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Activity 4. “Developing a methodology and compilation of forest accounts”

D1.12 Description of the methodology and methodological issues for forestry account

Methodological report

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Contents

Overview of the work done on compilation of European Forest Accounts (EFA)

This report outlines the work carried out under Activity 4. “Developing a methodology and compilation of forest accounts”.

The methods for the compilation of the European Forest Accounts (EFA) tables were tested and the results and observations are outlined in the following subchapters. Viewpoint of the planned amendments of the regulation 691/2011 on environmental economic accounting regarding forest accounts was also considered.

For the production of the forest accounts a project team was involved comprising Statistics Estonia, Estonian Environment Agency, Estonian University of Life Sciences and main stakeholders from Ministry of Environment.

In a first phase of the project the methods and available data sources were analyzed and preliminary set of the tables were filled for Estonia. Tables were analyzed and at the intermediate stakeholder meeting the feedback from the experts and users was received.

In the second phase of the project and based on the received feedback Eurostat was consulted on the definitions of forest accounts. Also, methodological consultation was carried out with Statistics Slovenia on forest accountants regarding the general methods and practice for the compilation of the tables and interpretation of the definitions (not financially covered under current workstream).

Proposed amendment of the regulation 691/2011 regarding forest accounts was analyzed in detail and suggested methods were tested. Despite the fact that the work with the definition on international level is still in evolution, the progress on the compilation of the EFA tables, co-operation between the statisticians, forestry scientists and experts community and stakeholders was considered a success and the workplan was carried out in developing and adapting the definitions and concepts.

Regarding wooded land and timber assets calculations in physical units, table A1a and A2a, basic data are largely available and the links to international reporting’s (JFSQ and GFRA) were analyzed. The testing of the applicability of the EFA definitions was carried out. Predominant issues were related to the internal consistency of the EFA definitions while compiling of the balance on wooded land and timber assets and flows in Estonia. Report outlines the results and the issues of the scope and definitions tackled. Shortcomings and challenges and the issues arising from the application of different data sources, data availability and inconsistencies were listed and analyzed. The cooperation with the Estonian Environment Agency was crucial for obtaining the results on valuation of forest land and timber assets in physical units.

Regarding wooded land and timber assets calculations in monetary units, for table A1b and A2b, overview of the theoretical background and efforts so far in the valuation of forest land and timber stocks were studied and feasible theoretical and practical approaches were analyzed. For the valuation of the forest four approaches were analyzed and considered theoretically feasible. Two approaches were tested numerically and eventually one of the two approaches was selected and suggested based

on methodological maturity and data availability. Reporting tables contain data for both approaches currently.

Regarding the valuation of the timber stocks and flows three parallel methods were analyzed and tested and one method was also suggested as most beneficia. Reporting tables contain all three approaches currently. As one of the approaches (net present value of the future income approach) is in use for the valuation of the biological assets of the state forest, the further work for the improvement of this approach was suggested by project experts currently. Report outlines in the following subchapters the details of the various approaches and challenges faced. The cooperation with the Estonian University of Life Sciences was crucial for obtaining the results on valuation of forest land and timber assets in monetary units.

Compilation of the Table B1, B2, as well as the supply and use tables for wood in rough in monetary units, (B3A and B3B) and supply and use tables of wood in rough in physical units, C1a and C1b were mainly the task of Statistical Office. If in general the data sources and respective categories in national accounts and basic enterprise statistics gave a good starting point to compile these tables, assumptions for the derivation of more detailed necessary breakdowns were made. Some of the categories like coverage of the timber final consumption category was considered as one of the categories which needs future improvements.

For the supply and use tables in physical units the compiled JFSQ (Joint Forest Sector Questionnaire) was considered to be a rather good source of the information and for the cross-referred definitions. Analyses and the cooperation with those who compile the timber balance brought up some aspects for improvement both for timber balance and supply use tables in physical units. Discussion brought up the probable case that the estimation of the physical quantity of foreign trade of wood in rough may vary in sense of reflecting the timber under bark or over bark. It was suggested that future analyses are needed as probably enterprises could indicate their production and export not uniformly.

In a second phase of the project Statistics Estonia has contributed also to the methodological development of EFA handbook on the dedicated Eurostat webinars for the development European Forest Accounts Handbook on (two meetings) and in bilateral methodological discussions.

Statistics Estonia presented the preliminary results on the Eurostat Expert meeting of Forest Accounting on March 2023. Several of the methodological challenges were addressed and some feedback and suggestions on the methodological questions raised was received from Carl Obst who the main coordinator for is the developing of European Forest Accounts Handbook.

At the end of the activity second milestone seminar was carried out outlining main results, problems faced and discussion points. Seminar involved relevant experts from the area of forest statistics and accounts stakeholders and also main players on the field. The alternative proposed valuation methods were also discussed and handled also on this joint seminar bringing together organizations and experts from different backgrounds. Conclusions of the meetings is added as annex. Work done and feedback received both from the stakeholders and project experts defines for Statistics Estonia also the bases for possible upgrades in the methods and testing of various approaches in coming year and also contribution to the handbook if relevant. The issues for the future's methodological advancement of the forest assets valuation were pointed out. It was agreed that if additional data sources for the asset valuation will become available these data sources will be analyzed as well. It was agreed that work on the development of the methodology and the valuation of wooded land assets needs to continue.

