Annex

Explanatory Note to the revised National Forest Accounting Report for Sweden

Government Offices of Sweden

Ministry for the Environment

Introduction

This explanatory note follows the technical recommendations by EU Commission on the National Forest Accounting Report for Sweden. The responses also include points from the LULUCF expert group assessment report in case they involve additional aspects on the principles and criteria commented by the EU Commission. References to updated sections, tables and figures in the revised NFAP are given in the annex. Technical updates in the modelling of the FRL are presented in addition to the responses to the specific recommendations in the final section of this annex.

Technical recommendations on Article 8(5) Principles

1) Provide transparent documentation of forest management practices in the reference period. Ensure that the approach used in the determination of the FRL reflects the continuation of sustainable forest management practices as documented in the reference period, excluding policy assumptions on harvest rates from the FRL calculation. Provide transparent information on harvest-to-growth ratio from the reference period. In light of 100% harvest rate of net biomass increment applied in the FRL on productive forest land managed for wood supply regardless of age-class distribution, explain how this is applied to modelling of the FRL and revise the FRL accordingly.

Response:

- Sustainable forest management in Sweden is fulfilled by promoting a sustainable growth of trees on managed forest land (MFL) used for wood supply. This is e.g. supported by the Forestry act that makes regeneration after final felling mandatory and sets a minimum age for final felling. Managed forest land set aside mainly for nature conservation is protected according to relevant national environmental quality objectives in line with commitments to the Convention on Biological Diversity.. This is in line with e.g. Annex IV (f) of regulation EU/2018/841. Sweden expects that the net removals on MFL not used for wood supply will be similar in the compliance period as for the FRL.
- In the revised FRL, Sweden is following the recommendation by the EU Commission and has revised the assumptions for the simulations of the FRL. Sweden simulates a continuation of the actual management practices as documented in the reference period, excluding policy assumptions on future harvest rates. The harvest-to-growth ratio in the simulations now reflects the average conditions during the reference period 2000-2009. Statistics of harvest and growth during the reference period has been documented based on the Swedish NFI (table 12) and the statistics has been adopted to the definitions used in the forest model (Heureka)
- The age-class distribution is controlled by simulating harvests that fulfils the minimum age for final felling and according to a model that prioritize which stands that will be harvested. The change in the harvest rate is the only major change in settings arising from the revised simulation along with an updated priority model. The age class distribution of the forests will likely not influence the accounting much.

2) Ensure that harvest volumes projected in the FRL are in line with Art 8(5), reflecting the evolution of dynamic age-related forest characteristics, and revise the FRL accordingly.

Response:

- Swedish forests have a relatively even aged structure and we do not expect that Sweden will gain or lose in the accounting due to skew age class distribution.
- The projected harvest volumes are presented in figure 4 with an explanation how Article 8.5 influence on harvest volumes. The results demonstrates that the model projects the development accurately.
- Sweden has revised its application of Article 8(5) regarding the management practises documented in the period 2000 to 2009, also including harvest intensity as documented in table 12.

Technical recommendations on Annex IV, Section A Criteria

c) Justify how the proposed FRL ensures a robust and credible accounting system in light of documented forest management practices during the reference period.

Response:

- Harvest-to-growth ratio has been adjusted to the historical level during the reference period, see response to technical recommendations on Article 8(5) above. The resulting FRL is presented along with historical data from the GHG-inventory (table 2 and table 11), where categories in the GHG-inventory have been reorganized in order to be comparable to those applied in the modelling of the FRL. Overall, there is good agreement between the FRL 2021-2025 and the averages for the reference period 2000-2009 for the overlapping subcategories (table 11), which implies that a robust and credible modelling system is used.
- The forest simulation has been updated with a function for the priority of harvesting objects that better reflects the forestry practises during the reference period, which is based on actual forest owner behaviour. This has resulted in less frequent harvests in old forests (figure 7-9) and older age classes are maintained or increases compared to the previous FRL.

