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Report of the technical assessment of the forest management reference level submission of Finland submitted in 2011

Contents

I. Introduction and summary

A. Overview

1. This report covers the technical assessment (TA) of the submission of Finland on its forest management reference level (FMRL), submitted on 25 February 2011 in accordance with decision 2/CMP.6. The TA took place (as a centralized activity) from 23 to 27 May 2011 in Bonn, Germany, and was coordinated by the UNFCCC secretariat. The TA was conducted by the following team of nominated land use, land-use change and forestry experts from the UNFCCC roster of experts: Mr. Nagmeldin G. Elhassan (Sudan), Mr. Giacomo Grassi (European Union (EU)), Ms. Rehab Ahmed Hassan (Sudan), Mr. Vladimir Korotkov (Russian Federation), Mr. Rae-Hyun Kim (Republic of Korea) and Mr. Kevin Black (Ireland). Mr. Nagmeldin G. Elhassan and Mr. Giacomo Grassi were the lead reviewers. The TA was coordinated by Ms. María José Sanz-Sánchez (UNFCCC secretariat).

2. In accordance with the “Guidelines for review of submissions of information on forest management reference levels” (decision 2/CMP.6, appendix II, part II), a draft version of this report was communicated to the Government of Finland, which provided comments that were considered and incorporated, as appropriate, into this final version of the report.

B. Proposed reference level

3. Finland’s submission contains an updated value for the FMRL that replaces the previous value (–13.70 million tonnes of carbon dioxide equivalent (Mt CO_2 eq) per year) inscribed in decision 2/CMP.6. The new value is –20.1 Mt CO_2 eq with removals from harvested wood products (HWP) using the first-order decay function. The FMRL value is –19.3 Mt CO_2 eq assuming instantaneous oxidation from HWP.

4. Finland explained that the previously submitted value of its FMRL has been changed because of several changes in its greenhouse gas (GHG) inventory. These include recalculation of carbon stock changes in living biomass, dead organic matter and soils. Since the 2009 GHG inventory submission, Finland has implemented new national biomass models for trees, as well as new biomass conversion factors for biomass growth and drain. The litter input data for the soil model were recalculated due to the changes in the biomass estimation. The weather data applied in the soil carbon model YASSO were revised, based on a recommendation of the expert review team (ERT).

5. During the TA, Finland also provided additional information on HWP indicating that a mistake had been found in the calculation of the ratio of industrial round wood consumption from the domestic harvest due to the fact that industrial round wood exports as well the imports and exports of chips, particles and wood residues were not subtracted from the domestic round wood production. As a result, the removals appeared smaller than they should have been and, accordingly, the HWP contribution to the FMRL has been increased to –1.166 Mt CO_2 eq compared with the previously submitted value of –0.715 Mt CO_2 eq. This additional information implies a further revision of Finland’s FMRL.

II. General description of the reference level

A. Overview

6. Finland's FMRL is an average value of the projected removals and emissions in the period 2013–2020. The projection of the carbon stock changes has been developed based on the results of two models, the SF-GTM forest sector model and the MELA forestry model, which were used to produce the scenario based on the national forest inventory (NFI) data. Projections of emissions from nitrogen (N) fertilization and biomass burning were estimated based on the emissions reported in the GHG inventory. For the projection of CO_2 emissions/removals from HWP the data from the FAOSTAT database, national forestry statistics and the Long-term Climate and Energy Strategy were used.

B. How each element of footnote 1 to paragraph 4 of decision 2/CMP.6 was taken into account in the construction of the reference level

1. Historical data from greenhouse gas inventory submissions

7. Finland estimated the emissions and removals from forest management using the same data source (NFI), methods, conversion factors and emission factors that were used for its national GHG inventory. As explained by Finland, in reporting under the Convention it uses a slightly different definition for forest land from that used for forest land in reporting under the Kyoto Protocol. In the Protocol reporting, forests that are smaller than 0.5 hectares (ha) are excluded, but in the Convention reporting they are included. Afforestation and reforestation areas since 1990 and future deforestation areas are excluded from the FMRL. The average value for deforestation is calculated based on the period 2004–2008 and assumed as an annual deforestation rate in 2009–2020. The source categories and gases that are included in the FMRL are the same as those included in the national GHG inventory. Possible emissions from force majeure are included in the historical emissions but not in the model projection. The emissions and removals from biomass, dead organic matter and soil organic matter were recalculated in line with the new biomass conversion factors and other changes made for the 2011 GHG inventory.

8. Finland provided transparent information regarding its historical and projected removals and emissions, explaining how these relate to its GHG inventory reporting under both the Convention and the Kyoto Protocol.

2. Age-class structure

9. Finland's age-class structure is consistent with its projected FMRL. Finland stated that the area of forests over 120 years does not decrease by 2020 because such forests are mainly in the protected areas in North Finland where felling is prohibited.

3. The need to exclude removals from accounting in accordance with decision 16/CMP.1, paragraph 1

10. See paragraph 32 below on factoring out.

4. Other elements

<u>Forest management activities already undertaken</u>

11. Finland provided a clear description of how current forest management is considered in the construction of its FMRL. All forests in Finland are under forest management.

Finland used the latest NFI (2004–2006) data to represent the effects of the activities already undertaken in the model used. The forest management activities simulated by MELA are in accordance with the Forest Management Practice Recommendations (2006), which are in common use in Finland. With regard to continuity with the treatment of forest management in the first commitment period of the Kyoto Protocol, Finland stated that the information on forest management is provided in the same way as in the first commitment period except for HWP.

C. Pools and gases

12. Living biomass, dead organic matter and soil pools are included. Nitrous oxide (N_2O) emissions from fertilization and emissions from biomass burning (controlled burning and wildfires) are also included. On the other hand, N_2O emissions from drainage of soils are not included in the FMRL, but are not reported in the GHG inventory either, and liming of forest lands does not occur in Finland. The carbon pools and GHG sources in the FMRL are consistent with Finland's 2010 GHG inventory.