In addition to general framework of the forest accounts reporting, also the links to related and other standards like UN SEEA EA and national accounts (SNA and EA) were handled. It was still considered

important that the foreseen coherence between forest and ecosystem accounts is obtained and described.

The co-operation with other NSI-s was discussed as one of the possible further steps for developing further forest accounts in sense of refinement of the accounts.

Ministry of Environment has acknowledged that EFA is useful for the policy analyses. Stakeholders thanked project team who have done a remarkable effort in analyzing methodology and available data for the EFA compilation and compiled the first round of the tables and setting up a discussion forum for the results.

Several working meetings and three milestone seminars were carried out:

1. Final seminar comprising the analyses of the results and involving rather wide range of users and experts (Summary, Annex 1)
2. Intermediate seminar analyzing preliminary results and stock taking (Summary, Annex 2)
3. Project kickoff meeting, no separate summary

The model year for the development of the methodology and compilation of the data for T+2 was selected to be 2019 as the year for which also monetary supply and use table data became available by 2022 in Estonia.

1 Compilation of EFA table A1a: Area of wooded land (1000 ha)

Current chapter provides an overview of the data sources for the compilation of the tables on wooded land balance (Table A1a) applied methods, overview of the process of the compilation, links to international reporting's (LULUCF and GFRA). The issues related to the application of the EFA definitions of wooded land are highlighted.

Problems arising from the basic characteristics of the used data sources: Variability of estimates acquired with sampling method and differences in definitions are discussed. Detailed overview and feedback are given on the compilation of each variable in a balance.

Issue of the compilation of the balance is handled methodologically as starting and the final assets are independent estimates and not the result of a balance sheet calculations. Estimates of changes added to the initial state do not add up to the final asset. It is described how the situation could be solved: for example, the difference is allocated to the balancing entry in case of the forest land and then the balancing entry is attributed proportionally to forest land subcategories according to the opening area.

Provided approach for wooded land asset account allows the annual reporting on table A1a with actual estimates and do not include any data modelling (forecasting, inter-/extrapolation). To the possible extent the reporting kept coherence with other international reporting routines (FRA, Forest Europe, IPCC LULUCF).

1.1 Data sources for the compilation of the EFA table A1a: Area of wooded land

National Forest Inventory (NFI) is the primary information source for the tables A1a and A2a. NFI is carried out by the Forest Department of the Estonian Environment Agency (EstEA). NFI provides following EFA wooded land and timber related data:

1. area of forest land and other wooded land and other land uses (cropland, grassland, wetlands, settlements, and other land);
2. dynamics of the area of land-use changes (including afforestation and deforestation);
3. volume of woody biomass (including living biomass and deadwood) on different land use and land-use change categories (including forest land and other wooded land);
4. increment of growing stock on forest land;
5. felling volumes as a basis for removals' estimates; and
6. designation of forest according to availability for wood supply

The use of data which are produced based on agreed methodologies continuously is an essential and important precondition for the compilation of forest accounts. The NFI has a long history in Estonia, started in 1999. The NFI is a systematic collection of forest, forestry, and land-use information on network of sample plots. Methodologically, the NFI is designed as an annual and continuous research effort. Design of the Estonian NFI is a systematic sample without pre-stratification. The network of sample plots covers the whole country (and all land-use categories) and is planned as a five-year cycle. The sampling intensity is the same throughout the whole country. The sampling grid is designed to meet the accuracy requirements at the national level. Approximately 370 clusters (ca 5 500 sample plots) measured each year. An observation unit is an individual field plot that is the center of sample circles with defined radii. The method of sampling with partial replacement is used. Plots are divided into permanent clusters (plots re-measured in every 5 years) and temporary clusters that form 800 meter squares. All population units have an equal probability of being selected into the sample. The results are point estimates of multiple population parameters based on the measurement data. As all

NFI estimates are based on sampling, they are not absolute. Therefore, each estimate of a general parameter is always accompanied with a sampling error. The sampling scheme and design are described in more detail by Adermann (2010)[1].

NFI has an important role in decision-making on the sustainable management of forests and future projections – in large-area forest management planning such as estimating the optimum cutting level. NFI statistical estimates are the basis for national[2] and international statistical reporting: e.g., United Nations/FAO Forest Resources Assessment[3], the Ministerial Conference on the Protection of Forests in Europe (Forest Europe aka MCPFE)[4], information on forest carbon pools and changes for the LULUCF sector in the GHG inventory[5]. The usage of NFI as the primary data source guarantees the comparability with already reported estimates to other major international forest related reporting frameworks.

Estimates for "Afforestation and other increase" and "Deforestation and other decrease" of forest land come from GHG reporting CRF tables[6]. Most recent data submission i.e., 2023 was used for 2019 figures, where land-use change data are provided for every single year for 1990–2021.

Data for subcategories of forest land and other wooded land area according to the availability for wood supply are based on NFI plot data. Locations of the sample plots are compared to the nature protection GIS layers from the Estonian Nature Information System EELIS.