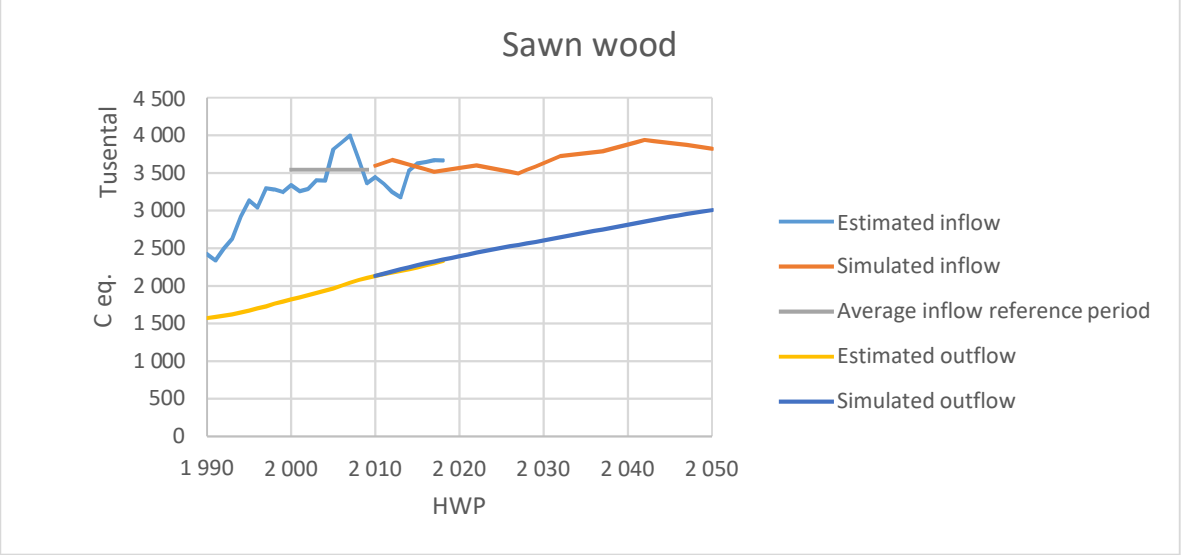
d) Provide an explanation on the decreasing trend of HWP sink and include the projected shares of different HWP categories while harvests are increasing.

Response:

- The revised FRL is recalculated based on updated harvest levels and the trend in HWP now follows the harvest rates more closely, see figure 10 and the figure supplied below.
- The change in the HWP pool is based on inflow and outflow from the pool. The recalculated HWP inflow per sub-category (sawn wood, wood based panels and paper and paper products) is based on the simulated harvested volumes of sawlogs and pulpwood. Since harvest of fuelwood cannot be simulated by the Heureka-system, fractions of the simulated volumes of sawlogs and pulpwood were transferred into fuelwood at the same rate as during 2000-2009 before the sawlogs and pulpwood entered the HWP-calculations. Sawlogs were transferred into sawn wood at the same rate as during 2000-2009, while the remaining part of the sawlogs were added to the volume of pulpwood, which in turn was allocated to wood based panels, energy and pulp and paper as during 2000-2009. The initial stock in 2010 of each product category was taken from the GHG-inventory calculations.
- There was a large input of products during the reference period due to increasing harvest rates and forest industry production in the reference period and in the period before the reference period. Since the main part of the outflow is calculated as a fraction of this large pool, the outflow does not react rapidly to sudden inflow changes as exemplified with sawn wood in the figure below. Thus, the rapid harvest increase before and during the reference period resulted

in a large difference between in- and outflow and thereby a large reported HWP-sink. In the simulations the harvest of saw logs do not increase during the first 20 years. So the inflow of sawn wood remain rather constant while the outflow from the pool increase as the HWP pool grow larger, which results in a lower HWP-sink compared to the reference period. Since the revised FRL assumes a lower harvest rate, the HWP sink has decreased accordingly, as compared to the FRL in the original NFAP.