D. Approaches, methods and models used

13. The same gain–loss[please confirm] method as that used in the GHG inventory and the biomass conversion factors recalculated for the 2011 submission have been applied to estimate carbon stock change in living biomass. For projections of carbon stock change in biomass, the models SF-GTM and MELA were used to drive the mean value for increment and drain. The afforestation and reforestation areas have been subtracted from total increment and the deforestation area subtracted from total drain. The total gain and loss were computed by multiplying the mean increment and mean drain by the annual forest management area. The methodology for the estimation of carbon stock changes in soil, litter and dead wood on mineral soils and drained organic soils is the same as in the GHG inventories (2010 national inventory report (NIR), 2011 NIR). For managed mineral forests soils, the Yasso model was applied. This method combines forest inventory data, biomass models, litter turnover rates and dynamic soil carbon modelling. The method used for emissions estimation from drained organic soils combines forest inventory data, biomass models, litter turnover rates and country-specific emission factors. For biomass burning and N_2O emissions from N-fertilization, the method in the GHG inventory (2010 NIR) was used and the values used for the years 2009–2020 were assumed to be at the level of the average of the years 2004–2008.

14. The approaches and methods used by Finland are both transparent and consistent.

E. Description of the construction of the reference level

1. Area under forest management

15. Finland provided a transparent description of the area used in the construction of its FMRL. The area under forest management was 21.904 million ha in 2006 (2010 NIR), with a projected area of 21.688 million ha in 2020. The area under forest management from 2009 to 2020 was projected from the area reported in the GHG inventory (2010 NIR) for forest management in 2008 (see table 7 in the submission). All forests in Finland are managed and under forest management activity, so new forest land was not expected to come into the accounting outside the reported forest management area. The time series for the forest management area was constructed as follows: for the years 1990–2008, the areas for forest management were as reported in the GHG inventory (2010 NIR); an annual average of deforestation areas in the period 2004–2008 was calculated and this was subtracted every

year from the forest management area until 2020; afforestation, reforestation and deforestation areas were not included (this is why the forest management area shows a decline in table 7 of the submission).

2. Relationship of the forest land remaining forest land category with the forest management activity reported previously under the Convention and the Kyoto Protocol

16. See chapter II.B.1 (paras. 7 and 8 above) on historical data from the GHG inventory submission.

3. Forest characteristics

17. Finland provided information on the characteristics of its forest resources relevant to the construction of its FMRL. The age-class distribution in 2006 is based on the tenth NFI (2004–2006). This distribution was used as an initial state in the MELA scenario to develop the distribution for 2016 and 2026. Increments of growing stock for 2010, 2020 and 2030 were constructed based on the increments that MELA predicted for periods 2006–2015, 2016–2025 and 2026–2030. The MELA increment predictions were based on the growth models, mortality models, increment of growing stock measured in the tenth NFI, the growth level (growth index) computed from data in the sixth to the tenth NFIs and the forest management practices executed by the model. According to the Forest Management Practice Recommendations, maturity of a forest stand is determined by the mean diameter of a stand and the stand age.

4. Historical and assumed harvesting rates

18. Finland reports that logging removals and the total drain statistics compiled by the Finnish Forest Research Institute were used for its FMRL projections and for the GHG inventory (2010). The historical removals and drain were used to estimate the litter input to the soil.

19. The ERT noted that for forest management in 2009, Finland reports very different values for removals reported under the Kyoto Protocol in 2011 (–50279 Gg CO_2 eq) from those in the FMRL submission (–16687 Gg CO_2 eq). The ERT noted that the FMRL submission should show information consistent with the other submissions from Finland (e.g. Kyoto Protocol reporting).

20. Finland explained that the net sink in 2009 in its FMRL submission is based on the MELA model and corresponds to the objective of its National Forest Programme (NFP). The objective of the NFP is to increase annual felling by up to 65–70 million cubic metres by 2015. The NFP is still valid and forms the basis for the forest policy in Finland. The MELA model was run for the years 2006–2050 but the actual net sink for forest management for the years 2007–2009 could not be considered in the model. The year 2009 was exceptional in the inventory because of the economic recession (low harvesting rates and thus a high sink).

21. The ERT noted that a relatively small increase in the harvesting rate predicted for 2013–2020 produces nearly a halving of the sink reported for most recent years. When analysing possible reasons for the sudden decline of the sink predicted for 2010 onwards, the ERT noticed a sudden change in the values of the gains (i.e. increment) in living biomass between the period 2000–2009 (data from the GHG inventory) and the period 2010–2020 (data from the model). Given that gains typically reflect the age-class structure, they typically show gradual changes. The different values of increments used by the models and those used for the GHG inventory suggests a possible inconsistency.

22. Finland explained that the change in the gains between current Kyoto Protocol reporting and its FMRL submission is not great (approximately 8 per cent), and that when total drain is considered (i.e. harvest, waste wood and natural mortality), the future increase is substantial (about 20 per cent). Finland indicated that reports on the use of the MELA model have been published, most of them in peer-reviewed journals. The historical harvest and drain values have not been used in the MELA model for the FMRL construction. The assumption on future loggings is the key driver for the reference level sink. Even if the historical harvest and drain were to be applied for the years 2006–2009, the harvesting rate would be at a higher level for 2010 and onwards, and the effects of the changes in the age-class structure would be less significant. Finland presumes that the result of a rerun for the period 2013–2020 would be similar to that in the scenario presented in its FMRL submission.

23. The ERT does not question the functioning of the model or the assumption of future loggings, which certainly have a prominent role in setting the FMRL. However, the absolute value of the FMRL is also significantly affected by the increment value used by the model. The ERT notes that the assumptions on future harvest may account for a large part of the sudden decrease in the sink between 2000–2009 and 2010–2020, but not for all of it. The ERT also notes that the 8 per cent difference in the values of the increment used by the model and in the latest GHG inventory corresponds to about 8–10 Mt CO_2 eq. This difference probably plays a role in the sudden decrease of the sink.

24. The ERT considers that a model used for predictive purposes should demonstrate the ability to reproduce past levels and trends of emissions and removals approximately as reported in the GHG inventory. This is necessary to ensure time-series consistency. If this does not happen, the model's results should be somehow ex post-processed using techniques recommended by the Intergovernmental Panel on Climate Change (IPCC) to ensure time-series consistency.

25. In response to an initial recommendation by the ERT to evaluate the model's results in relation to the data reported in the GHG inventory (e.g. for 2006–2009), Finland provided two new model runs and additional explanations and comments (see annex, section B). The Party explained that the difference between the GHG inventory and the model's run is caused by the fact that the GHG inventory uses increments measured in the last NFI (2004–2008), whereas the model uses growth estimates representing the long-term average growth level (1977–2008). Finland considers that the reported emissions and removals cannot be exactly the same as the predicted emissions and removals because predicted values contain assumptions for models and included policies. Furthermore, Finland stated that post-calibration of the model's results is not considered valid because the assumptions and the model's parameters will no longer stand.