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[1] Adermann, V. (2010). Estonia. *In*: Tomppo, E., Gschwantner, T., Lawrence, M., McRoberts, R. (eds). National forest inventories: Pathways for common reporting. Dordrecht: Springer, pp. 171–184.
[2] Yearbook Forest 2021: https://keskkonnaportaal.ee/sites/default/files/Teemad/Mets/Mets2020.pdf; NFI 2021 estimates: https://keskkonnaportaal.ee/sites/default/files/Teemad/Mets/SMI2021_tulemused_0.pdf
[3] https://www.fao.org/forest-resources-assessment/en/
[4] https://foresteurope.org/state-of-europes-forests/
[5] https://unfccc.int/documents/461808
[6] UNFCCC National Inventory Submissions 2023, CRF (common reporting format) tables Estonia 2023 https://unfccc.int/documents/627752

1.2 Methodology for the compilation of EFA table A1a: Area of wooded land

1.2.1 Comparison of the definitions in national reporting, FRA, LULUCF and EFA

EFA tables A1a compilation is based on FRA definitions.

Forest area and other wooded are estimated according to the FRA (UNFAO – Forest Resources Assessment) definitions[7]:

1. ***Forest land:*** *Land spanning more than 0.5 hectares with trees higher than 5 meters and a canopy cover of more than 10 percent, or trees able to reach these thresholds in situ. It does not include land that is predominantly under agricultural or urban land use.*
   All temporarily unstocked forest areas and regeneration areas which have yet to reach a crown density of 10 per cent and a tree height of 5 meters are also included as forest, as are areas which are temporarily unstocked because of human intervention such as harvesting, or natural causes (fires, etc.) but which are expected to revert to the forest. Forest land also includes abandoned shifting cultivation land with a regeneration of trees that have, or are expected to reach, a canopy cover of 10 percent and tree height of 5 meters.
2. ***Other wooded land:*** *Land not classified as "Forest", spanning more than 0.5 hectares; with trees higher than 5 meters and a canopy cover of 5-10 percent, or trees able to reach these thresholds in situ; or with a combined cover of shrubs, bushes and trees above 10 percent. It does not include land that is predominantly under agricultural or urban land use.*

Estonian Forest Act[8] defines forest land as follows:

§ 3. Forest and forest land

(2) 'Forest land' means land that meets at least one of the following requirements:

1) is entered in the cadastral register as a forest land parcel;
2) is a plot of land with an area of at least 0.1 hectares and woody plants with the height of at least 1.3 metres and with the canopy density of at least 30 per cent grow there.
(3) The land of yards, residential land, parks, cemeteries, green areas, berry gardens, orchards, forest nurseries, gardening centres, arboreta, and plantations of trees and shrubs is not deemed forest land for the purposes of this Act.
(4) For the purposes of this Act, 'tree and shrub plantation' means a site of habitat established for intensive growing of trees and shrubs on non-forest land where trees and shrubs are grown with regular planting spacing and managed uniformly by age.

As many of the most important estimates from NFI are connected to forest land area, the difference between the national and international forest land area definition has caused confusion. Forest land area definition according to the FRA is widely used in international reporting. Comparing the definitions, it appears that according to the FRA definition the forest land covers areas which are reported under other land-use categories according to the national definition (see the following: Table 1. Forest land and other wooded land area according to national and FRA designation in 2018) Therefore the

[7] FAO (2018). Terms and definitions FRA 2020. Forest resources assessment working paper 118. https://www.fao.org/3/I8661EN/i8661en.pdf
[8] https://www.riigiteataja.ee/en/eli/ee/510022014001/consolide/current

estimates of forest area in national and international reporting are not directly comparable. It is common in international reporting to aggregate the Forest land and Other Wooded Land into total wooded land area estimate but still use the detailed title "Forest and other wooded land". For the compilation of the current EFA table on wooded land (A1a) FRA definitions were used in principle as mentioned in the beginning.

Table 1. Forest land and other wooded land area according to national and FRA designation in 2018[9]

	Total area of Estonia			of which FRA forest land					of which FRA other wooded land				
Estonian land category	1000 ha	Share (%)	RE* (%)	1000 ha	Share (%)	RE* (%)	Share from land category	Share from total area	1000 ha	Share (%)	RE* (%)	Share from land category	Share from total area
Forest land	2330.9	51.4	1.1	2330.9	95.3	1.1	100.0	51.4	0				
Bushes	67.6	1.5	9.3	20.8	0.9	16.8	30.8	0.5	41.2	42.1	11.7	60.9	0.9
Natural grassland	237.7	5.2	4.9	34.0	1.4	13.0	14.3	0.7	31.7	32.4	13.0	13.3	0.7
Swamp, bog	222.7	4.9	5.1	57.1	2.3	10.3	25.6	1.3	21.8	22.3	16.9	9.8	0.5
Other	1675.1	36.9	1.2	3.5	0.1	39.8	0.2	0.1	3.1	3.2	43.3	0.2	0.1
Total	4533.9	100.0		2446.3	100.0	1.1		54.0	97.8	100.0	7.7		2.2

There is no need for additional calculations or re-categorization of other land-use classes in compiling EFA table on wooded land A1a. NFI is using next to the Estonian national land-use classification the international wooded land classification (FRA: forest land, other wooded land). Relevant land-use categories (both national and international) are attributed to the sample plots and sub-plots during the fieldwork.

FRA forest land area includes areas from other land-use classes by national classification. See Table 2. Matrix of land-categories based on Estonian national classification and LULUCF in 2021 (1000 ha) according to NFI, where IPCC forest land coincides almost fully to the FRA forest land area definition.

