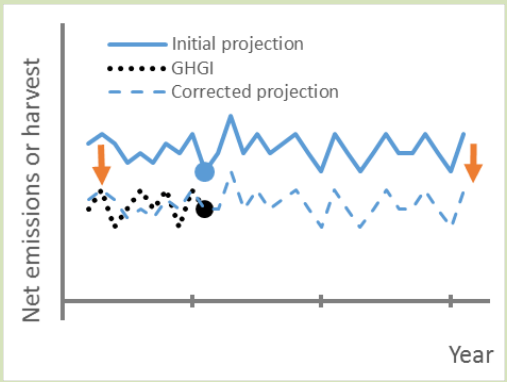
Problem: The projection only matches a single time point in the GHGI, not the overall GHGI

Solution: Calibrate the projection ignoring outliers (see also Section 2.4.3).



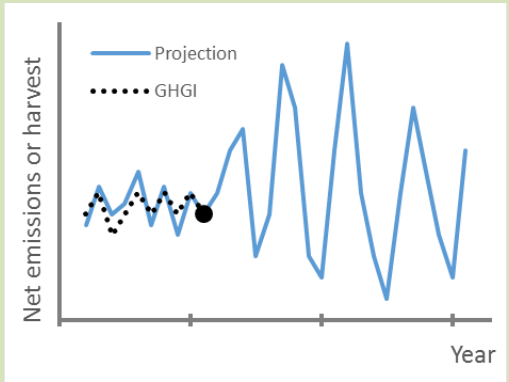
Problem: The trend of the GHGI is not consistent with the trend of the projection

Solution: Refine the model (see also Section 2.4.3).



Problem: The initial projection is on a different overall level than the GHGI

Solution: Calibrate the projection to be in line with the overall level of the GHGI (shown with dashed line). See also Section 2.4.4.



Problem: The projected inter-annual variability is much larger than the inter-annual-variability in the GHGI

Solution: Refine the model. See also Section 2.5.

ANNEX III

Filled in example of table for Step 1

In this annex to the technical guidance document, we illustrate how a Member State may document information sources for forest characteristics in strata through the use of tables. The tables below only serve as examples and a Member State is of course free to select another way of documenting the information sources.

Table 11: Filled in example of Table 2.

Forest characteristics	Data references	Stratum ID where the characteristics and reference are relevant
Aboveground biomass	NFI, 2009	All
Belowground biomass		
1) Floodplain forests	Krejza et al., 2017	1-9
2) All other forests	Zianis et al., 2005	10-250
Area of strata	NFI, 2009	All
Species composition		
1) State forests	NFI, 2009	1, 5, 15, 25, 30-250
2) Private forests	Brus et al., 2011	2-4, 6-14, 16-24, 26-29

References for the Table 11:

Brus, D.J., Hengeveld G.M., Walvoort D.J.J., Goedhart P.W., Heidema A.H., Nabuurs G.J., Gunia K. (2011) Statistical mapping of tree species over Europe. European Journal of Forest Research 131 (1): 145–157

Krejza J., Světlík J., Bednář P. (2017) Allometric relationship and biomass expansion factors (BEFs) for above- and below-ground biomass prediction and stem volume estimation for ash (Fraxinus excelsior L.) and oak (Quercus robur L.). Trees, 31 (4): 1303-1316

NFI (2009) National Forest Inventory

Zianis D., Muukkonen P., Mäkipää R., Mencuccini M. (2005) Biomass and stem volume equations for tree species in Europe. Silva Fennica Monographs 4, 63 pp.

Filled in examples of tables for Step 2

In this sub-section we illustrate how Member State may document their FMPs through the use of Table 3 to Table 6. The table below only serve as examples and a Member State is of course free to select to document their national specific FMPs in other ways.

Table 12: Filled in example of Table 3.