26. The ERT considers the information above provided by Finland very useful, but also notes that this information does not fully explain the differences between the GHG inventory and the model's results (see figure 1 in the annex for a comparison of data from the GHG inventory and various model runs provided by Finland during the TA). For instance, for 2009 the difference in the sink between the GHG inventory and the MELA model scenario low harvesting (using the same level of harvest as the GHG inventory) is nearly 25 Mt CO_2 eq. This significant difference highlights a potential important inconsistency between the model's results and the GHG inventory. This difference appears only in small part explainable by the different gross increments used by the GHG inventory and the model (see figure 2B in the annex). In an additional response, Finland explained that a further cause of the above difference for 2009 is due to the treatment of natural mortality in the model versus the GHG inventory (i.e. in the model the low harvest in 2009 led to an increase in natural mortality). The ERT considers this additional information as useful.

5. Harvested wood products

27. During the TA, Finland provided additional information indicating a mistake in the contribution of HWP to the FMRL, which is calculated to be –1,166 Gg CO_2 eq as opposed to the value given in its FMRL submission (–715 Gg CO_2 eq) (see para. 5 above).

28. Emissions and removals from HWP were calculated from domestically produced and consumed HWP. Wood used for production originated in forests that are accounted for under Article 3 of the Kyoto Protocol. The approach employed was the stock change approach, which Finland used to report carbon stock changes in HWP to the secretariat, but the exported HWP was excluded. Finland used the first-order decay function with default half-lives. Default conversion factors for conversion from product units to carbon was used from the *2006 IPCC Guidelines for National Greenhouse Gas Inventories* (hereinafter referred to as the 2006 IPCC Guidelines). FAOSTAT data and national forestry statistics were used for the years 1961–2009 (table 13 of the submission). From 2010 to 2020 the production of sawn wood, wood-based panels, paper and paperboard was set in accordance with the results of the SF-GTM model and the MELA scenario. The quantity of exported products was estimated by multiplying the average export of goods for the period 2000–2009 by the annual production figures.

29. Finland indicated that in its calculation all harvested wood was allocated to forest management. Therefore, accounting under Article 3 should be part of the technical correction as suggested in document FCCC/KP/AWG/2010/18/Add.1, chapter II, annex I, paragraph 15 quater.

30. Information reported on HWP is transparent and consistent with national inventory reporting.

6. Disturbances in the context of force majeure

31. Finland's FMRL construction does not include force majeure. Finland has experienced large-scale storm damage that could be classified as force majeure disturbances. However, in the current GHG inventory this damage is included as a part of the NFI measurements, but not reported separately.

7. Factoring out

32. Use of a projected reference level is considered to factor out dynamic age-class effects. With the present state of science and knowledge, the effects of elevated CO_2 concentrations and indirect nitrogen deposition are considered to be approximately the same in the reference level and in the estimated period (i.e., the commitment period), and therefore they can be assumed to factor out.

F. Policies included

1. Description of policies

33. Finland provided a very transparent and detailed description of the regulations, laws and policies that have been taken into consideration in the construction of its FMRL. It is also made clear in the submission that the current national forest act was adopted in 1996 and the current NFP was last updated in 2008.

2. How policies are taken into account in the construction of the reference level

34. Both the NFP 2008 and the NFI 2006 were taken into account in the modelling framework used to construct the FMRL, and only the EU regulations adopted before the end of 2009 are considered.

III. Conclusions and recommendations

35. The FMRL submitted by Finland contains complete information on all the elements required by decision 2/CMP.6. The information submitted describes in a transparent manner the data, methodologies and assumptions used and how the elements contained in footnote 1 to paragraph 4 of decision 2/CMP.6 have been addressed in the construction of the FMRL.

36. As described in paragraphs 18–26 above, during the TA the ERT noted a potential inconsistency between the input data (e.g. increment and historical harvest) used by the model and the data used in the latest GHG inventory, which may have an impact on the estimation of the FMRL. The ERT recommended that the Party evaluate the model's results in relation to the data reported in the latest GHG inventory through a rerun of the model using all the available historical harvest data, and then comparing the model's results with data reported in the GHG inventory (e.g. for the period 2006–2009). If significant discrepancies are noticed, the techniques recommended by the IPCC to ensure time-series consistency could be considered (e.g. 2006 IPCC Guidelines, volume 1, chapter 5.3), for example, through a post-calibration of the model's results.

37. In response to the above-mentioned recommendation, Finland provided two new model runs and additional explanations and comments (see annex, section B). Finland explained that the difference between the GHG inventory and the model's run is caused by the fact that the GHG inventory uses increments measured in the last NFI (2004–2008), whereas the model uses growth estimates representing the long-term average growth level (1977–2008). Furthermore, Finland stated that post-calibration of the model's results is not considered valid because the assumptions and the model's parameters will no longer stand.

38. The ERT considers that a model used for predictive purposes should demonstrate the ability to reproduce past levels and trends of emissions and removals approximately as reported in the GHG inventory. If this does not happen, the model's results should be somehow ex post-processed with techniques recommended by the IPCC (e.g. overlap) to ensure time-series consistency. Finland stated that post-calibration of the model's results is not considered valid because the assumptions and the model's parameters will no longer stand. The ERT agrees that any post-processing (e.g. calibration of model's results) of the model's results would change the coherence of the assumptions made by the model, but at the same time it considers that for the purpose of setting the FMRL values the consistency and comparability between the GHG inventory and the model's results is of utmost importance. Finland also stated that it considers the IPCC overlap technique as not applicable because the GHG inventory provides annual values while the estimates computed by the model for the FMRL represent average values for a much longer period. The ERT recognizes this difference between the GHG inventory and the model's results and for this reason considers that it would be better to compare the model's results and the GHG inventory for at least two years (e.g. 2006–2009).

39. The ERT considers the information provided by Finland very useful. This information shows that the differences between the model results and the data reported in the GHG inventory are mainly due to the following factors:

(a) Future increment is affected by the fellings;

(b) The GHG inventory uses increments measured in the last NFI (2004–2008), whereas the model produces growth estimates of which the annual variation in climatic factors are removed using the growth indices, resulting in lower increments used by the model versus the GHG inventory;

(c) The different treatment of natural mortality in the model versus the GHG inventory.

