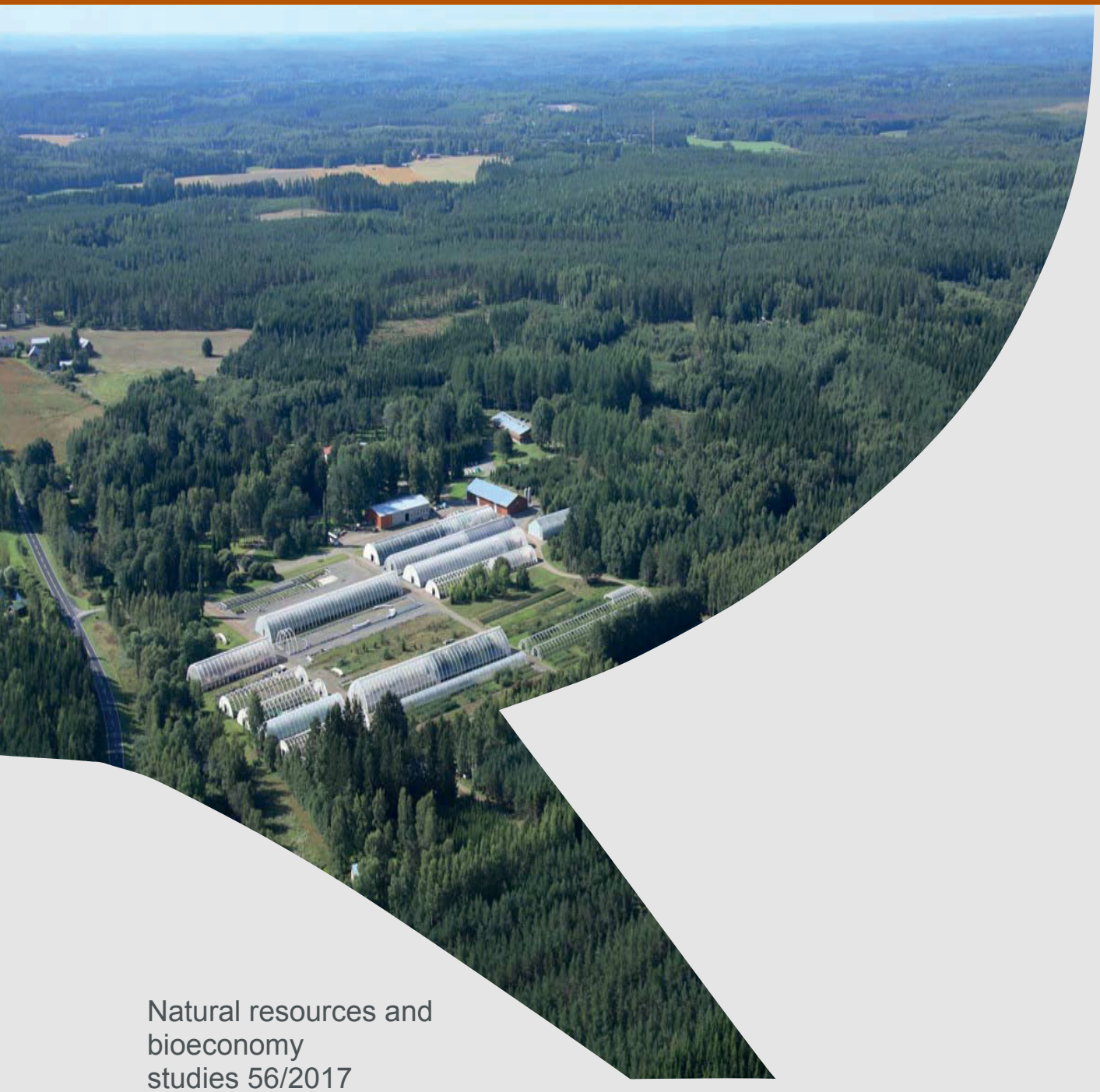

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Summary

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On 20 July 2016, the European Commission presented a proposal for a Regulation to integrate the greenhouse gas emissions and removals from land use, land-use change and forestry (hereinafter LULUCF) in the EU 2030 Energy and Climate Package (COM/2016/479 final). The regulation is to provide EU's own accounting rules for the LULUCF sector after 2020 when the second commitment period of the Kyoto Protocol expires.

The commitment for the Member States is to ensure that the LULUCF sector shall not create debit in the periods 2021-2025 and 2026-2030. Six accounting categories are included in the proposed approach: afforested land, deforested land, managed cropland, managed grassland, managed forest land and managed wetland. All categories except managed wetland are mandatory to include into the accounts. The net emissions and removals from afforested and deforested lands in the periods 2021-25 and 2026-30 are proposed to be accounted in full while the accounting of the other categories bases on a reference value. Emissions and removals from managed cropland, grassland and wetland are compared to an average of a reference period and managed forest land to a reference level. The forest reference level should be based on the current forest management practices and intensity as documented for 1990-2009. The proposal does not give clear explanation for what the intensity means neither guidance on how to determine it.

Quantitative impacts of the proposed accounting rules for Finland were assessed. The emissions and removals reported to the United Nations Framework Convention on Climate Change (UNFCCC) for 1990-2014 were reclassified according to the proposed accounting categories. Best available scenarios for the future development of land use were employed and the emission estimates for 2015-2030 calculated with the methods used in the greenhouse gas inventory. According to the accounting, afforestation, managed grassland and managed wetland would create credit. Deforestation and managed cropland accounts would result in debits in 2015-30. Managed forest land account would generate credits or debits depending on the harvest rate and accounting of wood products. The results suggest that the LULUCF sector in Finland would not achive the commitment in the period 2020-2030 nor would there be credits to be used as flexibility towards the effort sharing sectors.

Although the scenarios involve great uncertainties, and unpredictable changes in the emissions from deforestation can occur, forests can be expected to remain a biological carbon sink in the future. Despite the large sink of Finnish forests, it is not likely that the LULUCF sector would gain any removal units with the proposed accounting rules. Less limited use of the sink of forest management in accounting and flexibilities would encourage increasing carbon sequestration in the land use sector.

Keywords: land use, greenhouse gases, climate policy, forestry, agriculture

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Summary in Finnish

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EU:n komissio antoi 20.7.2016 asetusehdotuksen maankäyttö, maankäytön muutokset ja metsätalous -sektorin (Land Use, Land-Use Change and Forestry, jäljempänä LULUCF) sisällyttämisestä EU:n 2030 energia- ja ilmastopakettiin (COM/2016/479 final). Asetuksen tarkoituksena on antaa jäsenmaille EU:n sisäiset säännöt LULUCF-sektorin päästöjen ja poistumien tilinpitoon Kioton pöytäkirjan velvoitekauden jälkeen.

Ehdotus tuo uutena LULUCF-sektorille velvoitteita varmistaa, että vuosien 2021–2025 ja 2026–2030 päästöt eivät ole poistumia suuremmat. Tilinpitoluokkia ehdotukseen sisältyy kuusi: metsitys, metsäkato, hoidettu metsämaa, hoidettu viljelysmaa, hoidettu ruohikkomaa ja hoidetut kosteikot. Luokista viisi ensimmäistä ovat maille pakollisia, hoidetut kosteikot voitaisiin maan niin halutessaan myös sisällyttää tilinpitoon. Metsityksen ja metsäkadon tilikauden nettopäästöt/-poistumat laskettaisiin mukaan velvoitteeseen täysimääräisinä. Viljelysmaan, ruohikkomaan ja kosteikkojen tasetta verrattaisiin vuosien 2005–2007 keskiarvoiseen tilanteeseen. Metsämaan laskentaan ehdotetaan kansallisesti määritettyä metsien vertailutasoa. Vertailutasoa voidaan pitää eräänlaisena tavoitetilana, ja jos se saavutetaan, maa voisi laskea todettujen nettopoistumien/-päästöjen ja vertailutason erotuksen hyödykseen. Tälle laskennalliselle nielulle asetettaisiin kuitenkin kattoluku, joka määrittäisi kuinka paljon nielua voidaan käyttää LULUCF-sektorin velvoitteen täyttämiseen. Laskennalliset päästöt sen sijaan olisivat mukana kokonaisuudessaan. Vertailutason tulisi perustua nykyisiin metsänhoidon käytäntöihin ja käytön intensiteettiin, niin kuin on dokumentoitu vuosille 1990–2009. Ehdotuksesta ei kuitenkaan selviä mitä metsien käytön intensiteetillä tarkoitetaan ja kuinka se voitaisiin määrittää.

Asetusehdotuksen määrällisiä vaikutuksia Suomelle arvioitiin soveltamalla ehdotuksen laskentasääntöjä Luken laatimiin maatalouden, metsämaan ja maankäytön muutosten skenaarioihin. Laskelmien mukaan metsistä saatava ehdotuksen mukainen maksimihyöty 25 milj. CO_2 ekvivalenttitonnia, ei riittäisi kattamaan muista tileistä aiheutuvia päästöjä. Suurin päästö aiheutui metsäkadosta, noin 30 milj. CO_2 ekvivalenttitonnia. Vaikka skenaarioihin sisältyy suuret epävarmuudet, ja metsäkadon päästössä voi tapahtua ennakoimattomia muutoksia, metsien voidaan olettaa säilyvän biologisena hiilinieluna myös tulevaisuudessa.