There is no uncertainty from the classification of land-use areas in NFI but there exists the uncertainty from the subjectivity of the designation by fieldworkers, as the land category is the assessed not measured attribute. It may add extra variability especially in case of the phenomena with the relatively small area (e.g., Other wooded land area). There are some land-use categories where woody vegetation may reach the forest land or other wooded land parameters. In those cases, the trees are not measured e.g., on corridors under powerlines or other infrastructure objects, on slopes of the inland water bodies esp. ditches); land-use is determined on the sample plot according to Estonian land category system but not by the FRA wooded land categories.

[9] Statistiline mets 20 aastat statistilist metsainventeerimist Eestis, Keskkonnaagentuur 2019, page 27, https://keskkonnaportaal.ee/sites/default/files/2021-12/Statistiline%20mets%20-%2020%20aastat%20statistilist%20metsainventeerimist%20Eestis.pdf

Table 2. Matrix of land-categories based on Estonian national classification and LULUCF in 2021 (1000 ha) according to NFI[10]

Estonian land-category	LULUCF land-category (1000 ha)					
	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land
Forest land (M)	2 117.9					
Unstocked forest land (MM)	207.8					
Arable land (PM) (excl. PK, PR)		663.1				
Permanent crops (PK)		2.7				
Long-term permanent grassland (PR)		311.1				
Bushes (P)	20.4		41.2			
Natural grassland (RM)	36.4		207.7			
Swamp, bog (S)	60.8		25.2	141.8		
Inland water bodies (SV)				266.4		
Peat quarry (KT)				25.5		
Opencast pit (K) (excl. KT)					7.9	
Settlements (excl. T, TR)					201.0	
Roads, railways (T)					65.1	
Lines, power lines etc. (TR)					80.9	
Unusable arable land (KK)	4.2		2.6			36.5
Other land (Y)						7.8
Total	2 447.4	976.9	276.8	433.6	354.9	44.3

EFA defines the *other land with tree cover available for wood supply containing agro-forestry, short-rotation forestry and short-rotation coppices on agricultural land*. This is narrow approach (assuming that provided list is exclusive) compared to FRA definition:

- *OTHER LAND All land that is not classified as "Forest" or "Other wooded land".*

Explanatory notes:

1. For the purpose of reporting to FRA, the "Other land" is calculated by subtracting the area of forest and other wooded land from the total land area (as maintained by FAOSTAT).
2. Includes agricultural land, meadows and pastures, built-up areas, barren land, land under permanent ice, etc.
3. Includes all areas classified under the sub-category "Other land with tree cover".

- *OTHER LAND WITH TREE COVER Land classified as "other land", spanning more than 0.5 hectares with a canopy cover of more than 10 percent of trees able to reach a height of 5 meters at maturity.*

Explanatory notes

1. Land use is the key criteria for distinguishing between forest and other land with tree cover.
2. Specifically includes: palms (oil, coconut, dates, etc.), tree orchards (fruit, nuts, olive, etc.), agroforestry and trees in urban settings.
3. Includes groups of trees and scattered trees (e.g., trees outside forest) in agricultural landscapes, parks, gardens and around buildings, provided that area, height and canopy cover criteria are met.
4. Includes tree stands in agricultural production systems, such as fruit tree plantations/orchards. In these cases, the height threshold can be lower than 5 meters.
5. Includes agroforestry systems when crops are grown under tree cover and tree plantations established mainly for other purposes than wood, such as oil palm plantations.
6. The different sub-categories of "other land with tree cover" are exclusive and area reported under one subcategory should not be reported for any other sub-categories.
7. Excludes scattered trees with a canopy cover less than 10 percent, small groups of trees covering less than 0.5 hectares and tree lines less than 20 meters wide.

[10] Yearbook Forest2021, chapter 1. Forest Resources page 94, Estonian Environment Agency 2023, https://keskkonnaportaal.ee/sites/default/files/Teemad/Mets/Mets2021.pdf

EFA and FRA approaches for other wooded land with tree cover are different. In case of EFA approach the area of other wooded land with tree cover is almost non-existent in Estonia. In another hand we have the area of other wooded land with tree cover for which there is no entrance category in EFA.

1.3 Data processing for the compilation of the variables of the table A1a.

NFI provides annual **estimates for opening and closing stock for forest land and other wooded land area** (Table 3). Every NFI sample plot is assigned with status of land category including the designation to FRA forest and other wooded land. Data of sample plots are generalised to the whole territory of Estonia (every sample plot represents ca 156 ha of land).

It was possible to produce the breakdown to subcategories by types of forest in EFA tables as area estimates for subcategories of forest land and other wooded land according to the availability for wood supply. These categories are based also on NFI plot data. Locations of the sample plots are compared to the nature protection GIS layers from the Estonian Nature Information System EELIS. Every sample plot gets the protection status according to the strictest protection (quite often several different protection statuses overlap). The protection status is converted into 3 main forest categories:

1. Strictly protected forest or other wooded land area where no forest management is possible, equals to the "available for wood supply";
2. Protection forests where forest management is restricted but not forbidden.
3. Commercial forests where forest management is possible according to the rules set in Forest Act.