- Sawn wood is the most important pool (net removal) and the strong positive trend in inflow 1990-2008 was due to expanding forest industry capacity in combination with natural disturbances 2005-2008.



e) Provide a ratio between solid and energy use of forest biomass as documented in the period from 2000 to 2009 used for the estimation of the forest reference level and demonstrate it remains constant throughout the projection.

Response:

- The ratio between solid and energy use of forest biomass has been documented in the report in a transparent way as noted by in the synthesis report of the LULUCF expert group. In figure 10 the development and relative distribution of the harvest of different HWP subcategories are presented for the historical period 1990-2017 and for the FRL simulation.

f) Provide more information on the projected development of total forest area of old forest stands (>80 years). Provide additional information on the impact of projected increased harvest on biodiversity.

Response:

- Harvests are only simulated in MFL used for wood supply and since harvest rate in the revised FRL is less than 100% - and harvests are not allowed in forest not used for wood supply - the proportion of older tree stands will most likely increase.
- The forest simulation has been updated with a function for the priority of harvesting objects that better reflects the forestry practises during the reference period, which is based on actual

forest owner behaviour. As a result more old forests is maintained in the production land in the simulations compared to the previous FRL, especially forest older than 140 years.

- The documentation of age class distributions in the simulations show that old forest >120 years are increasing in the FRL (figure 7-9), mainly due to the contribution from areas protected from forestry.
- Even though the principle forest management practises remain constant, the predicted increase in forest growth has implications on the outcome of the simulations, e.g. regarding harvesting age. The increased growth leads to a more rapid basal area development and consequently the forests tend to become harvested at a younger age. This means that the diameter distribution in the forests will be maintained, but there will be a trend towards slightly younger stands in the managed forest land used for wood supply.

g) Demonstrate the consistency with the national projections of anthropogenic greenhouse gas emissions reported under Regulation (EU) No 525/2013. Provide explanations for possible differences between national projections and the proposed FRL.

Response:

- The purpose of the two projections are not the same and are not necessarily supposed to be similar. The national simulation under Regulation EU/2013/525 is a prognosis of the actual development to follow up whether Sweden will fulfil its commitment according to Regulation EU/2013/525, while the FRL is a scenario used in the accounting according to Regulation EU/2018/841.
- The principle methodology used in the two projections are the same, although the harvest rates assumed after 2010 are quite different in the two simulations, since the FRL rely on conditions during the reference period 2000-2009.
- Model development in the period after 2013 has resulted in different changes that have improved the estimates and enables a more complete representation corresponding to the GHG inventory.

h) Estimate the FRL based on the area under forest management as indicated in Annex IV, Part B (e) i. Use the conversion period for Land converted to forest land (Afforested Land) consistent with the latest national GHG inventory. Demonstrate the ability of the model used to construct the FRL to reproduce historical data from the national GHG inventory. Demonstrate the consistency between historical data from the national GHG inventory and modelled data for estimating the FRL for the reference period. Specifically, information is required on 1) the validation of simulated increments for all stands and present values of increment instead of total volume, 2) the demonstration of the modelling framework to reproduce historical harvest data, 3) the bias between measurements and model estimates for mineral soils.

Response:

- Afforested Land (AL) is now assumed AL 20 years after land use conversion.
- The initial state of the simulations in 2010 is based on data (and data base) used for the climate reporting. The net removals for living biomass during the reference period is reported using the stock difference method and does not separate growth and harvest. Reported and simulated changes in living biomass are compared in figure 2 of the report. A comparison about growth and harvests has to be made using alternative estimates from the same source

(The national Forest Inventory), see figure 4 in the report. Observe that e.g. harvest represent annual values while the net removals (figure 2) is reporting a trend (due to stock difference method, a five-year inventory cycle recommended by IPCC is used).