Isosta biologisesta hiilinielusta huolimatta maankäyttösektori ei ehdotetuilla tilinpitosäännöillä kovin todennäköisesti tule olemaan nettonielu. Vähemmän tiukat rajat metsän hiilinielun käytössä tilinpidossa ja joustoissa kannustaisivat paremmin nielun lisäämiseen.

Asiasanat: maankäyttö, kasvihuonekaasut, ilmastopolitiikka, metsä, maatalous

Contents

1. Introduction

On 20 July 2016, the EU Commission presented a proposal for a regulation on binding annual greenhouse gas emission reductions by Member States from 2021 to 2030 for the sectors not covered by the EU Emission Trading System excluding land use, land-use change and forestry (LULUCF) sector (COM/2016/482 final,) and a proposal for a regulation on the inclusion of the emissions and removals from LULUCF into the EU 2030 energy and climate package (COM/2016/479 final). The accounting of the LULUCF sector is not included in EU's emission reduction target for 2020. The current LULUCF Decision (529/2013/EU) sets out the accounting rules for the LULUCF sector and promotes the inclusion of the emissions and removals from LULUCF sector into EU's emission reduction commitment. Emissions and removals from the LULUCF are partly accounted under the Kyoto Protocol in the first commitment period 2008-2012 as well as during the second commitment period 2013-2020. The Commission considers that the LULUCF sector needs accounting rules for the post-2020 period after the Kyoto Protocol expires. The Commission also considers that the LULUCF sector needs to be coordinated within the EU in order to achieve a common goal of reducing emissions. The Paris Agreement sets out a goal of the balance between anthropogenic greenhouse gas emissions and removals in the second half of this century, which is also reflected in the proposal. On the background of the proposal is European Council's guidance on inclusion of the LULUCF sector in the EU's 2030 climate and energy framework. Currently there is a land based reporting under the United Nations Framework Convention on Climate Change (UNFCCC) and an activity based under the Kyoto Protocol. The LULUCF Decision requires the Member States to report also emissions and removals from cropland management and grazing land management, if they are not elected under the Kyoto Protocol. The proposed approach for post-2020 aims at one unified reporting to reduce the reporting burden. New accounting categories may change the allocation of emissions and removals between categories compared to the current situation. The aims of this study were to elucidate how the proposed accounting rules would affect the result of LULUCF sector accounting as well as the prospects of LULUCF to act as a net carbon sink.

2. Overview of the proposal

2.1. Land accounting categories

The proposed Regulation sets out the accounting rules for the LULUCF sector's emissions and removals and checking the compliance of the Member States commitments. Six land accounting categories are proposed based on the Convention reporting of the LULUCF sector. Five of the accounting categories are mandatory, namely afforested land, deforested land, managed cropland, managed grassland and managed forest land. The category of managed wetland is elective.

Afforested land includes all lands converted to forest land from other land use during the previous 20 years. Similarly, the deforested land covers all lands converted from forest land to other land use. The other categories consist of lands that have remained in the same land use for at least 20 years, and other conversions than already included in the afforested and deforested lands.

Remarks

Reasoning behind the proposed approach is streamlining the system with the UNFCCC land-based reporting framework. Since the scheme of international reporting under the Paris Agreement is open, there is a risk of two parallel reporting systems. If the EU reporting complied with the UNFCCC reporting, the costs would truly reduce. Now, the proposal mixes the categories; for example, some emissions and removals from wetlands and settlements will be accounted under the managed cropland and managed grassland.

For the sake of transparency, the reporting as under the UNFCCC would be a better option than the one now proposed. For example, the emissions of deforestation accounted in the end-use category would show the effects of land use decisions in the right subcategory (e.g. settlements or cropland). In that way, the impact of policies, such as incentives for clearing new agricultural land, would be fully reflected in the accounting of cropland.

2.2. Accounting rules

The general accounting rules relate to the preparation and maintenance of accounts and the accuracy, completeness, consistency, comparability and transparency of the accounts and the provided data. Member States should ensure that emissions and removals are not double-counted. The accounts should include changes in carbon stocks of above-ground and below-ground biomass, litter, dead wood, soil organic carbon and harvested wood products (HWP). A carbon pool that is not a source could be excluded, except above-ground biomass and harvested wood products on managed forest land. The accounts would include emissions of carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). A 20 years conversion period should be used for land use changes. An exception is the afforested land category, for which a 30 years conversion period could be used.

Emissions and removals from afforested and deforested lands should be accounted as the total emissions and removals in 2021 to 2025 and 2026 to 2030. For managed cropland, managed grassland and managed wetland a reference value defined as an average of emissions and removals in 2005 to 2007 times five will be employed[1]. The emissions and removals from managed forest land in periods 2021-2025 and 2026-2030 will be compared to a forest reference level. The maximum amount which a Member State could account for in a period from the net removals of forest land is

[1] A reference value based on years 2005-2009 is also proposed.

limited to 3.5% of base year's total emissions excluding the LULUCF sector multiplied by five. (Table 1)

Harvested wood products are to be included in accounting categories afforested land and managed forest land using the first order decay function and default half-lives or a country specific methodology and values at least as detailed and accurate as those specified. The default method is to start from year 1900 from a carbon stock value of zero. HWP in solid waste disposal sites and energy wood are accounted for based on instantaneous oxidation and HWP from deforested land is not included.

The accounting of natural disturbances will continue according to the same principles as applied under the Kyoto Protocol and as reported under the Decision No 525/2013 /EU.

Table 1. Accounting rules by accounting categories.

Account	Rule
Afforested land	Total emissions and removals of afforested lands in 2021-2025 and 2026-2030.
Deforested land	Total emissions and removals of deforested lands in 2021-2025 and 2026-2030.
Managed cropland	Average of 2005-2007 emissions/removals times five is subtracted from emissions and removals in 2021-2025 and 2026-2030.
Managed grassland	Average of 2005-2007 emissions/removals times five is subtracted from emissions and removals in 2021-2025 and 2026-2030.
Managed forest land	Forest reference level times five is subtracted from 2021-2025 and 2026-2030 emissions/removals. Net removals are restricted by a cap of 3.5% of total emissions of base year / base period.
Managed wetland	Average of 2005-2007 emissions/removals times five is subtracted from emissions and removals in 2021-2025 and 2026-2030.

Remarks

The 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC 2006) gives a default of 20 years for a land to remain in a conversion category. The assumption is that during that time, the carbon stocks would reach equilibrium when a Tier 1 method is used. The transition time is depended on natural and ecological circumstances, and longer periods are encouraged to be used under higher Tiers. Thus, it is artificial to give an exact time in legislation for this kind of calculations. This would mean, that if a country uses a longer transition time than 20 of 30 years, the emission estimation should be done in two phases for the accounting. It also should be noted, that for lands converted to peat extraction the recommended default transition period is five years (IPCC 2006).

The proposed accounting rules for managed forest land restrict the use of forest carbon sink twice, by a reference level and a cap. The accounting involves the anthropogenic emissions and removals and the use of a cap is usually reasoned to capture the human-induced emissions and removals. Harvested wood products are genuinely human-induced and hence the use of a cap to account them needs more argumentation.

For harvested wood products it is very restricting to set the start of the function to year 1900. It is also unclear, what the starting year for afforested land is meant to be. Instead of strict rules, it would be better first to know, how the reporting under the Paris Agreement will be done in order to avoid two separate reporting schemes.

2.3. Forest reference level and national forestry accounting plan

The Regulation would require Member States to submit national forestry accounting plans to the Commission. The plan contains a new or an updated forest reference level established according to the criteria set out and elements listed in Annex IV. The plan should be public, subject to public consultation and reviewed by the Commission. New reference levels will be submitted to the Commission by the end of 2018 for the period 2021-2025 and by 30 June 2023 for 2026-2030.

The reference level is suggested to be based on the continuation of current forest management practices and intensity as documented for 1990-2009 by forest types and age class. The consistency between employed methods and data to establish a reference level and those used in national greenhouse gas inventory is one of the elements to include in the accounting plan. If inconsistencies occur, a technical correction of the reference level needs to be submitted to the Commission at least at the end of the accounting periods. The Commission will review technical corrections.

Remarks

The proposal set out some criteria and principles for the construction of a forest reference level. The wording 'current' referring to years 1990-2009 is contradictory since the mentioned forest management practices and intensity (of roundwood removals or use of tree biomass) are historical. The meaning of the intensity is not specified and leaves the interpretation of it to the Member States. Forests management can be based also on other forest characteristics than age class. For example, in Finland a mean diameter of a forest stand is nowadays a more important criteria to make a regeneration decision than the age. Thus, a more general specification would be more practicable in a regulatory text.

If a separate projection for harvested wood products is established without connection to the forest projection, the projection might not be realistic. The timber assortments by tree species may not meet the tree species and forest structure as projected for forests.