Protection forests and commercial forests together form the area of forest available for wood supply. Distribution of the forest categories according to the nature protection regimes has been agreed with the Ministry of Environment. For more details see Yearbook Forest 2021, chapter Environment[11]. Data of sample plots are generalized to the whole territory of Estonia (Table 3).

Regarding the estimates for "Afforestation and other increase" and "Deforestation and other decrease" there are no direct measured total area estimates about increase and decrease of wooded land area, not from NFI or other sources. Remote sensing techniques enable to assess better the forest area loss than gain. Remote sensing usually detects the change in forest cover (tree cover) not the change of land-use (forest land area). Indirectly the forest area increase can be detected from changes of other land-use. This approach is used in reporting the greenhouse gas (GHG) emissions of land-use, land-use change and forestry (LULUCF) sector (change of land-use on NFI sample plots). Estimates for "Afforestation and other increase" and "Deforestation and other decrease" of forest land come from GHG reporting CRF tables[12]. The present system of calculation of land-use matrix over the time-series in GHG reporting includes the reverse (backward) calculation of land use areas according to land-use changes over the whole period. This causes the situation where closing area will not sum up from the opening area and changes in case of earlier years. This difference (between closing area and opening area and changes) in forest land area in Table A1a is attributed to the "Balancing item" category. There is a starting research effort in collaboration with Tartu University and Estonian Environment Agency to elaborate a new calculation scheme which will avoid the recalculation of full time-series. The results

[11] Yearbook Forest2021, chapter 9. Environment, Estonian Environment Agency 2023, https://keskkonnaportaal.ee/sites/default/files/Teemad/Mets/Mets2021.pdf
[12] UNFCCC National Inventory Submissions 2023, CRF (common reporting format) tables Estonia 2023 https://unfccc.int/documents/627752

will be available in 2024. There is also on-going research project in Estonian University of Life Sciences about the application of airborne laser scanning (ALS) for validation of land-use change data.

Afforestation area by the State Forest Management Centre is almost only statistical source on increase of wooded land but it provides only partial coverage. **Estimate of "Afforestation and other increase" of forest land area** in table A1a originates from LULUCF reporting (Table 4). LULUCF reporting framework uses NFI plot data to assess land use and land-use change areas. As the total area of change is small, the estimate has quite high relative error. It must be noted that this is combined estimate of changes of different land-use categories not the independent estimate about forest land increase. This kind of estimate is not available for sub-categories of forest land and for other wooded land area. In case of subcategories of forest land area, the approach is the allocation of the increase proportionally to the share of subcategory from the total forest land area of opening stock in table A1a. There is no data to distribute the increase to subcategories of forest land in another way. It can be assumed that afforestation and other increase takes place mostly on forest area available for wood supply. Increase of wooded land can take place also on FNAWS, mostly by natural expansion as afforestation component is not possible. This may be the research question in further development of reporting methodology.

There are different data sources available for **"Deforestation and other decrease" of wooded land**: actual deforestation areas in state forests, deforestation notifications submitted by landowners/managers to Estonian Environment Board. Unfortunately, those sources have their definite disadvantages. There have been cases where other land categories (not forest land) have been reported for deforestation (e.g., in case of big nature restoration areas). Forest notifications signal the will of the landowner but there is no data whether the deforestation was carried out. Estimate of "Deforestation and other decrease" in table A1a (Table 5) originates from LULUCF reporting and is identical to the approach used for afforestation (change of forest land area into other land-use categories on NFI sample plots). As the total area of change is small, the estimate has quite high relative error. It must be noted that this is combined estimate of changes of different land-use categories not the independent estimate about forest land increase. This kind of estimate is not available for sub-categories of forest land and for other wooded land area. There is no data available to distribute the decrease to subcategories of forest land in another way. It can be assumed that deforestation and other decrease takes place mostly on forest area available for wood supply. But there exist cases where nature restoration projects (e.g., restoration of wetlands or meadows) or infrastructure projects (e.g., extension or establishment of military polygons) may use the deforestation measures. This maybe the research question in further development of reporting methodology.

Balancing item The present system of calculation of land-use matrix over the time-series in GHG reporting includes the reverse (backward) calculation of land-use changes and land use areas over the whole period. As mentioned above this causes the situation where closing area will not sum up from the opening area and changes in case of earlier years. The difference in forest land area is attributed to the "Balancing item" category in table A1a. The balancing item of forest land was distributed for subcategories of forest land area proportionally to the share of subcategory from the total forest land area of opening stock in table A1a. There is no data available to distribute the balancing item to subcategories of forest land in another way. This maybe the research question in further development of reporting methodology.

Statistical re-classification (+/-) Re-classification of the total forest land area does not exist on total level but only for subcategories. Changes in total forest land area should be covered by flow items ("Afforestation and other increase" and "Deforestation and other decrease"). However, it is not yet clear methodologically and needs to be clarified in guidance document for the compilation of EFA. In case

of the sub-categories of forest land area the re-classification is possible as there exist the opening and closing areas for Forest available for wood supply and Forest not available for wood supply (distribution based on the forest categories according to protection status). The reclassification is justified as there is an on-going process of creation of new and re-valuation of existing protection regimes (change in protection status). The area of strictly protected forest land has steadily increased i.e., the areas which formerly belonged to the FAWS category were moved to FNAWS category as a consequence of legal process. The re-classification was calculated as a final step after the opening/closing area, flow items and balancing item were filled in the table.