- Simulation of the development during 1990-2010 has been carried out based on the modelling framework applied for the FRL for living biomass, see section 1.6 (under Annex IV, section A (h)). The simulation was based on historical data of the forest state and documented historical forest management practises and the same principles for land conversion as the GHG inventory. The results are presented as changes in GHG emissions as CO_2 equivalents for living biomass and related to historical data from GHG inventory (figure 4a). Annual net forest increments and harvests for the period 1990-2010 are presented along with standing volumes (figure 4b).
- A former research study was used as reference for the validation of the soil model. However, it was based on simulations over very long time-span (1926-2000) using historical forest data reflecting the long term development. The short term changes in the latter part of the simulation period are rather uncertain. A direct validation of the model with regards to mineral soil carbon is conceptually difficult since the humus and mineral soil pools are not differentiated. The resulting FRL is compared to the GHG-inventory data and presented for harmonised reporting categories (table 11), which means that litter, soil and stumps (normally reported as Dead wood) are combined. The results shows a rather good agreement between the litter/soil/stump pool and the GHG-inventory data considering the uncertainties and does not indicate the presence of any strong bias in the modelling.

Technical recommendations on Annex IV, Section B Elements

c) Document sustainable forest management practices in the reference period, including information on harvesting intensities per strata, using consistent sources, definition and units, and apply those to the forest development during the simulation, and subsequently the calculation of the FRL.

Response:

- Table 10 in the National Forest Accounting Plan presents the document sustainable forest management practices in the reference period for different regions (strata). These settings have been applied in the simulation of the FRL for the different regions.
- Additional information on forest management practises in the reference period – harvesting intensities (for different strata) are found in table 2, table 12, figure 1, and figure 4.

e) i Provide the area under forest management consistent with Table 4.A ("Forest land remaining Forest land") from the latest national GHG inventory using the year preceding the starting point of the projection, and the future development of the managed forest land area, including afforested and deforested land.

Response:

- The area of Forest land remaining Forest land 2010 reported in Submission 2019 was 27 877 000 ha and formed the basis for the simulations. The Forest land area at the start of the simulation was 27 479 000 ha and the difference compared to the reported value is that an area of ca 400 000 ha in the mountain region was included in the reported value, this difference will be adjusted for in the coming reports to the UNFCCC. These unmanaged forests in the mountain region are low productive and near steady state, which means that they have an insignificant influence in the GHG-reporting.

- After 2010 the area of managed forest land increased by the inflow from afforested land (in average 18 000 ha per year) and decreased by the outflow of deforested land (in average 12 600 ha per year) so the areas of Forest land 2015, 2020 and 2025 were 27 506 000, 27 531 000 and 27 560 000 ha respectively.

e) iii Provide information on increments, age-related dynamics and rotation length. Provide the projected increment per strata for historic data and the compliance period.

Response:

- General information on increments are given in figure 1 and figure 3
- Information on age related dynamics are given in figure 7, figure 8, and figure 9
- Information on increment for historic data are given in figure 3 and figure 4b
- Increment for the compliance period are given in table 3 and figure 16

Technical updates in the simulations of the revised FRL

- In the work on the revised FRL, a number of technical updates of the modelling system have been made. These updates were partly made in order to meet the requests from the EU technical recommendations and partly to improve the quality in the simulations.
- In the Swedish GHG-inventory the uptake in small trees (<10 cm diameter) is based on a constant value calculated based on NFI data from a long time period. This approach was chosen since the measurements were deemed too uncertain for annual follow-up. In order to achieve better consistency between the FRL and the GHG-inventory, the same methodology has been introduced in the revised FRL and the smaller trees are not handled by the forest model anymore.
- The forest simulation has been updated with a function for the priority of harvesting objects that better reflects the forestry practises during the reference period. The previous FRL showed an initial decline in the amount of older (spruce) forests as a result of the previously applied model. Now, the amount of old forests is maintained or increases in the simulation.
- The area and volume of pre-commercial thinning was decreased slightly compared to the previous FRL, due to an observed overestimation found in the simulations.
- The initialization of the model for litter and soil was improved by applying a spin-up period during 1990-2009, assuming an annual litter input that was increasing up to the same level as the first period of the forest simulation (2010-2014) at a similar rate as the growth.