The set criteria are very challenging to implement in the current models used for projections. For example, how to take into account the conservation of biodiversity as set out in the EU Forest Strategy and the EU Biodiversity Strategy. The reference level should also be consistent with the national projections of greenhouse gas emissions and removals reported under the Regulation (EU) No 525/2013 (MMR). So, should the projections reported under the MMR be the same as the reference level, or is it possible to update them?

A five-year accounting period is a short time for the forestry sector, and forestry policies available are very limited. This does not create incentives for long-term carbon sequestration. Even a small incentive for forest owners to increase carbon stocks could significantly reduce logging, as it is reasonably advantageous to a forest owner to postpone harvest for 10 years (Laturi et al. 2016). On the other hand, logging and hence the carbon stocks can change significantly without climatic policy, depending on wood demand, forest owners' goals and conservation values.

2.4. Commitments and flexibilities

The commitment for the Member States is to ensure that in the LULUCF sector, the emissions do not exceed removals as accounted with the proposed accounting rules in 2021-2025 and 2026-2030 – that is the "no-debit rule". This commitment is for the whole sector, thus a net emission from a single category can be compensated by net removals in other categories. A member state can also use flexibilities from the effort-sharing sector and from other member states to fulfil the commitment. A transfer of the LULUCF surplus to the effort-sharing sector or to another member state is possible, but only if the surplus comes from combined accounts of afforestation, deforestation,

managed cropland and managed grassland. The most probable sink, forest management, cannot be used to compensate emissions of the effort-sharing sector or other member states. The proposal for a Regulation on binding annual greenhouse gas emission reductions by member states from 2021 to 2030 (COM(2016) 482 final) allows member states to use a limited amount of net removals from LULUCF to compensate exceeded annual emission allocations in the effort-sharing sector. At the EU level, the maximum amount to use is 280 million tonnes CO_2 eq. in the period 2021-2030. There is an open possibility to use also the removals from managed forest land, when the delegated act to update the forest reference levels is adopted. The Commission is empowered to adopt delegated act to modify Article 7 paragraph 1 to include net removals from the accounting category managed forest land into the flexibilities.

After all transfers, it is possible to bank the remaining quantity of the net removals from period 2021-2025 to the period 2026-2030.

Remarks
The proposal presents provisions for member states to achieve their compliance with the no-debit rule. If the LULUCF accounting results in credit, the net removal from forests cannot be used in the effort-sharing sector. The final word is left to the Commission to adopt delegated act to modify the Article 7 of the proposed Regulation on binding annual greenhouse gas emission reductions, which could enable use of managed forest land accounting category for flexibilities.

2.5. Amendments to Regulation No 525/2013/EU

The proposed Regulation has its impacts to Regulation No 525/2013/EU (MMR), under which the greenhouse gas inventory and LULUCF accounts are reported to the Commission for years 2013-2020. Amendments are proposed to the annual reporting and the reporting of national policies and measures. New Annex IIIa to the MMR Regulation is proposed concerning the methodologies for monitoring and reporting the LULUCF sector.

Remarks
The reporting to the Commission under the proposed Regulation will be at the end of the accounting periods in 2027 and 2032 on each of the proposed accounting categories (compliance report). Nevertheless, the amendments to the MMR Regulation indicate that the reporting would be done annually. The text is not clear, if the UNFCCC reporting would fulfil the requirement, or if the emissions and removals should be reported separately in different land accounting categories. The purpose of the proposed new Annex IIIa is ambiguous to comprehend. For example, the IPCC guidelines for National Greenhouse Gas Inventories do not recognize any 'globally calibrated standard emission factors and parameter values'. According to Annex IIIa, the Member States are encouraged to use Tier 3 methodology using non-parametric modelling calibrated to national circumstances. It is unclear what 'non-parametric modelling' means in this context. It also seems unnecessary to include guidance on appropriate methodologies for LULUCF in Regulation, if the IPCC methodologies will be acceptable in the greenhouse gas inventory in future. Additionally, Member States are necessitated to submit a reasoned request to the Commission by 31 December 2020 to apply different methodologies than specified in the Annex. This is an open clause, since the reasons to the possible derogation are not illustrated.

3. Impacts of the proposed accounting on Finland

3.1. Land use scenarios

The quantitative effects of the LULUCF proposal were assessed based on national projections. In the calculations, the scenarios for forests (Lehtonen et al. 2016) and agriculture by the Natural Resources Institute Finland (Luke) calculated for the climate and energy strategy 2016 were applied. Area estimates of land use categories and land-use changes as well as emission and removal estimates of land-use change classes are based on the scenarios made by the Natural Resources Institute Finland in 2015 (Haakana et al. 2015). Land-use change estimates for the built-up areas relied largely on the methodology presented by Tiitu et al. 2015, which made it possible to introduce more drivers in the scenarios, for example, taking into account the demographic trends. Assumptions used in the area scenarios are presented in Haakana et al. 2015.

3.2. Emission scenarios and accounting

3.2.1. Afforested and deforested land

Afforested lands will remain a net sink until 2030 according to the estimates of emissions and removals by Haakana et al. (2015) (Figure 1). The most significant removals will occur in afforested grasslands. Emissions of afforested wetlands are expected to increase as abandoned peat extraction areas are being afforested and where the growth of the trees does not exceed the emissions caused by peat decomposition. The removal effect of afforested cropland is also expected to turn into small emissions, as the oldest afforestation areas with the largest removals are transferred to forest land (conversion period of 20 years).

In the period 2021-2030, net emissions from deforestation will decrease slightly (Figure 2). The most important factor contributing to the reduction in emissions is the decrease in the area of cleared arable land as the oldest areas are transferred to the managed cropland category and the clearance rate is expected to reduce in the future.

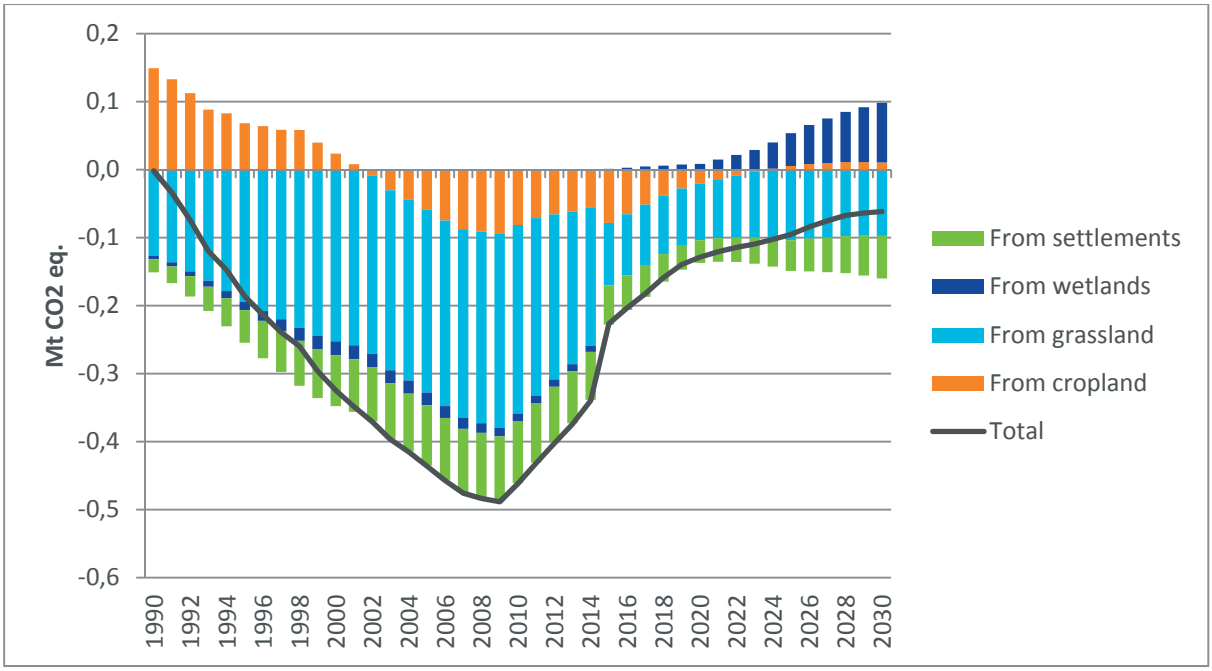

Figure 1. Emissions and removals from afforested land 1990-2014 and predicted development 2015-2030.