Forest Management Practice		
Index	**Name of Practice**	**Short Description of Practice**
FMP 1	Pine clearcutting long	Even aged pine forest with long rotation and regenerated by clearcut
FMP 2	Pine clearcutting short	Even aged pine forest with short rotation and regenerated by clearcut
FMP 3	Pine uniform shelterwood	Even aged pine forest regenerated with consecutive cuttings applied on the whole area
FMP 4	Pine non uniform shelterwood	Even aged pine forest regenerated with consecutive cuttings applied on groups, strips or different spatial patterns
FMP 5	Spruce clearcutting	Even aged spruce forest regenerated by clearcutting
FMP 6	Spruce non uniform shelterwood	Even aged spruce forest regenerated with consecutive cuttings applied on groups, strips or different spatial patterns
FMP 7	Spruce close to nature	Spruce forest with close to nature cuttings and natural regeneration (e.g. group selection)
FMP 8	Beech timber shelterwood	Even aged beech forest managed to produce timber and regenerated with consecutive cuttings
FMP 9	Beech close to nature	Beech forest with close to nature cutting and natural regeneration (e.g. group selection, single tree selection)
FMP 10	Oak timber provision	Oak forest with long rotation and regenerated by clearcut or shelterwood
FMP 11	Mixed forests with selective systems	Forest with mixed tree species and uneven aged management (e.g. group selection, single tree selection)
FMP 12	Oak coppice	Oak coppice with short rotation cycle for firewood production
FMP 13	Chestnut timber coppice	Chestnut coppice with standards for timber
FMP 14	Eucalyptus pulpwood	Eucalyptus plantation for pulpwood production with short rotation cutting cycle
FMP 15	No intervention	Forest without active management
FMP 16	Nature conservation and biodiversity protection without management	Forest without management and aimed to protect and preserve biodiversity
FMP 17	Nature conservation and biodiversity protection with management	Forest with management oriented to biodiversity protection and preservation
FMP 18	Soil protection	Forest with management oriented to soil protection
FMP 19	Water purification	Forest with management oriented to water purification
FMP 20	Close to Nature Forest	Forest with close to nature management and minimal intervention

Table 13: Filled in example of Table 4.

Forest management practice		Silvicultural operations with final harvesting							
		Pre-commercial thinning		First commercial thinning		Second commercial thinning		Final cutting	
Index	Name of practice	Age (yrs) or Dbh (cm.)	% biomass harvest*	Age (yrs) or Dbh (cm.)	% biomass removals *	Age (yrs) or Dbh (cm.)	% biomass removals*	Age (yrs) or Dbh (cm.)	% biomass removals*
FMP 1	Pine clearcutting long	>10	15%	>20	15%	N.A.	N.A.	120 - 140	95%
FMP 2	Pine clearcutting short	>10	15%	>20	15%	N.A.	N.A.	60 - 80	95%
FMP 3	Pine uniform shelterwood	N.A.	N.A.	>20	15%	>30	15%	80-120	95%
FMP 4	Pine non uniform shelterwood	N.A.	N.A.	>20	15%	>30	15%	80-120	95%
FMP 5	Spruce clearcutting	>10	15%	>20	15%	N.A.	N.A.	80-100	95%
FMP 6	Spruce non uniform shelterwood	N.A.	N.A.	>20	15%	>30	15%	80-120	95%
FMP 8	Beech timber shelterwood	N.A.	N.A.	>20	15%	>30	15%	80-120	95%
FMP 10	Oak timber provision	N.A.	N.A.	>20	20%	N.A.	N.A.	80-120	95%
FMP 12	Oak coppice	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	20-30	90%
FMP 13	Chestnut timber coppice	>10	15%	N.A.	N.A.	N.A.	N.A.	30-40	85%
FMP 14	Eucalyptus pulpwood	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	12-20	95%
FMP 15	No intervention	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
FMP 16	Nature conservation and biodiversity protection without management	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
FMP 18	Soil protection	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	100-120	70%
FMP 19	Water purification	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	100-120	70%

*percentage of standing biomass at the time of intervention

Table 14: Filled in example of Table 5

Forest Management Practice		Silvicultural operations without final harvesting	
Index	**Name of Practice**	**Years between operation (yrs.)**	**% biomass removals**
FMP 20	Single tree selection	15-20	15%
FMP 21	Single tree selection and thinning	15-20	25%
FMP 22	Group selection	20-25	25%

Table 15: Filled in example of Table 6

Stratification of MFL			% distribution of Forest Management Practices					Sum Total (%)
Ownership type	Main tree species	Productivity class	FMP Index 1	FMP Index 2	FMP Index 3	FMP Index 4	…	
Private commercial forest owners	Pine	I	12%	88%	0%	0%		100 %
		II	16%	82%	0%	0%		100 %
	Spruce	I	0%	0%	0%	0%		100 %
		II	0%	0%	0%	0%		100 %
	Birch	I	0%	0%	0%	0%		100 %
		II	0%	0%	0%	0%		100 %
	Aspen	I	0%	0%	0%	0%		100 %
		II	0%	0%	0%	0%		100 %
State owned forest	Pine	I	51%	44%	5%	0%		100 %
		II	41%	54%	5%	0%		100 %
	Spruce	I	0%	0%	0%	0%		100 %
		II	0%	0%	0%	0%		100 %
	Birch	I	0%	0%	0%	0%		100 %
		II	0%	0%	0%	0%		100 %
	Aspen	I	0%	0%	0%	0%		100 %
		II	0%	0%	0%	0%		100 %

ANNEX IV

Overview of implementation of Kyoto protocol in the EU Member States

Table 16, Table 17 and Table 18 give an overview of the reporting of LULUCF activities by the Member States under KP second commitment period.