The ERT notes that, for setting the FMRL, Finland used a model which does not reproduce the level of removals reported in the GHG inventory (i.e. for the year 2009 the removals estimated by the models are about half those in the GHG inventory), creating an inconsistency in the time series. The ERT also notes that IPCC techniques to ensure time-series consistency could address the above inconsistency.

Annex

Documents and information used during the technical assessment

A. Reference documents

Submission of information on forest management reference levels by Finland, 18 April 2011. Available at <http://unfccc.int/files/meetings/ad_hoc_working_groups/kp/application/pdf/awgkp_finland_2011.pdf>.

National greenhouse gas inventory of Finland submitted in 2010. Available at <http://unfccc.int/5270.php>.

National greenhouse gas inventory of Finland submitted in 2011. Available at <http://unfccc.int/5888.php>.

B. Additional information provided by the Party[1]

B.1 Comparison of data from the GHG inventory and model runs provided by Finland

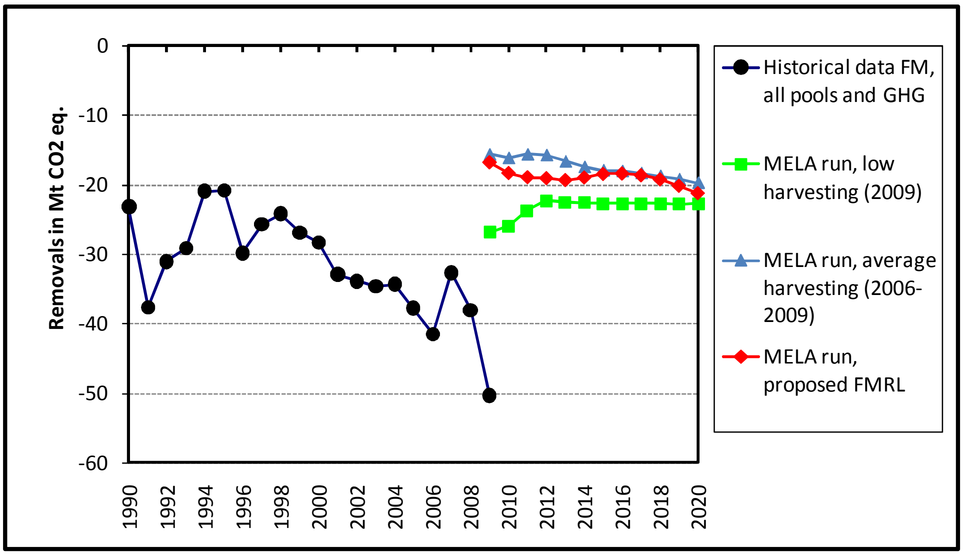


Figure 1. Comparison of data from the GHG inventory and various model runs provided by Finland during the TA

B.2 Additional information provided by the Party

In the conclusions and recommendations of the zero order draft report, the ERT recommended Finland to evaluate the model's results in relation to the data reported in the latest GHG inventory. The ERT highlighted a question of the different values of increments used by the model and used for GHG inventory and suspected a possible inconsistency

[1] Reproduced as received from the Party.

between these increment values. The ERT also considered that the actual harvests of years 2006-2009 could have an effect on the level of the FMRL. Historical harvest volumes were not directly utilized in the construction of the FMRL. The ERT recommended a re-run of the model with the latest historical harvest data.

In response to the ERT's recommendation, the MELA model was re-run to estimate the future increment of growing stock and drain. The MELA model is designed to optimally run and produce results for 10-year periods. Therefore the annual harvest volumes were not applicable to use. The two re-runs of the model were conducted with different harvest levels to illustrate the effect of two different historical harvest rates to the future development of forest resources.

The first run represented an average harvest rate calculated from harvest volumes of years 2006-2009 and the second run represented a low harvest rate being the harvest volume of the year 2009 (Table 1). The submitted FMRL represented the high harvest rate. In the FMRL the harvests were set according to the National Forest Programme 2015 (NFP 2015) (Government Resolution 27.3.2008) for 2006 and onwards.

Table 1. Harvesting removals (M m^3/yr) in the three MELA runs.

	2007-2009
Low harvesting (2009)	54.514
Average harvesting (2006-2009)	64.360
FMRL	69.673

For the re-runs two historical harvest rates, the average harvest and the low harvest were set for years 2007-2009. The model was set to reach the NFP 2015 target harvest rate in 2015. For years 2010-2014 an average of the historical rate and the NFP rate was used. (Figure 1)

Data from the 10th National Forest Inventory (NFI) from years 2004-2008 were used in the model re-runs. The new scenarios start from year 2007, because more recent data were used. The submitted FMRL scenario started from year 2006.

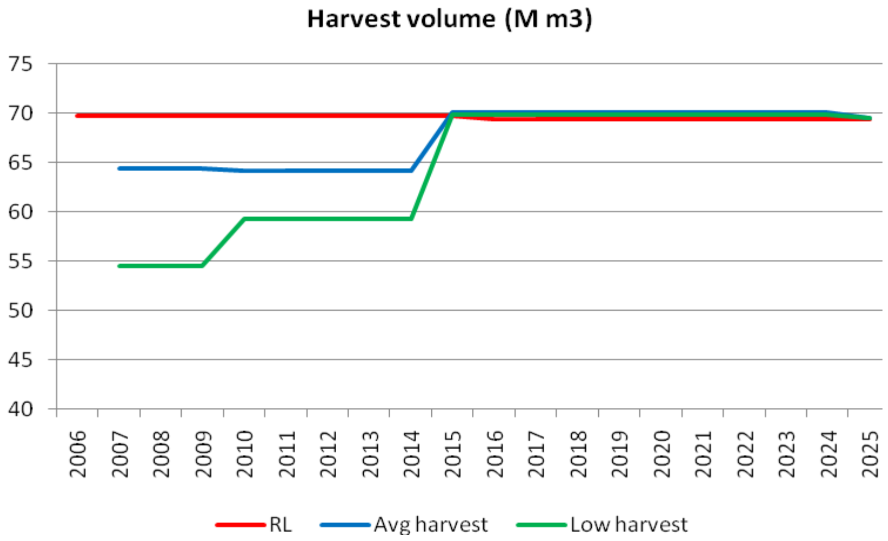
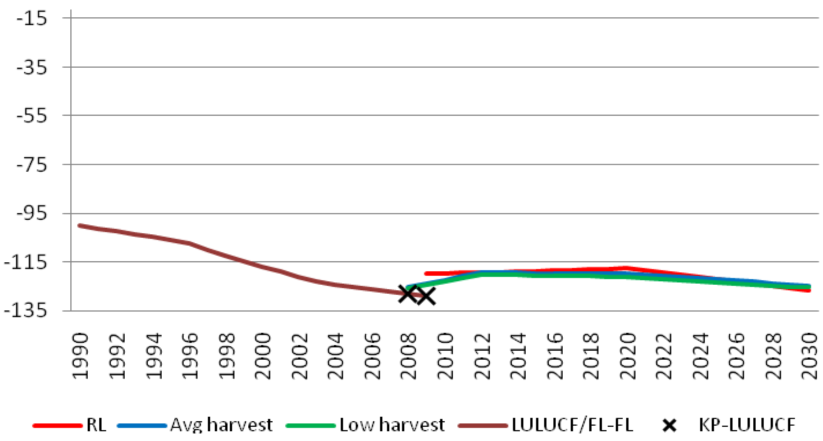