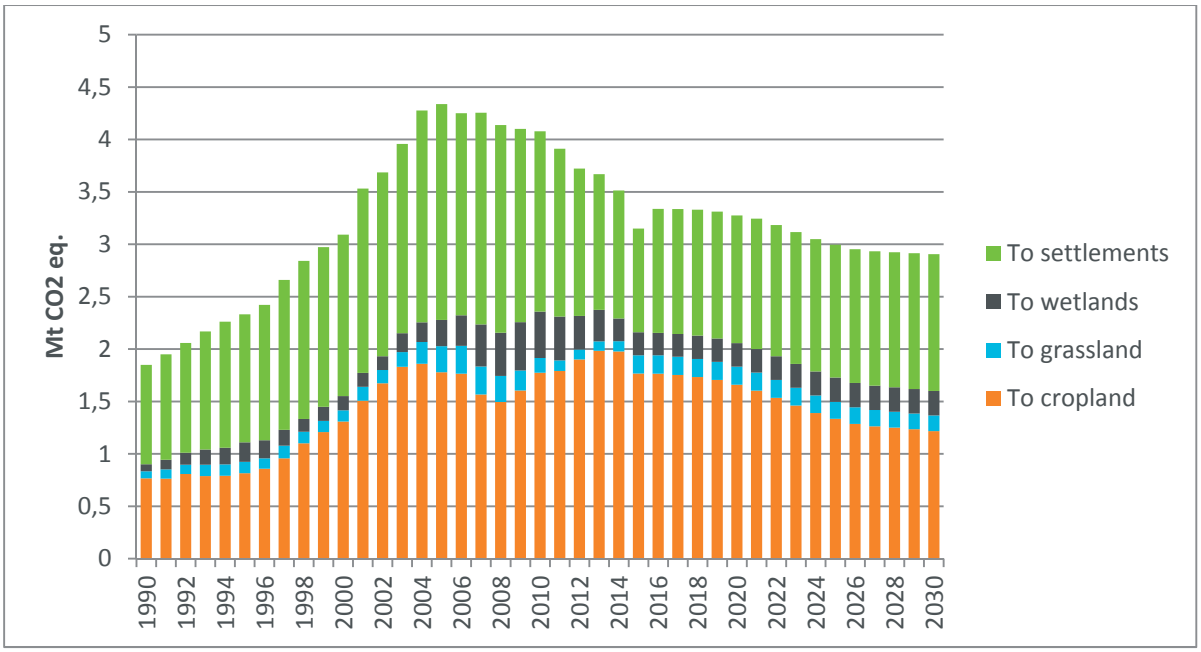

Figure 2. Emissions from deforested land 1990-2014 and predicted development 2015-2030.

According to the proposal, also harvested wood products are accounted under afforested land. If a 20-year transition period is used for afforestation, the significance of wood products for this category is low. Based on the national forest inventory data, the first thinning occur some 15 years after afforestation and the harvested roundwood is mainly small-sized timber (Hamberg et al. 2016). It is likely that the harvested wood products would cause a removal which is less than 0.5 Mt CO_2 even using a 30 years conversion period. Hamberg et al. (2016) reported an annual removal of 0.06 Mt CO_2 for forests of which the oldest afforestation had taken place 25 years ago (refers to period 1990-2014). Wood harvested from afforested sites is mainly used for pulp and paper or energy. The short half-life of paper and paperboard makes it computationally sensitive to changes in production volumes; the reduction in production is rapidly reflected in the decline in carbon stock of paper.

The net emission/removal of afforestation and deforestation is calculated in the accounts in full, i.e. the effect on the LULUCF sector's obligation is the same as the emissions/removals reported for the accounting period. According to Luke's estimation, the net removals for afforestation remain low, just under 0.5 million tonnes of CO_2. In the projection, the net emissions of deforestation will be about 15 million tonnes of CO_2 in both periods. As a result, in periods 2021-2025 and 2026-2030 afforestation and deforestation would create debits of 15 Mt CO_2 eq. and 14 Mt CO_2 eq. respectively (Table 2).

Table 2. Accounting of afforested and deforested land (Mt CO_2 eq.). Negative accounting result generates credit and positive debit.

Accounting category	Net emission (+) /removal (-) in a period			Accounting result		
	2021-2025	2026-2030	Total	2021-2025	2026-2030	Total
Afforested	-0.5	-0.4	-0.9	-0.5	-0.4	-0.9
Deforested	15.6	14.6	30.2	15.6	14.6	30.2
TOTAL	15.1	14.3	29.3	15.1	14.3	29.3

Sensitivity analysis: 30 years vs. 20 years conversion period

As the proposal for a regulation also allows a conversion period of 30 years for afforestation, the carbon balance of afforested areas was estimated for 30 years conversion period in addition of the 20-year conversion period in place. In Finland, growth of trees is quite slow and afforested soils still lose carbon for several years after the land use change (Karhu et al. 2011), thus the conversion period of 30 years for afforestation brings the benefits out better.

The calculation was done for soils and tree biomass. Since the area of organic soils is greater with the longer transition period, also the emissions are higher. Organic soils remain a source of emissions throughout the transition period. Mineral soils turned to be a sink for the whole period, and the existing sink was large. In particular, in afforested agricultural lands a longer time since conversion means greater carbon sequestration.

Tree biomass increases in time in all conversion categories, so the biomass sink was greater over a 30-year conversion period. The calculation did not take into account possible felling in forests older than 20 years, as both calculations have used the same growth rates.

The combined carbon sink of soil and biomass is significantly higher over a conversion period of 30 years (Figure 3). The results are not fully comparable to the above-mentioned removals of the afforestation category, as the minor emissions from losses of agricultural biomass at the conversion phase and nitrogen mineralization were not estimated.

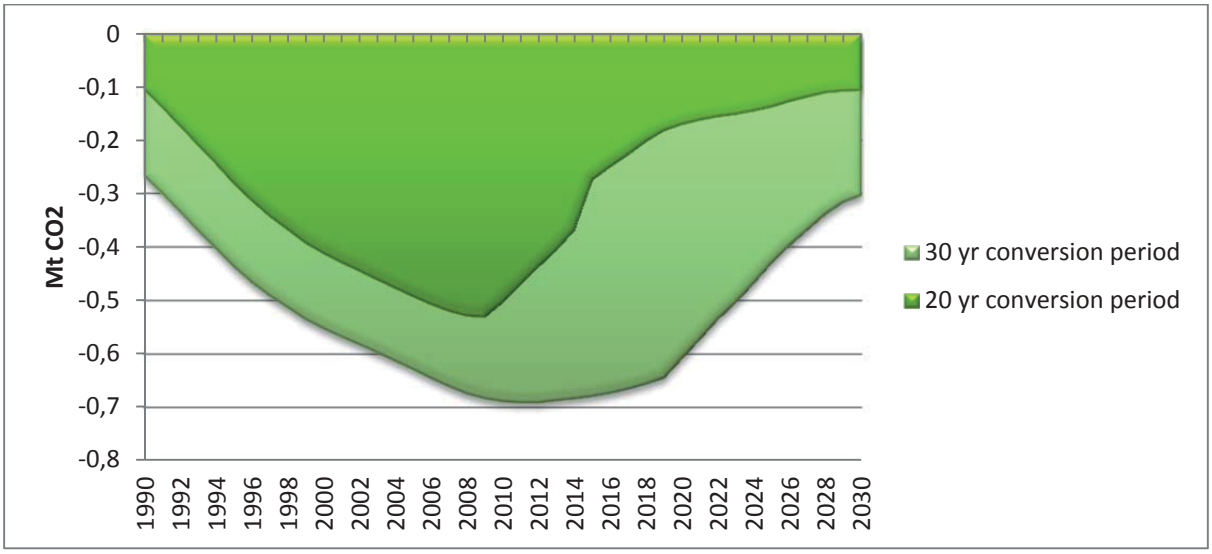

Figure 3. Combined carbon balance of soils and tree biomass in afforested lands with the conversion periods of 20 and 30 years.

3.2.2. Managed cropland and grassland

The reported emissions of managed cropland without the area reported under deforestation have been about 5 Mt CO_2 eq. annually in the period 1990-2014 (Figure 4). However, the emissions have been projected to increase after 2020 due to two main reasons; partly because the clearing of new arable land on organic soils is estimated to continue (50% of the current level) and partly because according to the proposed land-based calculation rules the emissions from arable land under deforestation will move to this category after a 20-year conversion period. New agricultural land was cleared more than usual over 2000-2005 and this explains most of the increase in post-2020 emissions. Managed cropland account is predicted to create a debit of 8.6 Mt CO_2 in 2020-2030 (Table 3).

The emissions from managed grassland have fallen from 1990 to 2014 due to re-cultivation of abandoned fields that are transferred from this category to managed cropland (Figure 5). The decline in emissions is also affected by the fact that the share of organic soils among the abandoned fields has decreased, reflecting the higher expansion rate of farms in areas where organic soils are common. For future years, rather steady grassland area and emission development have been predicted which would result in a small credit for managed grassland account (Table 3).

Together these two accounts would amount a net debit of 7.8 Mt CO_2 eq. (Table 3).