Table 16. Voluntary KP-LULUCF activities elected by Member States in the second commitment period, and accounting timing selected.

Member State	Art 3.4 elected activities 1	Accounting frequency
Austria	---	end of CP
Belgium	---	end of CP
Bulgaria	---	end of CP
Croatia	---	end of CP
Cyprus	---	end of CP
Czech Republic	---	end of CP
Denmark	CM, GM	annual
Estonia	---	end of CP
Finland	---	end of CP
France	---	end of CP
Germany	CM, GM	end of CP
Greece	---	end of CP
Hungary	---	annual
Ireland	CM,GM	end of CP
Italy	CM, GM	end of CP
Latvia	---	end of CP
Lithuania	---	end of CP
Luxemburg	---	end of CP
Malta	---	end of CP
Netherlands	---	end of CP
Poland	---	end of CP
Portugal	CM, GM	end of CP
Romania	RV	end of CP
Slovakia	---	end of CP
Slovenia	---	end of CP
Spain	CM	end of CP
Sweden	---	end of CP
United Kingdom	CM, GM, WDR	end of CP
Iceland	RV	end of CP

Table 17. C pools for which estimates have been reported under each of the KP-LULUCF activities.

Member State	CHANGE IN CARBON POOL REPORTED							GREENHOUSE GAS SOURCES REPORTED							
	AGB	BGB	Litter	Dead wood	Soil		HWP	Fertilization	Drained, rewetted and other soils		Nitrogen mineralization in mineral soils	Indirect N_2O emissions from managed soil	Biomass burning		
					Min	Org		N_2O	CH_4	N_2O	N_2O	N_2O	CO_2	CH_4	N_2O
Afforestation / Reforestation															
Austria	R	R	R	R	R	NO	R	NO	NO	NO	R	NO	NO	NO	NO
Belgium	R	R	R	R	R	NO	R	NO	NO	NO	R	NO	NO	NO	NO
Bulgaria	R	IE	R	NO	R	NO	R	NO	NO	NO	NO	NO	R	R	R
Croatia	R	R	R	NO	R	NO	NO	NO	NO	NO	NO	NO	R	R	R
Cyprus															
Czech Republic	R	R	R	R	R	R	R	NO	NO	NO	NO	NO	NO	NO	NO
Denmark	R	R	R	R	R	R	R	IE	R	R	NO	R	NO	NO	NO
Estonia	R	R	R	R	R	R	R	NO	NE	NE	NO	NO	IE	R	R
Finland	R	R	IE	IE	R	R	R	R	R	R	R	R	R	R	R
France	R	R	R	R	R	IE		NO	NO	NO	R		R	R	R
Germany	R	R	R	R	R	R	IE	NO	NO,R	NO,R	R	R	IE,NO	IE,NO	IE,NO
Greece	R	R	NR	NR	NR	NO	NO	NO	NO	NO	NO	NO	R	R	R
Hungary	R	R	NR	NR	NR	NO	IE	IE	NO	NO	NO	NO	IE	R	R
Ireland	R	R	R	R	NO	R	R	IE	R	R	NO	IE	R	R	R
Italy	R	R	R	R	R	NO	R	NO	NO	NO	R	R	R	R	R
Latvia	R	R	R	R	NO	R	NO	NO	R	R	NO	NO	NO	NO	NO
Lithuania	R	R	R	NO	R	R	IE	NO	R	R	NO	NO	R	R	R
Luxemburg	R	R	R	R	R	NO	IO	NO	NO	NO	NO	NO	NO	NO	NO
Malta	NR	NR	NR	NR	NR	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Netherlands	R	R	NR	R	R	R	IE	NO	NE	NE	R	NO	R	R	R
Poland	R	R	R	R	R	R	NO	NO	NO	NO	NO	NO	R	R	R