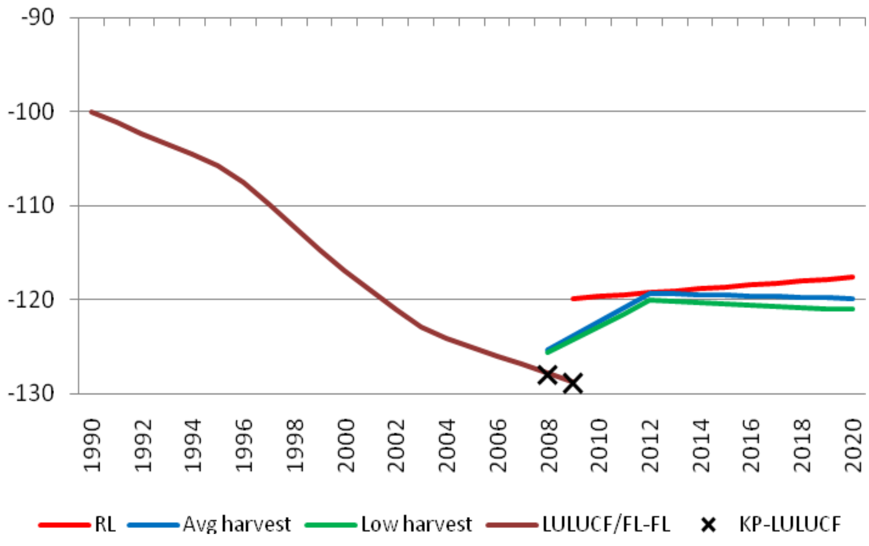
Figure 1. Harvest volumes in the three MELA runs. RL = harvest rate of the submitted FMRL, Avg harvest = average harvest rate for years 2007-09, Low harvest = low harvest rate for years 2007-09.

Results of the model re-runs and evaluation of model's results in relation to the reported data

In Figure 2.A and 2.B are the removals (increment) of the tree biomass reported in the latest GHG inventory and the predicted removals in the submitted FMRL and as results of the two re-runs. The reported values and the projections overlap in years 2008 and 2009. The reported KP-LULUCf removals are higher than the predicted ones. The difference between the reported KP-LULUCF and the predicted removals in 2008 is 2.6 Tg CO_2 (Avg harvest) and 2.4 Tg CO_2 (Low harvest) and in 2009 5.0 Tg CO_2 and 4.7 Tg CO_2, respectively. The difference is caused by the difference between MELA increment and actual increment (i.e. measured increment). In the GHG inventory, estimates are calculated from the increments measured in NFI whereas the MELA growth estimates represent the long-term average growth level. That is discussed more detailed below.



A.



B.

Figure 2. The reported and predicted removals in living tree biomass (Tg CO_2). RL = harvest rate of the submitted FMRL, Avg harvest = average harvest rate for years 2007-09, Low harvest = low harvest rate for years 2007-09, LULUCF/FL-FL = reported under the Convention from forest land remaining forest land, KP-LULUCF = reported under the Kyoto Protocol from Forest management.

Reported biomass increment data

The biomass increment of living trees was estimated using tree-level measurements on field sample plots of the NFI and Finnish biomass models (Repola et al. 2007, Repola 2008 and Repola 2009). For the 2011 submission (NIR 2011), the data came from the NFI8, NFI9 and NFI10. In addition to the current biomass, estimation of biomass five years before the inventory was conducted. This was obtained from measurements of five years' increment in the breast-height diameter and in the height of trees. The differences divided by five served as estimates of annual biomass increments. The total annual biomass increments of living trees were estimated separately from the three NFIs for mineral and organic soils of Southern and Northern Finland. Each estimate was allocated to the appropriately weighted mean of the mid-points of the five years' period of increment measurements. Interpolation between these time points and extrapolation beyond them was carried out as described in the NIR 2011.

This measured growth is affected by annual growth variation caused mainly by weather conditions, which increase or decrease growth.

Growth in MELA model

MELA calculations are long-term calculations so the models used must correspond with the long-term increment level. In MELA growth models the increment is calibrated to long-term average increment (Hynynen et al. 2002). Because the future weather and climate conditions and thus growth are not known, MELA uses long-term historical growth data.

The level of basal area growth models was calibrated with NFI10 trees measured in 2004-2008. Before calibration, the measured growth was corrected with growth indexes based on NFI data to correspond with the average level of growth in 1977-2008. This was done to reduce the effect of annual variability in weather conditions on diameter growth.

The calibrated model can not produce the same level of growth as the measured results if the increment affected by weather in the measurements differs from the long-term average increment (Kari Härkönen, pers.comm. 2011).

The values in the growth indexes (Figure 3 and 4) are scaled so that the average of the period 1965-2009 equals 100. Even though this is not the same growth index as in MELA calculations (MELA growth index is based on years 1977-2008) it can be seen that the values of growth indexes in years 2004-2008 (based on NFI10 measurements) have been mostly more than 100. It means that the increment used in MELA models has been scaled to correspond with the long-term average. This is why MELA increments are a little smaller than the measured increments for those years.