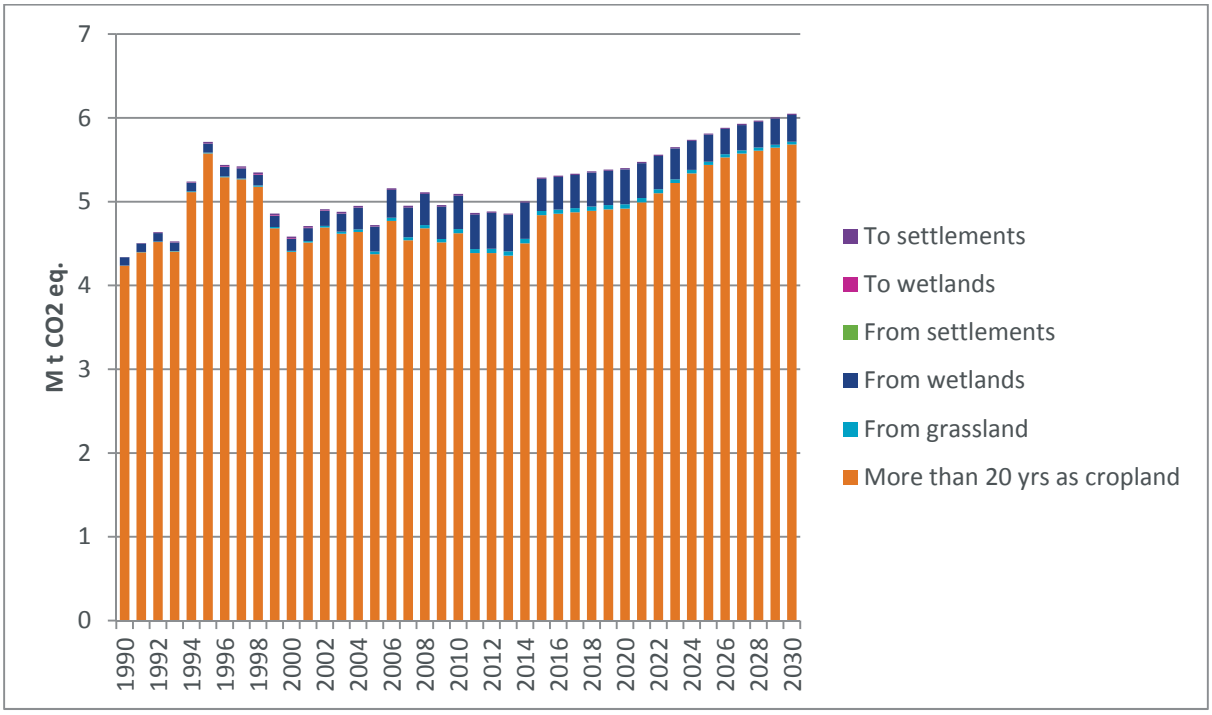

Figure 4. Emissions from managed cropland 1990-2014 and predicted development 2015-2030

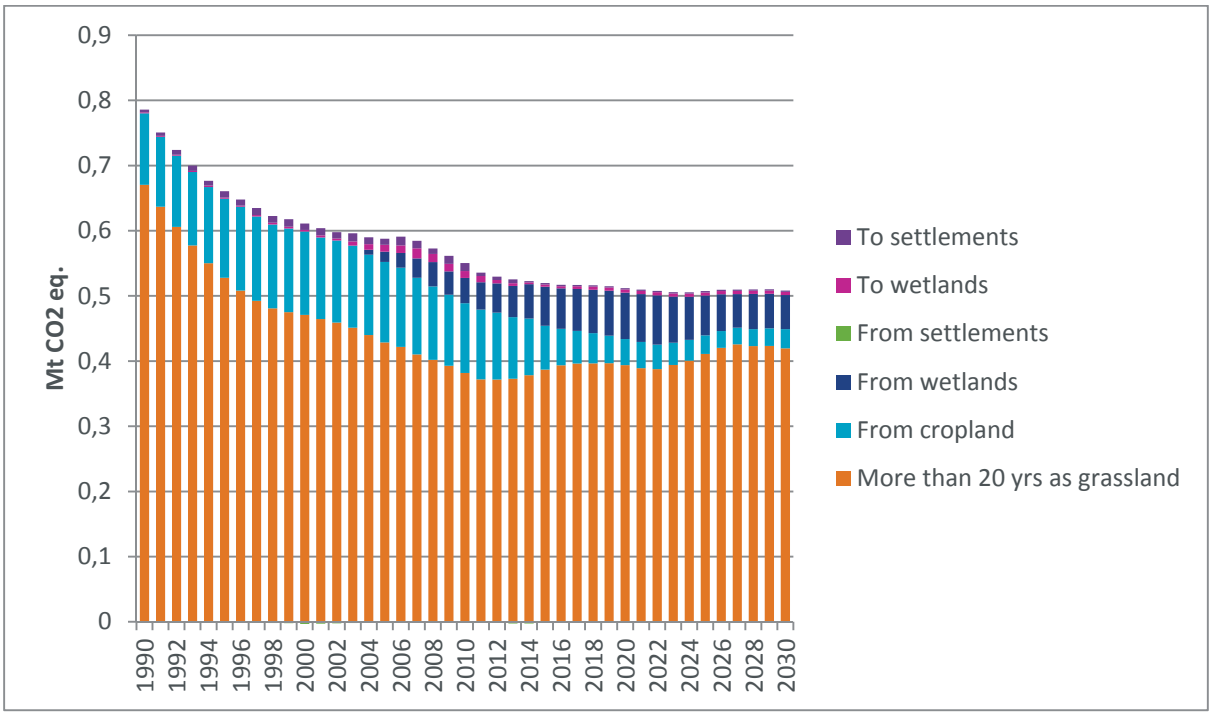

Figure 5. Emissions from managed grassland 1990-2014 and predicted development 2015-2030

Table 3. Accounting of the agricultural land (Mt CO_2 eq.). Reference value: average of emissions/removals in 2005-2007 multiplied by five. Negative accounting result generates credit and positive debit.

Accounting category	Net emission (+)/ removal (-) in a period		Reference value	Accounting result		
	2021-2025	2026-2030		2021-2025	2026-2030	Total
Managed cropland	28.2	29.8	24.7	3.5	5.1	8.6
Managed grassland	2.5	2.6	2.9	-0.4	-0.4	-0.8
TOTAL	30.7	32.4	-	3.1	4.7	7.8

Note: There are other options for the reference value. The result would be only slightly different with a reference value based on the average of years 2005-09. In that case, the total for cropland would be 8.3 and that for grassland -0.7 Mt CO2 eq.

Sensitivity analysis: alternative scenarios for agricultural land

The above scenarios are very uncertain and thus a couple of alternative scenarios with different development curves are presented for agricultural soils. In the “best case” scenario it was estimated that the area of cultivated organic soils will not increase after 2020, the proportion of perennial grasses will rise from the present 57% to 80%, and on 20% of the grassland the groundwater table will be raised to 30 cm by 2030 using controlled subsurface drainage. Emissions decrease due to lower total area, lower emission factors for perennial crops and raised groundwater table. The area of cultivated organic soils would be 213,000 ha in 2030. The accounted emissions from managed cropland and deforestation according to this scenario would be significantly lower than in the baseline scenario (Table 4). However, assumptions about the effectiveness of the policy measures are unrealistic as the measures leading to the depicted changes would be expensive to implement.

In the “worst case” scenario, the fields would be cleared as in the last 10 years until 2030, when the area of cultivated organic soils would be 288,000 ha in 2030, compared to 245,000 ha in the baseline scenario. Compared to the baseline scenario, emissions would increase both in the managed cropland category and in the deforestation and both classes would have higher net emissions throughout the reference period (Table 4). This may even be a possible developmental process and would make it more difficult to fulfil the no-debit rule.

Table 4. Accounting of managed cropland and deforestation with mitigation measures (”Best case”), as in base scenario (Baseline) or with clearing of agricultural fields continued as in the last 10 years (”Worst case”).

	Net emissions (debits) 2021-2030 Mt CO_2 eq.		
	Managed cropland	Deforested land	Total
”Best case”	0.2	27.1	27.3
Baseline	8.6	30.2	38.8
”Worst case”	10.0	34.4	44.4

3.2.3. Managed forest land

The scenarios calculated for the preparation of Finland’s energy and climate policy strategy 2016 were employed for the forest land. Lehtonen et al. (2016) presents three scenarios for the development of forest resources and greenhouse gas emissions and removals based on different forest harvesting targets defined by the Ministry of Agriculture and Forestry. The harvest level in the baseline scenario (S1) is an average of years’ 2013 and 2014 roundwood removals. The second scenario (S2) bases on the roundwood removals derived from the domestic consumption of roundwood by Finnish forest industries. The report on Finnish Forest industries 2015-2035 is prepared by Pöyry Management Consulting for the Ministry of Economic Affairs and Employment. The third scenario (S3) is a greatest sustainable cutting removal potential. The applied assumptions were:

- Volume of imported roundwood stays at the current level of 9.1 million cubic meters
- In the S1, the increase of 5 mill. m^3 in the annual domestic roundwood removals is included according to the decided investments
- In the S2, the increase of 12 mill. m^3 in the annual domestic roundwood removals is included according to the estimated new demand
- The consumption of forest chips increases to 13.5 mill. m^3 by 2020 according to the National Energy and Climate Strategy (2013) and National Forest Strategy 2025 (2015).