Portugal	R	R	R	IE	R	NO	R	IE	NO	NO	R	IE	R	R	R
Romania	R	R	R	NO	R	NR	R	IE	NO	NO	R	R	R	R	R
Slovakia	R	R	R	NO,NR	R	NO,NR	NR	NO	NO	NO	NO	NO	R	R	R
Slovenia	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Spain	R	IE	NR,R	NR,R	NR,R	NO	NR	NO	NO	NO	NE,R	IE,NE	IE,NO,R	NO,R	NO,R
Sweden	R	R	R	R	R	R	R	NO	R	R	R	R	NO	NO	NO
United Kingdom	R	IE	R	IE	R	R	R	R	NE	R	R	R	R	R	R
Iceland	R	R	R	NO	R	R	NO	R	R	R	NO	NO	NO	NO	NO
Deforestation															
Austria	R	R	R	R	R	NO	IO	NO	NO	NO	R	NO	NO	NO	NO
Belgium	R	R	R	R	R	NO	R	IE	NO	NO	R	NO	NO	NO	NO
Bulgaria	R	IE	R	R	R	NO	R	NO	NO	NO	NO	NO	NO	NO	NO
Croatia	R	R	R	IE	R	NO	R	NO	NO	NO	R	NO	NO	NO	NO
Cyprus															
Czech Republic	R	R	R	R	R	R	R	NO	NO	NO	R	NO	NO	NO	NO
Denmark	R	R	R	R	R	R	R	IE	R	R	R	IE	NO	NO	NO
Estonia	R	R	R	R	R	R	R	NO	NE	NE	NO	NO	NO	NO	NO
Finland	R	R	IE	IE,R	R	R	IO	IE	R	R	R	IE	R	R	R
France	R	R	R	R	R	IE		NO	NO	NO	R		R	R	R
Germany	R	R	R	R	R	R	NO	NO	NO,R	NO,R	R	R	NO	NO	NO
Greece	R	R	R	R	R	NO	NO	NO	NO	NO	R	NO	NO	NO	NO
Hungary	R	R	R	R	R	NO	IO	IE	NO	NO	R	R	IE	R	R
Ireland	R	R	R	R	R	R	IO	IE	R	R	R	IE	NO	NO	NO
Italy	R	R	R	R	R	NO	R	NO	NO	NO	NO	NO	NO	NO	NO
Latvia	R	R	R	R	R	R	R	IE	R	R	IE	IE	NO	NO	NO
Lithuania	R	R	R	R	R	R	IO	NO	NO	NO	R	NO	NO	NO	NO
Luxemburg	R	R	R	R	R	NO	IO	NO	NO	NO	R	NO	NO	NO	NO
Malta	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Netherlands	R	R	R	R	R	R	IO	IE	NE	NE	R	IE	R	R	R

Poland	R	R	R	R	R	R	R	NO	NO	NO	NO	NO	NO	NO	NO
Portugal	R	R	R	IE	R	NO	R	IE	NO	NO	R	IE	R	R	R
Romania	R	R	R	NO	R	NR	R	IE	NO	NO	R	R	R	R	R
Slovakia	R	R	R	R	R	NO,NR	NR	NO	NO	NO	NO	NO	NO	NO	NO
Slovenia	R	R	R	R	R	NO	IO	NO	NO	NO	R	NO	NO	NO	NO
Spain	NR,R	IE,NR	NR,R	NR,R	NR,R	NO	NR	NO	NO	NO	NE,R	IE,NE	NO,R	IE,NO,R	IE,NO,R
Sweden	R	R	R	R	R	R	IO	NO	R	R	R	R	NO	NO	NO
United Kingdom	R	IE	R	IE	R	IE	IO	NO	NO	NO	R	R	R	R	R
Iceland	R	NO	NO	NO	R	R	NO	NO	R	R	NE	NO	NO	NO	NO
Forest Management															
Austria	R	R	IE	R	R	NO	R	NO	NO	NO	NO	NO	IE	R	R
Belgium	R	R	NO	NO	R	NO	R	NO	NO	NO	R	NO	NO	NO	NO
Bulgaria	R	IE	R	R	R	NO	R	NO	NO	NO	NO	NO	R	R	R
Croatia	R	R	NO	NO	NO	NO	R	NO	NO	NO	NO	NO	R	R	R
Cyprus															
Czech Republic	R	R	IE	R	R	R	R	NO	NO	NO	NO	NO	R	R	R
Denmark	R	R	R	R	R	R	R	IE	R	R	NO	IE	NO	NO	NO
Estonia	R	R	R	R	R	R	R	NO	NA	NA	NO	NO	IE	R	R
Finland	R	R	IE	IE	R	R	R	R	R	R	R	R	R	R	R
France	R	R	R	R	R	IE		NO	NO	NO	R		R	R	R
Germany	R	R	R	R	R	R	R	NO	NO,R	NO,R	R	R	IE,NO	NO,R	NO,R
Greece	R	R	NR	NR	NR	NO	R	NO	NO	NO	NO	NO	R	R	R
Hungary	R	R	NR	NR	NR	R	R	IE	NO	NO	NO	NO	IE	R	R
Ireland	R	R	R	R	NA	R	R	IE	R	R	NO	IE	R	R	R
Italy	R	R	R	R	NR	NR	R	NO	NO	NO	NO	NO	R	R	R
Latvia	R	R	R	R	NO	R	R	NO	R	R	R	R	R	R	R
Lithuania	R	R	R	R	NO	R	R	NO	R	R	NO	NO	R	R	R
Luxemburg	R	R	R	R	R	NO	IO	NO	NO	NO	NO	NO	NO	NO	NO
Malta	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