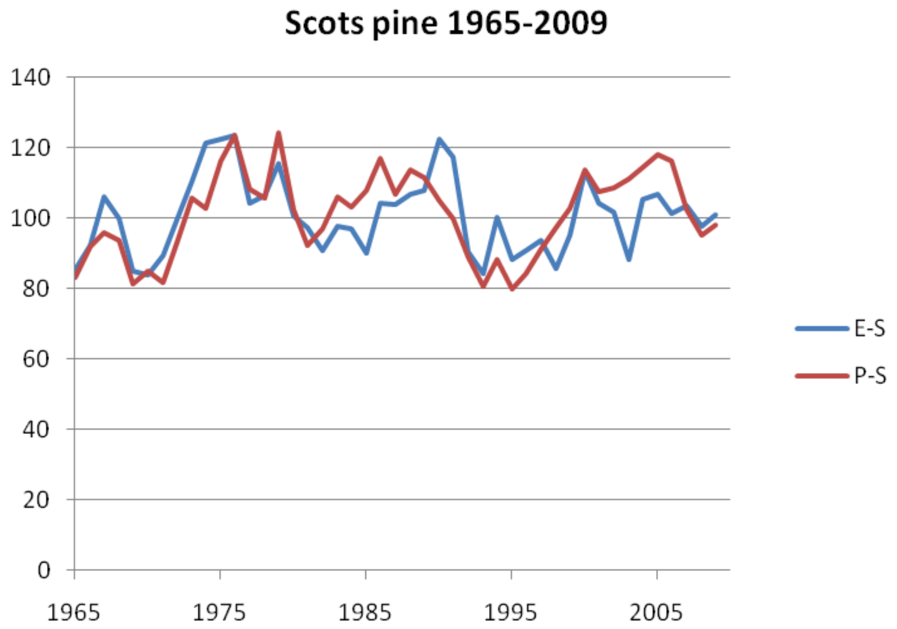


Figure 3. An example of growth index for Scots pine in Southern (E-S) and Northern (P-S) Finland.

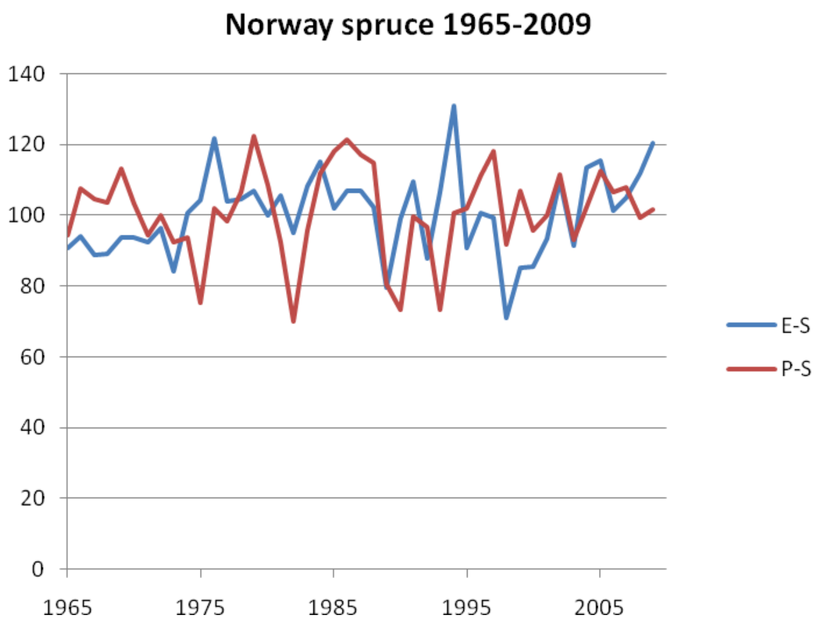


Figure 4. An example of growth index for Norway spruce in Southern (E-S) and Northern (P-S) Finland.

Dead organic matter and soil organic matter pools

To be able to assess the total effects of the model's re-runs, the emissions and removals from dead organic matter and soil organic matter carbon pools were also recalculated.

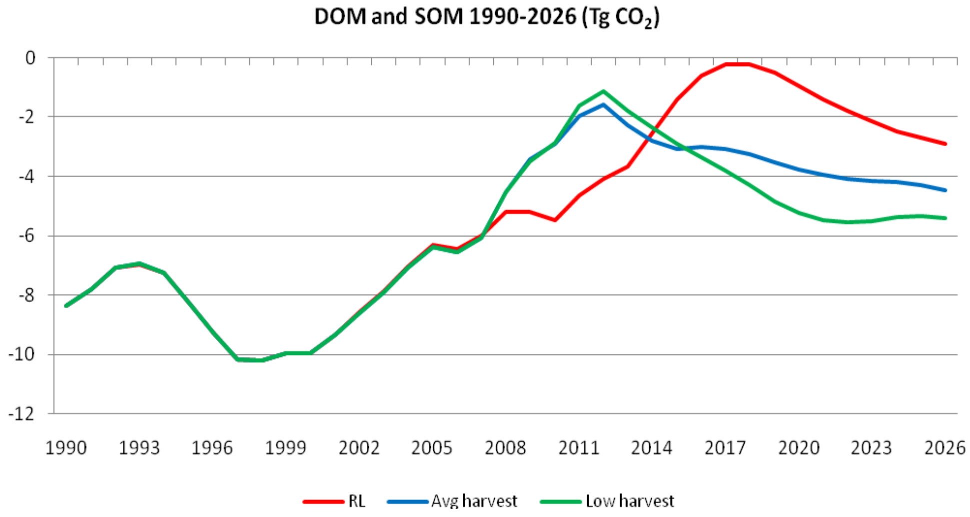


Figure 5. Dead organic matter and soil organic matter based on the three MELA runs.

The new combined dead organic matter and soil organic matter (DOM and SOM) curves (average harvest and low harvest) reach the low-sink peak earlier than the RL curve (Figure 5). The peak is also lower. The low harvesting level in the period of 2009-2014 causes a large sink in period 2013-2020. The curve of average harvesting level is similar to the curve of low harvesting level, but the sink is smaller due to higher harvesting level in the period of 2009-2014. The high harvesting level in the beginning of RL-projection can be seen as a lowering sink until 2018.