MELA2012 (Redsven et al. 2013) forestry model was employed for the forest scenarios. The model predicts development of forest resources like volume of growing stock, increment, natural mortality, harvest removals and tree biomass stocks. The carbon stock change in soil organic matter for mineral forest soils was calculated using Yasso07 soil model. The input to the Yasso model was derived from the MELA-model results. For organic forest soils (drained peatlands) and for non-CO_2 greenhouse gases the methods and emission factors used in the greenhouse gas inventory were applied. Same results of the scenarios S1, S2 and S3 are presented in Table 5.

Table 5. Results of scenarios S1, S2 and S3. Volume of the growing stock represents the stock in the beginning of the period (Lehtonen et al. 2016).

Scenario		2015-2024	2025-2034	2035-2044
S1	Growing stock, mill. m³	2 438	2 628	2 794
	Increment, mill. m³	100.5	100.4	105.4
	Drain, million m³	81.5	83.8	82.7
	Roundwood removals, mill. m³	69.2	73.4	73.1
	Net removals, Mt CO2 eq.	-21.2	-21.7	-32.2
S2	Growing stock, mill. m³	2 439	2 613	2 709
	Increment, mill. m³	100.7	99.8	104.0
	Drain, million m³	83.3	90.2	90.3
	Roundwood removals, mill. m³	71.2	79.8	80.8
	Net removals, Mt CO2 eq.	-19.6	-13.3	-20.0
S3	Growing stock, mill. m³	2 437	2 464	2 443
	Increment, mill. m³	99.5	96.2	99.2
	Drain, million m³	96.8	98.3	97.7
	Roundwood removals, mill. m³	85.0	88.6	88.6
	Net removals, Mt CO2 eq.	-0.8	5.5	-0.3

The net sink of forest land decreases in all scenarios in 2015-2030 (Figure 6). Thereafter growth is expected to increase until year 2044, thus the net sink increases after 2030. The scenarios prepared followed current Finnish forest management practices. Natural processes were predicted with prevailing and extensively used models. A rational decision maker was assumed to maximize the economic outcome. The production of historical information had not been taken as a premise for the scenario development. The initial stage of the scenarios is based on the forest resource data according to the 11th National forest inventory. The start of scenarios has not been fitted or calibrated to the forest sink reported in the national greenhouse gas inventory.

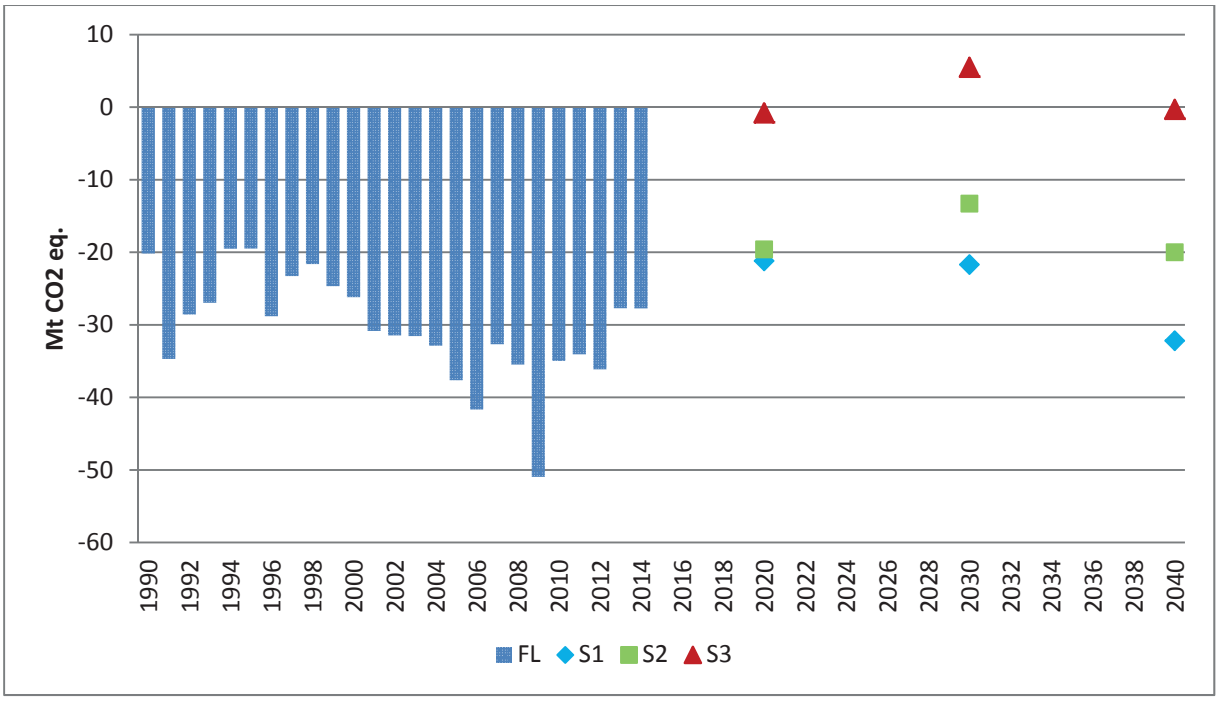

Figure 6. Reported net removals from forest land 1990-2014 (FL), and three scenarios on the development of forest land net emissions and removals.

Harvested wood products (HWP) are included in the managed forest land account. In Finland, wood products have been a sink during the period 1990-2014, with the exception of 2009 (Hamberg et al. 2016). The S1 and S2 scenarios of forests anticipate that wood products remain as a sink in the years 2021-2030. However, the S1 scenario will produce diminishing removals because production remains constant after 2015 and products manufactured at the turn of the 21st century are starting to leave the stock. According to the S2 scenario, the harvested wood product removals would remain constant.

The forest reference level (FRL) in Annex II to the proposed Regulation is the same as the Forest Management reference level with harvested wood products for the second commitment period of the Kyoto Protocol. For Finland, the FRL without HWP is -19.3 Mt CO_2 eq. and -20.466 Mt CO_2 eq. with HWP. In Table 6, the managed forest land sink is compared with the FRL value of -19.3 Mt CO_2 eq. (row FL). Harvested wood products were recalculated so that their calculation complies with the rules of the KP2 period. In this case, the FRL is -23 Mt CO_2 eq. per year (row FL+HWP).

Applying the accounting rules to Scenario S1, managed forest land account results in a net sink for the periods 2021-2025 and 2026-2030. When the harvested roundwood removals increase (S2), the comparison to the reference level would give net removals only for the period 2021-2025 when HWP is included. Scenario S3 turned forest land to a reported source in 2021-2030, and thus the managed forest land account would generate debit in both periods. Development of the carbon stock change in HWP was not estimated for the Scenario S3. In this scenario, the volume of harvested logs is higher than in other scenarios, but less energy wood is harvested. It can be assumed that the proportion of sawnwood would also be higher than in the other scenarios and so the sink of the HWP would cover some of the emissions.

The amount of calculated net removal of managed forest land is proposed to be limited by a cap. The cap is defined to be 3.5% of the total emissions in 1990 excluding LULUCF. Finland's cap would amount to 12.5 Mt CO_2 eq. in a five years accounting period. (Table 6)

Table 6. Accounting of managed forest land. The forest reference level (FRL) -19.3 Mt CO_2 eq. (row FL) is the forest management reference level for the 2nd commitment period of the Kyoto Protocol without HWP and -23.0 Mt CO_2 eq. with HWP (row FL+HWP). LE = less or equal, GT = greater than. Negative accounting result generates credit and positive debit.

	Net removals in period		Reference level	Calculation		Cap	Accounting result		
	A	B	C	A-C	B-C	D	IF (A-C) LE (-D) → -D IF (A-C) GT (-D) → (A-C)		
	2021-2025	2026-2030	FRL x 5	2021-2025	2026-2030		2021-2025	2026-2030	2021-2030
Scenario S1									
FL	-106.6	-108.6	-96.5	-10.1	-12.1	12.5	-10.1	-12.1	-22.2
FL+HWP	-129.9	-128.3	-115.0	-14.9	-13.3	12.5	-12.5	-12.5	-25.0
Scenario S2									
FL	-91.7	-66.5	-96.5	4.8	30.0	12.5	4.8	30.0	34.8
FL+HWP	-123.8	-96.6	-115.0	-8.8	18.4	12.5	-8.8	18.4	9.7
Scenario S3									
FL	2.3	27.5	-96.5	98.8	124.0	12.5	98.8	124.0	222.8

3.2.4. Managed wetland

Wetland remaining wetland is the main source of emissions in the category of managed wetland (Figure 7). These emissions consist mainly of emissions from peat production areas. According to the projection (Haakana et al. 2015), peat production area is not expected to grow from the present. On the contrary, the area transferring from peat production to other land use will grow, as a significant part of the peat production fields are already at the end of their life cycle. As a result, wetland emissions will be slightly reduced by 2030. The managed wetland seems to produce a small credit (Table 7). However, the calculation is very uncertain and does not include, for example, emissions or removals from the restoration of drained organic soils.