Due to the lack of data, and methodological scope of NFI, it is not possible to currently compile statistics on **"Other land with tree cover available for wood supply"** according to EFA definitions. The EFA definition currently includes agro-forestry, short-rotation forestry and short-rotation coppices on agricultural land. Those land-use types are almost non-existent in Estonia. There have been scientific test trials with the short rotation coppice of willow species. The hybrid aspen plantations have been planted on agricultural lands but those fulfil the forest land definition requirements before being felled. However there exist trees outside the forest land and urban settings e.g., inland water-bodies (trees on the slopes and sides of the ditches), infrastructure (trees on the corridor of power-lines) which are not assigned with the forest-land or other wooded land label in NFI. This item could be the research question in further development of reporting methodology. There is a reasonable amount of woody biomass removed from outside the wooded land (infrastructure, inland water bodies – slopes of the ditches). This creates the inconsistency between the tables A1a and A2a.

Due to high variability (high relative error), small area of the phenomenon and lack of data it is not possible to assess properly the **flow items of other wooded land**. The relative error of OWL estimates (phenomenon with relatively small area) is much higher than actual changes. Further analysis is needed before those items can be reported to avoid confusing high fluctuations in stock estimates (mostly caused by extreme stock estimates on single sample plots). As there are no flow estimates available the Statistical re-classification item was used to indicate the change between the opening and closing area of Other wooded land and Other wooded land available for wood supply.

1.4 Results for the EFA table A1a: Area of wooded land and links to other reporting frameworks

Current chapter outlines two relevant tables related to the compilation of the table on wooded land assets. First one is a timeseries of the official statistics on wooded land in Estonia displaying the timeseries available for categories opening and closing stock (Table 3. Area of wooded land in 1999–2021 according to NFI). Compliant data to this table are also reported to international organizations via routine reporting. Second table (Table 4) is one of the IPCC reporting tables "Increase and decrease of forest land area in 2019 according to GHG reporting; Areas and changes in areas between the previous and the current inventory year" regarding forest area changes which are referred in previous chapters. Marked with an asterisk are the calculations of the total changes of forest land area (increase and decrease). Third table (Table 5) displays the EFA table A1a for the year 2019. The interrelations between the tables are marked in bold in both tables and marked with asterisks and explained in chapters above.

Table 3. Area of wooded land in 1999–2021 according to NFI

Year	Area of wooded land (1000 ha)				
	Forest			Other wooded land	
	Total	available for wood supply	not available for wood supply	Total	available for wood supply
2021	2447.41	1988.90	458.51	101.27	75.50
2020	2443.84	1999.94	443.91	100.60	74.63
2019*	**2450.51**	**2016.46**	**434.05**	**100.39**	**76.04**
2018**	**2446.52**	**2040.79**	**405.72**	**97.84**	**74.60**
2017	2438.46	2046.83	391.64	97.07	76.75
2016	2421.36	2062.18	359.18	96.98	77.71
2015	2421.42	2088.62	332.79	101.78	82.52
2014	2408.18	2106.48	301.70	103.35	84.83
2013	2379.50	2082.65	296.85	106.50	90.04
2012	2360.04	2079.65	280.39	108.16	91.49
2011	2348.89	2084.60	264.29	118.33	97.16
2010	2337.38	2088.56	248.82	127.89	106.32
2009	2337.48	2076.31	261.17	108.22	88.88
2008	2326.81	2070.52	256.29	87.13	69.39
2007	2345.42	2090.82	254.59	63.22	49.46
2006	2325.01	2086.05	238.96	35.51	29.43
2005	2300.87	2070.75	230.12		
2004	2282.13	2068.46	213.67		
2003	2254.69	2058.80	195.89		
2002	2215.05	2027.04	188.01		
2001	2235.37	2046.17	189.20		
2000	2243.01	2033.15	209.86		
1999	2194.14	1980.80	213.34		

* 2019 figures were used as closing area for 2019 in table A1a

** 2018 figures were used as opening area for 2019 in table A1a

Source: Estonian Environment Agency, NFI2021

Table 4. Increase and decrease of forest land area in 2019 according to GHG reporting[13]

TO:	Forest land (managed)	Forest land (unmanaged)	Cropland	Grassland (managed)	Grassland (unmanaged)	Wetlands (managed)	Wetlands (unmanaged)	Settlements	Other land	Total unmanaged land	Initial area	Total decrease*
FROM:	(kha)											
Forest land (managed)(2)	2445.29	NO	0.03	0.27	NO	0.08	NO	0.98	0.17	NO	2446.82	1.53
Forest land (unmanaged)(2)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
Cropland(2)	0.03	NO	976.06	0.30	NO	0.02	NO	0.36	0.03	NO	976.80	0.74
Grassland (managed)(2)	1.22	NO	0.84	278.73	NO	NO	NO	0.47	NO	NO	281.26	2.53
Grassland (unmanaged)(2)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
Wetlands (managed)(2)	NO	NO	NO	NO	NO	35.34	NO	NO	NO	NO	35.34	0.00
Wetlands (unmanaged)(2)	0.27	NO	NO	0.03	NO	0.03	398.50	0.04	NO	NO	398.87	0.37
Settlements(2)	0.02	NO	0.03	NO	NO	0.05	NO	350.59	NO	NO	350.68	0.10
Other land(2)	0.08	NO	NO	0.03	NO	NO	NO	NO	44.12	NO	44.23	0.11
Total unmanaged land (3)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
Final area	2446.91	NO	976.97	279.37	NO	35.52	398.50	352.42	44.31	NO	4533.99	
Net change(4)	0.09	NO	0.17	-1.90	NO	0.18	-0.37	1.74	0.09	NO	0.00	
Total increase*	1.62		0.90	0.63		0.18		352.07	0.20			