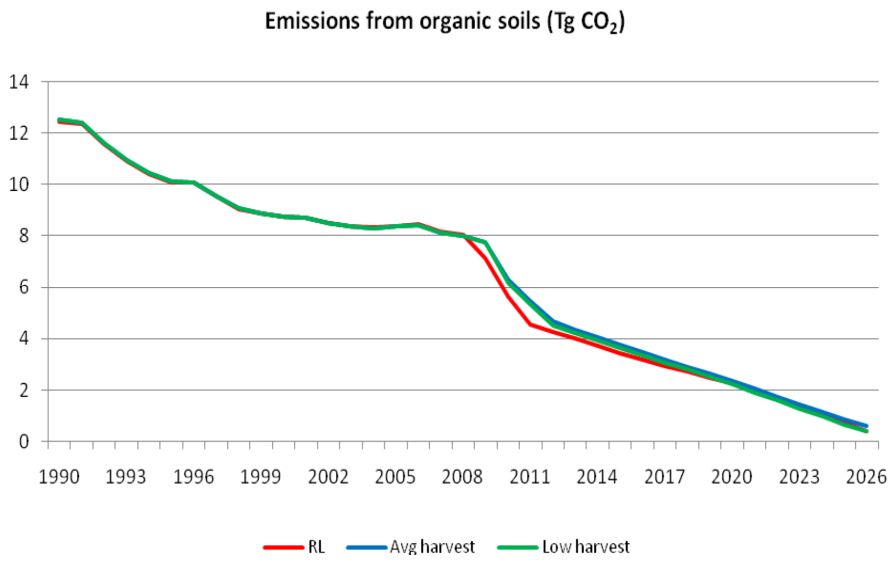


Figure 6. Emissions from organic soils based on the three MELA runs.

There is little difference in emissions from organic soils between different scenarios (Figure 6). Emissions in the average and low harvest scenarios are a little higher than RL emissions in 2013-2020. This is mostly due to increased litter from living trees because of lower harvesting levels.

Effects on FM reference level

Using the average historical harvest rate the RL would be 1.1 million tons lower than the submitted FMRL whereas using the low harvest rate the RL would be about 3.4 million tons higher than the submitted FMRL (Table 2). However we see that the MELA-run using only one year harvest level is not valid to be a base for the projection especially since the harvesting removals in 2009 were exceptionally low.

In para 35 the ERT suggests to consider the techniques recommended by IPCC to ensure time series consistency between reported GHG inventory data and model's results, if significant discrepancies are noticed after the re-run of the model.

Finland considers that the reported emissions and removals cannot be exactly the same as the predicted emissions and removals, because predicted values contain assumptions for models and included policies (future timber and bioenergy wood harvests). Ex-post calibration to model's results is not considered valid because the assumptions and model's parameters will no longer stand.

Table 2. The FM reference levels based on the results of two MELA re-runs (Tg CO_2 eq.).

	2009	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Average harvesting (2006-2009)												
Tree biomass	-19.9	-19.6	-19.2	-18.8	-18.8	-18.7	-18.6	-18.5	-18.5	-18.4	-18.3	-18.3
SOM+DOM min	-3.4	-2.9	-2.0	-1.6	-2.3	-2.8	-3.1	-3.0	-3.1	-3.2	-3.5	-3.8
SOM+DOM org	7.7	6.3	5.5	4.7	4.4	4.1	3.8	3.5	3.2	2.9	2.6	2.3
N-Fertilization	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019
Controlled burnings	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Wildfires	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
FM	-15.6	-16.1	-15.6	-15.7	-16.6	-17.4	-17.9	-18	-18.3	-18.7	-19.2	-19.7
AVG(13-20)FM	**-18.2**											
Low harvesting (2009)												
Tree biomass	-31.1	-29.3	-27.5	-25.7	-24.9	-24.2	-23.5	-22.7	-22.0	-21.2	-20.5	-19.8
SOM+DOM min	-3.5	-2.9	-1.6	-1.1	-1.8	-2.3	-2.9	-3.3	-3.8	-4.3	-4.8	-5.2
SOM+DOM org	7.7	6.2	5.3	4.5	4.2	3.9	3.6	3.3	3.1	2.8	2.5	2.2
N-Fertilization	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019
Controlled burnings	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Wildfires	0.029	0.029	0.029	0.030	0.030	0.030	0.030	0.030	0.031	0.031	0.031	0.031
FM	-26.8	-25.9	-23.7	-22.3	-22.5	-22.6	-22.7	-22.7	-22.7	-22.7	-22.8	-22.7
AVG(13-20)FM	**-22.7**											

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Further issues raised by the ERT and answers by the Party:

Issue 1:
Fig. 2B of the Finnish response indicates that the difference in GROSS REMOVALS between GHGI and the scenario used for the green line above is about 5 MtCO_2 for the year 2009. However, for the year 2009 the difference in the sink between GHGI and the scenario using 2009 harvest is nearly 25 MtCO_2. At first glance, this may suggest that other factors rather than harvest (which is identical) and increments (which seem to explain only 5 MtCO_2 difference) are involved.

Answer:

Table 1. Roundwood removals and total drain (M m^3/yr) in 2007-2009 in the three MELA runs and in KP-LULUCF 2009.

	Roundwood removals	Total drain
Low harvesting (2009)	43.7	69.2
Average harvesting (2006-2009)	53.3	79.0
RL	62.8	82.1
KP-LULUCF	47.7*	59.7

*KP-LULUCF contains all household use of roundwood and fuelwood consumed in small-sized dwellings, MELA models only contain the fuelwood proportion that fulfills dimensions of pulp wood (this is approximately ~30 % from the total fuelwood).

In KP-LULUCF the total drain in 2009 was 59.7 M m^3. In the MELA re-run based on 2009 harvest the total drain is 69.2 M m^3. The total drain consists of roundwood removals, logging residues of stems and natural mortality. In the MELA re-run using 2009 harvest, the low harvesting level compared to RL harvesting leads to increase of natural mortality. Natural mortality increases due to reaction of mortality models for dense forests that are not logged. Scenarios with lower harvests have typically higher natural mortality. Natural mortality modelling is based on self-thinning thresholds and also random death of older trees.

Issue 2:
Finland explains that the average growth rate of 1977-2008 was taken to reduce the effect of natural variability in weather conditions on growth. However, given the well-known increase of growth throughout EU in last decades, taking the average growth of 1977-2008 for modelling growth in 2020 may lead to a bias.