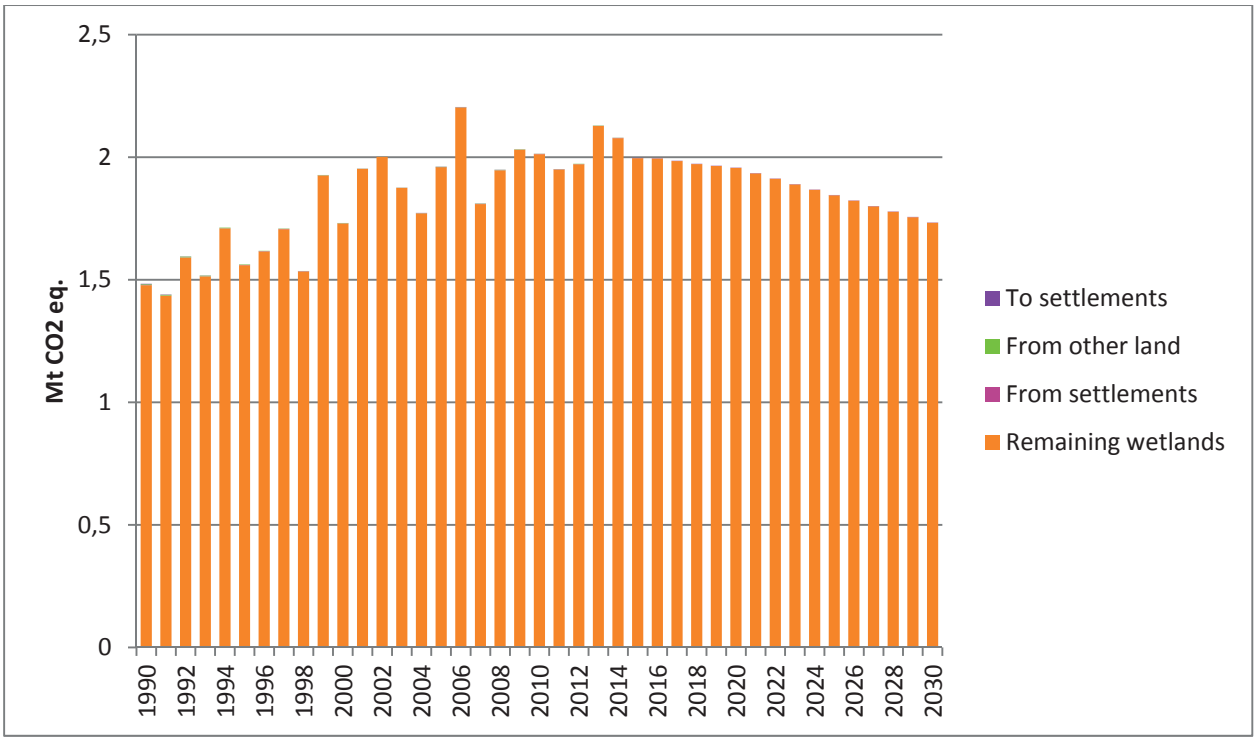

Figure 7. Emissions from managed wetland 1990-2014 and predicted development 2015-2030

Table 7. Accounting of managed wetland. Reference value is an average of emissions/removals in 2005-2007 multiplied by five. Negative accounting result generates credit and positive debit. (Mt CO_2 eq.)

Accounting category	Net emission (+)/ removal (-) in a period		Reference value	Accounting result		
	2021-2025	2026-2030		2021-2025	2026-2030	Total
Managed wetland	9.5	8.9	10.0	-0.5	-1.1	-1.6

Note: There are other options for the reference value. The result would not be different with a reference value based on the average of years 2005-09.

3.2.5. Lands and emissions excluded from the proposal

Two land use categories of the UNFCCC reporting are excluded from the proposal. These are settlements that have remained settlements for the past 20 years and other land remaining other land. Other land is typically unmanaged, so only the land area is reported. For settlements, the 2006 IPCC Guidelines requires that changes in all carbon pools be reported. Finland has applied the default method, which assumes that no changes are occurring. Haakana et al. (2015) estimated the total area of the settlements to grow from the current 1.47 million ha to 1.56 million ha by 2030 (Figure 8).

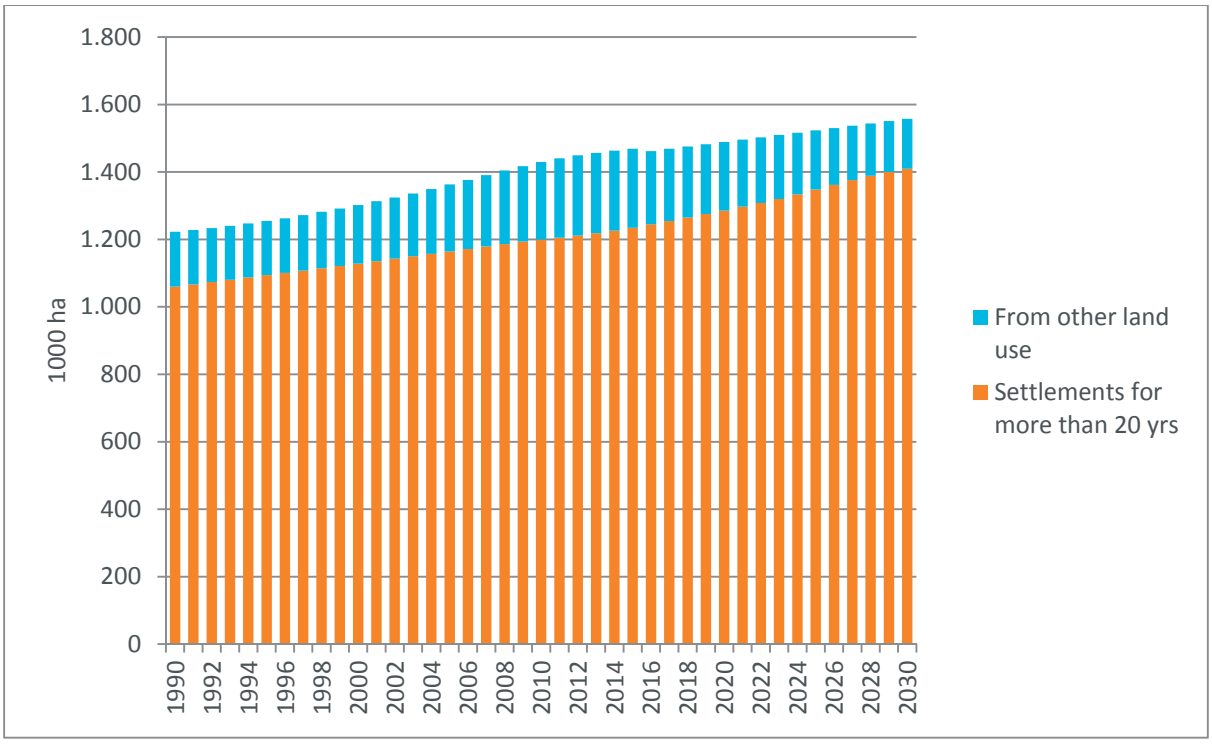

Figure 8. Development of the area of settlements until year 2030. The areas in the years 1990-2015 are based on Finnish greenhouse gas inventory and the years 2016-2030 are based on the projection by Haakana et al. (2015). Land converted to settlements during the last 20 years is presented separately from settlements remaining settlements.

3.2.6. Reported uncertainties

In the reporting under UNFCCC, the level uncertainties in the Finnish Greenhouse Gas Inventory for 2014 were from -3% to +5% without the LULUCF sector and from -29% to +37% with the LULUCF sector. The reported uncertainties of the LULUCF sector varied from -51% to +66%. In the Finland's Greenhouse Gas Inventory, the uncertainty of the LULUCF sector is the most significant, but also for the agriculture (-28% to +46%) and waste (-30% to +31%) sectors high uncertainties are reported. (Statistics Finland 2016) (Table 8).

Table 8. Uncertainties (%) of different land-use classes (CO_2) based on 2014 Greenhouse Gas Inventory. Variation in numbers means the lower and upper limit of uncertainty with respect to emissions (sloping distribution).

UNFCCC category	Uncertainty, % of category's emissions/removals
Forest land remaining forest land	-28..+38
Land converted to Forest land	-71..+120
Cropland remaining cropland	-71..+152
Land converted to cropland	-49..+95
Grassland remaining grassland	-178..+261
Land converted to grassland	-68..+142
Wetlands remaining wetlands	-70..+151
Land converted to wetlands	-49..+104
Settlements remaining settlements	-
Land converted to settlements	-29..+35

3.3. LULUCF and flexibilities

The whole situation of the LULUCF sector is obtained by summing up the results of the accounts. Two calculations were performed with two different forest scenarios S1 and S2 (Annex 1). In both calculations, the LULUCF sector is accounted as net emissions. The forest scenario S2 with HWP, gave a full credit 12.5 Mt CO_2 eq. from forest land but the debit from other accounts counteracted it. One disadvantage in the calculations is that the forest reference level was not constructed according to the proposal but the reference level for 2013-2020 of the Kyoto Protocol was used. Anyway, it is a conservative estimate of the potential forest sink and the actual reference level in 2021-2030 is judged to be even higher.