(1) For Parties using reporting approach 1 to represent land areas, only data on the initial and hter area per land use should be filled in. Notation key „NA" (not applicable) should be used in such cases for the specific land use transitions, allowing for the formulas in the cells for hter and initial areas to be overwritten. Coastal wetlands areas which are not part of total land area should not be included in this land matrix.

(2) Definitions for the respective land use categories used by the Party should be provided in the NIR, in accordance with the definitions of land use categories in Volume 4, chapter 3, section 3.2 of the 2006 IPCC Guidelines.

(3) Parties may report only the total area of unmanaged land area and enter the notation key IE hter the hter uaal unmanaged land uses categories.

(4) Net change is the hter area minus the initial area for each of the conversion categories shown at the head of the corresponding row. In the hter area row the net change equals zero.

[13] UNFCCC National Inventory Submissions 2023, CRF (common reporting format) tables Estonia 2023, https://unfccc.int/documents/627752

* Calculated for EFA, not a part of submission table; Afforestation and deforestation figures marked with bold were used in table A1a.

Table 5. A1 (a) Area of wooded land, in 1000 ha, Reference year = 2019

Code	Description	Opening area (December t-1) 2018	Afforestation and other increase	Deforestation and other decrease	Statistical re-classification (+/-)	Balancing item (+/-)	Closing area (December t) 2019
1	Forest	2446.52	1.62	1.53	0.00	3.91	2450.51
1.1	Forest available for wood supply	2040.79	1.35	1.28	-27.67	3.26	2016.46
1.2	Forest not available for wood supply	405.72	0.27	0.25	27.67	0.65	434.05
2	Other wooded land	97.84	n/a	n/a	2.55	0.00	100.39
2.1	Of which available for wood supply	74.60	n/a	n/a	1.45	0.00	76.04
3	Other land with tree cover available for wood supply	n/a	n/a	n/a	n/a	0.00	n/a

1.5 Problems of the compilation of EFA table A1a: Area of wooded land

In general, the compilation of the table could be considered feasible. As the handbook is not available yet some definitions to be applied are still open. The issues related to the application are EFA definitions will feed to the future development of this area of work at first in Estonia but also in some cases for the development and specification of EFA methodology itself via the specification of handbook.

The list of problems detected during project on table A1a are as follows:

- Shortcomings related to the application of the NFI methodology:

  - Estimates of opening and closing area are based on National Forest Inventory (NFI) where according to the methodology and its application the estimates are for the whole year not for the end or beginning of the calendar year (period of fieldwork measurements is from May to October);
  - NFI yearly estimates are calculated according to the measurements of the last 5 years and calculated estimate is attributed to the last year of field-works;
  - NFI is a sample-based inventory i.e., all estimates have statistical error which is bigger the smaller is the probability of occurrence of investigated phenomenon (especially in case of other wooded land category and flow items).

- Problems arising from the use of different data sources, or the data processing rules (see for the details 2.3):

  - Flow estimates for "Afforestation and other increase" and "Deforestation and other decrease" of forest land come from GHG reporting CRF tables. The present system of calculation of land-use matrix over the time-series in GHG reporting includes the reverse (backward) calculation of land use areas according to land-use changes over the whole period. This causes the situation where closing area will not sum up from the opening area and changes in case of earlier years.
  - Flow estimates are combined from changes of different land-use categories and are not the independent estimate about forest land increase/decrease. This kind of estimate is not available for sub-categories of forest land and for other wooded land area. In case of subcategories of forest land area, the approach is the allocation of the increase proportionally to the share of subcategory from the total forest land area of opening stock in table A1a.

- Distribution of balancing item or reclassification to sub-categories of forest land is based on their relative share not on actual data (see for the details 2.3).

- Data scope for "Other land with tree cover available for wood supply" according to EFA definition which includes agro-forestry, short-rotation forestry and short-rotation coppices on agricultural land but does not cover other categories of forest land with tree cover available for wood supply which are relevant in Estonia. There exist trees outside the forest land and urban settings e.g., inland water-bodies (trees on the slopes and sides of the ditches), infrastructure (trees under the corridor of power-lines) which are not assigned with the forest-land or other wooded land label in NFI.

- There is not enough data available now to assess properly the flow items of other wooded land. In another hand this category itself is negligible. The relative error of OWL estimates (phenomenon with relatively small area) is much higher than actual changes. Further analysis is needed before those items can be reported to avoid confusing high fluctuations in stock estimates (mostly caused by extreme stock estimates on single sample plots).

2 Compilation of EFA table A1b, monetary value of the wooded land

2.1 Data sources of EFA table A1b monetary value of the wooded land

The compilation of the monetary values of the forest land is mainly based on the data of the area of forest land and its changes in physical values which are presented in table A1a "Area of wooded land".