Answer:
Single tree growth models in MELA do not directly rely on long-term average growth. The model form and predictions are based on plots established since NFI7 (1977-1984). The models were calibrated with NFI10 data (2004-2008), to correspond with the recent, higher growth rate. However, the NFI10 data used was corrected with growth indexes (1977-2008) to reduce the effect of annual weather variations. This was done because the projections cannot be based on growth affected by the weather of few years. As can be seen from the growth indexes, the large-scale weather variation happens over longer period than 5 years and to capture the total variation in weather the 30 years time span was used.

Finland's response to the First order draft of the report of the technical assessment of the forest management reference level submission of Finland submitted in 2011

The ERT express that Finland has a possible inconsistency in the construction of the FMRL value. ERT notifies that the difference between gains predicted by the MELA model and those reported in the GHG inventory based on the NFI 10 data are ca. 8-10 Tg CO_2 eq. The ERT reports that this difference suggests a possible inconsistency for the FMRL value (see paragraphs 21, 23, 24 and 37).

Finland is of the view that the FMRL is consistent with the GHG inventory data and has provided additional information during the TA process to clarify this, and wants to give further clarification in relation to the above conclusion of the ERT.

The MELA model is mainly driven by the felling levels provided by the user. In addition, future increment is affected by the fellings. The national forest policy targets for annual cutting removals are ca. 63–67 million m^3 (Table 3 in the FMRL submission). High annual fellings decrease carbon sink of forest due to increased losses, but also by reducing increment. When harvesting level increases, the MELA model fells highly stocked stands to maximize net present values (NPV), and therefore total increment of growing stock is simultaneously reduced. Anyhow, the actual forest management decisions, reported in the GHG inventory, will differ from the management decisions made in MELA model that is based on NPV maximizing at regional scale.

The gains reported in the GHG inventory are based on the actual measured increments of the growing stock. In Finland, the inter-annual variability in increments is high due to the annual variation in climatic factors. The variation is so high that it can effect on the measured 5-years increment, of which the annual removals are derived in the GHG inventory. The MELA model produces growth estimates of which the influence of annual variation in climatic factors is removed using the growth indexes. This measure does not eliminate the effects of the future silvicultural treatments and harvesting or changes in age-class distribution and tree species composition. Growth indexes are computed from the measured tree level increment data from years 1977-2008 by tree species groups pine, spruce and broadleaved tree.

In the TAR, paragraph 24 ERT considers that model used for predictive purposes should demonstrate the ability to reproduce past levels and trends. Finland did two reruns of MELA with historical harvesting levels (Annex of the TAR). The results proved higher increment due to reduced harvesting and thereby demonstrating model's ability to produce increment estimates at the same level as in GHG inventory (Figure 2, in the annex of TAR). **Finland proposes that ERT corrects its comment on the inconsistency between the reported and predicted removals given in the TAR to be inline with the fact that higher harvesting level, which is in accordance with the national forest policy, changes the dynamics of forest development resulting in smaller gains compared to the GHG inventory.**

In paras 26 and 39 of FOD, the ERT considers the information provided by Finland very useful, but also notes that this information does not fully explain the differences between the GHG inventory and the model's results

Since Finland has explained from where the differences between the model results and data reported in GHG inventory arise (1) future increment is affected by the fellings, 2) GHG inventory uses increments measured in the last NFI (2004–2008), whereas the model produces growth estimates of which the annual variation in climatic factors are removed using the growth indexes and 3) the treatment of natural mortality in the model versus the GHG inventory), **Finland proposes that ERT modify paras 26 and 39 as follows:**

The ERT considers the information provided by Finland very useful, and notes that *this information does mainly explain the differences between the GHG inventory and the model's results.*

The ERT considers that there is an inconsistency between the removals reported in the national GHG inventory and the level of removals predicted based on the model's results (paragraphs 24, 38, 39).

The ERT recommends Finland to post-process the results used to the construction of the FMRL to ensure the time series consistency and comparability, which in this case mean the net emissions/removals reported in the national GHG inventory and the predicted/projected net emissions/removals produced for the FMRL. The ERT refers to the techniques recommended by IPCC. The ERT agrees with Finland's opinion that the post-processed results would no longer be coherent with the set assumptions and post-processing would distort dynamics of model results. ERT also states in TAR (para 23) that it does not question of functioning of the model or the assumptions on future logging.

The IPCC Good Practice Guidance for LULUCF and the 2006 IPCC Guidelines present several techniques to obtain consistency in time series (interpolation, trend extrapolation, overlap, and surrogate). Finland examined the techniques and considered the applicability of the overlap technique. The GPG for LULUCF says in Table 5.6.1 (p. 5.57):

TABLE 5.6.1
SUMMARY OF APPROACHES TO OBTAIN CONSISTENCY IN TIME SERIES

Approach	Applicability	Comments
Overlap	Data necessary to apply both the previously used and the new method must be available for at least one year.	• Most reliable when the overlap between two or more sets of annual emissions estimates can be assessed. • If the relationship between the two methods during the period of overlap is irregular, this approach should not be used for recalculation.

In the 2006 IPCC Guidelines about the overlap technique is discussed in more detail (Volume 1, Chapter 5 Time Series Consistency). The 2006 IPCC GLs says about the overlap technique:

- can be used when a new method is introduced but data are not available to apply the method (p. 5.8)
- new and old methods are used to estimate a time series so that they overlap (p. 5.8)
- time series can be constructed if there is a consistent relationship between the results of the old and new methods (p. 5.8)
- the method is not applicable if there is only one overlapping year because comparing only one year may lead to bias and it is not possible to evaluate trends (p. 5.9)
- if there is no consistent overlap between the results of the old and new methods, it is not good practice to use overlap technique (p. 5.9, Table 5.1).

TABLE 5.1
SUMMARY OF SPLICING TECHNIQUES

Approach	Applicability	Comments
Overlap	Data necessary to apply both the previously used and the new method must be available for at least one year, preferably more.	• Most reliable when the overlap between two or more sets of annual estimates can be assessed. • If the trends observed using the previously used and new methods are inconsistent, this approach is not *good practice*.

The conclusion was that the **overlap technique is not applicable in the case of net emissions/removals reported in the GHG inventory and the time series constructed for the FMRL.** The GHG inventory values are annual removals/emissions varying from year to year. The emissions and removals computed for FMRL represent average values for a much longer period.