According to the calculations, the LULUCF sector in Finland would not reach the no-debit rule (Annex 1). Thus, the effort-sharing sector cannot make any use of the LULUCF units. The amount, which Finland could use in the effort-sharing sector is 4.5 Mt CO_2 eq. in 2021-2030 (COM(2016) 482 final, Annex III). Even if the accounting result of the LULUCF sector showed credit, there still would not be any available credits for flexibilities due to the emissions from deforestation and croplands (Table 9).

Table 9. An estimate of the total LULUCF sector without the account of managed forest land (Mt CO_2 eq.). Negative accounting result generates credit and positive debit.

Accounting category	Net emission (+)/ removal (-) in a period		Reference value	Accounting result		
	2021-2025	2026-2030		2021-2025	2026-2030	Total
Afforested land	-0.5	-0.4	-	-0.5	-0.4	-0.9
Deforested land	15.6	14.6	-	15.6	14.6	30.2
Managed cropland	28.2	29.8	24.7	3.5	5.1	8.6
Managed grassland	2.5	2.6	2.9	-0.4	-0.4	-0.8
Total	-	-	-	18.2	19.0	37.2
Available for flexibilities				0	0	0

4. Conclusions

Based on the estimates of future emissions and removals for the relevant land use categories, it appears that the LULUCF sector in Finland would be a net sink of about 15 Mt CO_2 eq. annually. However, if accounted according to the Commission proposal, it would not fulfil the no-debit rule set for it by the Commission proposal for a regulation. The best available estimates for future development of LULUCF emissions and removals were used for these estimates. Looking at the results of this study, it is hard to envision a future with no debit in the LULUCF sector as there are good reasons to assume that Finland as a densely forested country cannot avoid deforestation due to e.g. building activities. Even if drastic changes were made in the management of croplands and grasslands and afforestation was enhanced, their effect would remain modest compared to the carbon losses in deforestation.

Reasoning behind the proposed approach is streamlining the system with the UNFCCC land-based reporting framework. Since the scheme of international reporting under the Paris Agreement is open, there is still a risk of two parallel reporting systems. For the sake of transparency, the reporting as under the UNFCCC would be a better option than the one now proposed. For example, the emissions of deforestation accounted in the end-use category would show the effects of land use decisions in the right subcategory (e.g. settlements or cropland). In that way, the impact of policies, such as incentives for clearing new agricultural land, would be fully reflected in the accounting of cropland. It is questionable if the period for transition between land uses should be given in legislation as the transition time depends on natural and ecological circumstances. It also seems unnecessary to include guidance on appropriate methodologies for LULUCF in Regulation if the IPCC methodologies will be acceptable in the greenhouse gas inventory in future.

The proposal encourages attention to be paid to land-use planning. However, the period 2021-2030 is already so close that in practice, many previous land use decisions made in the 2000's will affect emissions during that time. The potential for new measures to overcome the increase of emissions of, for example, clearing of peatlands for agriculture in the 2000's are limited. According to the sensitivity analysis, extensive intervention in the cultivation of organic soils would be required to turn agricultural land to a net sink.

The accounting of the LULUCF sector is multi-stage and there are many uncertainties. The greatest uncertainty is caused by the assumptions of the future scenarios. The land use sector forecast needs to take into account factors like demographic trends, policies and productivity in agriculture and forestry and magnitude and share of energy sources. For this reason, different forecasts give very different results and clear conclusions about future developments are difficult to make. For example, the results presented in this report differed significantly from the estimates that were based on the values published by the Commission as the reference scenario of Finland (EC 2016). Additionally, the constantly evolving emission estimation methods of the greenhouse gas inventory may affect the results significantly.

The forest reference level has a high importance for Finland. The reference level and, consequently, accounting of the managed forest land affects the net result of the LULUCF sector significantly. The determination of the reference level is very challenging because it would have to be based on the intensity of forest use in the period of 1990-2009 and so that the challenging criteria set out in the proposed regulation would be met. In Finland, forestry legislation and forestry guidelines have been renewed during and after the proposed base period. The way in which such changed circumstances should be taken into account should be clear before the forest reference levels are drawn up. One possibility could be to use a more recent base period.

Limits for the benefits, i.e. different caps, may remove the incentives to increase the carbon stocks over the upper limit. Incentives to increase the sinks could be enhanced by a greater share of credits from forest land. A cap based on the size of the sink is likely to be more encouraging than the total allowance compensation. However, in the case of Finland even the removal of the cap is

not expected to change the LULUCF sector into a sink. Modest possibilities to benefit from the sinks limit the battle against climate change by land use and place the LULUCF sector in a different position compared to other sectors. Without clear benefits from sinks, the sector can be seen mainly as one of the flexibilities to offset emissions from other sectors.

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ANNEX 1. Accounting results according to scenarios

Table 1a. Forest scenario S1

Accounting category	Net emissions /removals during period			Computational net emissions /removals during period			Accounting result of LULUCF sector		
	2021-2025	2026-2030	Reference value 5y	2021-2025	2026-2030	MFL cap	2021-2025	2026-2030	2021-2030
				Mt CO_2 eq.					
AFF	-0.54	-0.35	-	-0.54	-0.35	-	-0.54	-0.35	-0.89
AFF + HWP	-0.53	-0.37	-	-0.53	-0.37	-	-0.53	-0.37	-0.89
DEF	15.59	14.63	-	15.59	14.63	-	15.59	14.63	30.22
MCL	28.24	29.83	24.71	3.52	5.12	-	3.52	5.12	8.64
MGL	2.54	2.55	2.94	-0.40	-0.39	-	-0.40	-0.39	-0.79
MFL FL	-106.58	-108.59	-96.50	-10.08	-12.09	12.50	-10.08	-12.09	-22.16
MFL FL+HWP	-129.94	-128.35	-115.00	-14.94	-13.35	12.50	-12.50	-12.50	-24.99
LULUCF without HWP							8.09	6.92	15.01
LULUCF with HWP							**5.69**	**6.50**	**12.18**
MWL	9.45	8.89	1.99	-0.51	-1.07		-0.51	-1.07	-1.58
LULUCF without HWP+WL							7.58	5.85	13.43
LULUCF with HWP + WL							**5.17**	**5.42**	**10.60**

AFF = Afforested land, DEF = Deforested land, MCL = Managed cropland, MGL = Managed grassland, MFL = Managed forest land, MWL = Managed wetland, HWP = Harvested wood products.

Net emissions/removals from AFF and DEF are included in full.

In calculating MCL, MGL and MWL, the reference value is the average of 2005-2007 multiplied by five.

The MFL reference value is the forest management reference level for the second commitment period of the Kyoto Protocol multiplied by five. For harvested wood products, the reference level has been corrected to correspond to the estimate for 2016 greenhouse gas inventories. The computational sink is limited by the MFL cap, which is 3.5% of total 1990 emissions without the LULUCF sector, or about 2.5 Mt CO_2 eq. per year.

Positive figures (+) are the emission and the negative (-) are the removals.

Negative accounting result generates credit and positive debit.

Table 1b. Forest scenario S2

Accounting category	Net emissions /removals during period			Computational net emissions /removals during period			Accounting result of LULUCF sector		
	2021-2025	2026-2030	Reference value 5y	2021-2025	2026-2030	MFL cap	2021-2025	2026-2030	2021-2030
				Mt CO_2 eq.					
AFF	-0.54	-0.35	-	-0.54	-0.35	-	-0.54	-0.35	-0.89
AFF + HWP	-0.53	-0.37	-	-0.53	-0.37	-	-0.53	-0.37	-0.90
DEF	15.59	14.63	-	15.59	14.63	-	15.59	14.63	30.22
MCL	28.24	29.83	24.71	3.52	5.12	-	3.52	5.12	8.64
MGL	2.54	2.55	2.94	-0.40	-0.39	-	-0.40	-0.39	-0.79
MFL FL	-91.70	-66.50	-96.50	4.80	30.00	12.50	4.80	30.00	34.80
MFL FL+HWP	-123.77	-96.56	-115.00	-8.77	18.44	12.50	-8.77	18.44	9.68
LULUCF without HWP							22.97	49.01	71.97
LULUCF with HWP							**9.41**	**37.43**	**46.84**
MWL	9.45	8.89	1.99	-0.51	-1.07		-0.51	-1.07	-1.58
LULUCF without HWP+WL							22.46	47.94	70.39
LULUCF with HWP + WL							**8.90**	**36.36**	**45.26**

AFF = Afforested land, DEF = Deforested land, MCL = Managed cropland, MGL = Managed grassland, MFL = Managed forest land, MWL = Managed wetland, HWP = Harvested wood products.

Net emissions/removals from AFF and DEF are included in full.

In calculating MCL, MGL and MWL, the reference value is the average of 2005-2007 multiplied by five.

The MFL reference value is the forest management reference level for the second commitment period of the Kyoto Protocol multiplied by five. For harvested wood products, the reference level has been corrected to correspond to the estimate for 2016 greenhouse gas inventories. The computational sink is limited by the MFL cap, which is 3.5% of total 1990 emissions without the LULUCF sector, or about 2.5 Mt CO_2 eq. per year.

Positive figures (+) are the emission and the negative (-) are the removals.

Negative accounting result generates credit and positive debit.

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