Netherlands	R	R	NO	R	NO	NO	R	NO	NE	NE	R	NO	R	R	R
Poland	R	R	R	R	R	R	R	NO	R	NO	NO	NO	R	R	R
Portugal	R	R	R	IE	R	NO	R	IE	NO	NO	R	IE	R	R	R
Romania	R	R	R	NO	R	NR	R	IE	NO	NO	R	R	R	R	R
Slovakia	R	R	NO,NR	NO,NR	NO,NR	NO,NR	R	NO	NO	NO	NO	NO	R	R	R
Slovenia	R	R	NR	R	NR	NO	R	NO	NO	NO	NO	NO	R	R	R
Spain	R	IE	NR	NR	NR	NO	R	NO	NO	NO	NE	NE	IE,R	R	R
Sweden	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
United Kingdom	R	IE	R	IE	R	R	R	NO	NE	R	R	NO	R	R	R
Iceland	R	R	R	NR	R	R	R	NO	R	R	NE	NE	NO	NO	NO
Cropland Management															
Denmark	R	R	NO	NO	R	R			R		IE		NO	NO	NO
Germany	R	R	IE	IE,NO	R	R			NO,R		R		NO	NO	NO
Ireland	R	IE	NO	NO	R	NO			NO		IE		NO	R	R
Italy	R	R	NO	NO	R	R			NO		NO		R	R	R
Portugal	R	R	R	NO	R	NO			NO		R		R	R	R
Spain	R	IE	NR,R	NR	R	NO			NO		NE,R		NO,R	IE,NO,R	IE,NO,R
United Kingdom	R	IE	NR	NR	R	R			NE		R		NE	R	R
Grassland Management															
Denmark	R	R	NO	NO	R	R			R		IE		NO	NO	NO
Germany	R	R	IE	IE,NO	R	R			NO,R		R		NO	NO	NO
Ireland	R	IE	NO	NO	R	NO			NO		IE		NO	R	R
Italy	R	R	NO	NO	R	R			NO		NO		R	R	R
Portugal	R	R	R	NO	R	NO			NO		R		R	R	R
United Kingdom	R	IE	NR	NR	R	R			NE		R		NE	R	R
Revegetation Management															
Romania	R	R	R	R	R	NO		R	NO	NO	R	R	R	R	R
Iceland	R	IE	IE	NO	R	NO		R	NO	NO	IE	IE	NE	R	R

Wetlands Drainage and Rewetting																
United Kingdom	NR	NR	NR	NR		NR		NE	NE	NE		NE	NE	NE	NE	

Table 18. Values of FMRL and of its technical correction reported by the Member States, with information on the method applied to construct the FMRL.

Member State	Value inscribed in the Appendix to the annex to decision 2/CMP.7 (kt CO_2 eq/yr)	Technical correction	FMRL based on projections under a "Business-as-usual" scenario		
			Model-based projections using country-specific methodology	Model-based projections using JRC approach	Projections based on historical data assumed as proxy for a "business-as-usual"
Austria	-6516	5823	X		
Belgium	-2499	NA		X	
Bulgaria	-7950	23		X	
Croatia	-6289	905	X		
Cyprus	-157	NA			X
Czech Republic	-4686	NA		X	
Denmark	409	-83	X		
Estonia	-2741	NE		X	
Finland	-20466	-14545	X		
France	-67410	21795		X	
Germany	-22418	NE	X		
Greece	-1830	257			X
Hungary	-1000	-40		X	
Ireland	-142	-571	X		
Italy	-22166	-1680		X	
Latvia	-16302	11703		X	
Lithuania	-4552	-922		X	
Luxemburg	-418	182		X	
Malta	-49	49			X
Netherlands	-1425	NE		X	
Poland	-27133	NA	X		
Portugal	-6830	3286	X		
Romania	-15793	-3665		X	
Slovakia	-1084	-1214		X	
Slovenia	-3171	NE	X		
Spain	-23100	NO		X	
Sweden	-41336	9156	X		
UK	-8268	-14515	X		
EU	-315323	15943			
Iceland	-154	77	X		
EU+Iceland	-315476.5	16020			

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