Information about the market value of the transactions with unforested wooded land and with forest real estate is available in the Land Board (*Maa-amet*) price statistics database https://www.maaamet.ee/kinnisvara/htraru/ and in the annual real estate market reviews.

Other data sources used: The results of the land expectation value calculations have been obtained from the Chair of Forest and Land Management Planning and Wood Processing Technologies of the Estonian University of Life Sciences. Information about the 2022 regular land assessment is available on the Land Board's website https://maaamet.ee/maatoimingud-maakataster/maa-hindamine-ja-tehingud/2022-aasta-maa-korraline-hindamine.

2.2 Methodology for the table A1b, monetary value of the wooded land

Conventionally valuation of the forest deals with determining the financial value of the forest and its parts: land and the wood growing on it. In practice the reasons for determining the value of the forest are as follows: purchase and sale transactions, determination of compensation in case of expropriation, for the determining the tax, assessment of the value of forest land as loan collateral compensation for damages, insurance of the forest. All these uses determine specific valuation methods.

According to proposed methodology outlined in EFA guidelines by Eurostat[14], different prices must be applied to different types of land.

Four alternatives for the calculation of the value of the wooded land was handled and are described in subchapters below.

Land available for wood supply is normally valued on the basis of market transactions, either directly or as a ratio of known values of forest real estate.

Therefore, the proposal is to use the median price of transactions when assessing the value of forest available for wood supply in the Table 6.

Question is open and disputable how to value the forest land which is not traded (forest not available for wood supply). In forestry economics, the opportunity costs which measure forgone benefits from alternative land uses are applied to assess the value of nature conservation. Wooded land under strict protection for preserving habitats and natural values could be used for wood production as a second-best alternative. Woodland's ability to grow wood is similar despite the rules and restrictions imposed there. Considering this principle, similar transaction price was applied for different forest categories in the table A1b.

[14] Eurostat 2021. European Forest Accounts: Explanatory notes (version June 2021)

2.2.1 Alternative 1, A1b: area of wooded land on the basis of market transactions with unforested land

First alternative was to find the value of wooded land on the basis of market transactions with unforested land and to use the physical data which are calculated for the EFA table A1a (Wooded land, area of wooded land calculated on the bases of the transactions with unforested land, in hectares).

Following table provides data on the value of the wooded land calculated on the bases of the transactions with unforested land.

Table 6. Alternative 1. A1b Wooded land, area of wooded land calculated on the bases of the transactions with unforested land, in million euros, 2019

Code	Description	Opening area (December 2018)	Afforestation and other increase	Deforestation and other decrease	Statistical Re-classification (+/-)	Balancing item (+/-) *2	Closing area (December 2019)
1	Forest	3094.85	2.05	1.94	0	4.95	3099.90
1.1	Forest available for wood supply	2581.60	1.71	1.62	-35.00	4.12	2550.81
1.2	Forest not available for wood supply	513.24	0.34	0.32	35.00	0.82	549.09
2	Other wooded land	123.77	n/a	n/a	3.23	0.00	126.99
2.1	Of which available for wood supply	94.37	n/a	n/a	1.83	0.00	96.20
3.	Other land with tree cover available for wood supply *1	n/a	n/a	n/a	n/a	n/a	n/a

The median price of transactions with unforested forest land was 1,265 euro per ha in 2019 according to Land Board annual real estate review and are displayed below in Table 7. Transactions with unforested forest land for two years. This transaction price is used for all categories of forest and wooded land. The median price is multiplied by the physical units presented in the table A1a.

Table 7. Transactions with unforested forest land for two years, 2019[15] and 2022[16]

Year	Number	Area, ha	Average area	Value	Average value	Median	Standard deviation	Min price	Max price
2019	317	2754	8.8	3 655 770	1268	1265	509	198	2703
2022	36	179.2	5	478 640	2617	2636	741	990	4157

Following table also present the prices for the transactions with unforested forest for two comparative years.

2.2.2 Alternative 2, A1b: value of wooded land based on market transactions with forest

Second best approach if the data on the direct prices of unforested land are not available, suggested in guidance documents (EFA guidelines) is to use the value of wooded land on the basis of market transactions with forest comprising also timber stock in value as the number of transactions with forest is higher compared to the number of transactions with unforested wooded land. The share of the land in the value of forest had to be estimated.

[15] Maa-amet. 2020. Eesti kinnisvaraturg 2019. aastal
[16] Maa-amet. 2023. Eesti kinnisvaraturg 2022. aastal

Table 8 provides data on the value of the wooded land calculated on the bases of the transactions with forest.

Table 8. A1 (b) Wooded land, area of wooded land calculated on the bases of the transactions with forest, million euros

Code	Description	Opening area (December 2018)	Afforestation and other increase	Deforestation and other decrease	Statistical Re-classification (+/-)	Balancing item (+/-) *2	Closing area (December 2019)
1	Forest	3234.08	2.14	2.02	n/a	5.17	3239.35
1.1	Forest available for wood supply	2697.74	1.78	1.69	-36.58	4.31	2665.57
1.2	Forest not available for wood supply	536.33	0.36	0.33	36.58	0.86	573.79
2	Other wooded land	129.34	n/a	n/a	3.37	0.00	132.71
2.1	Of which available for wood supply	98.61	n/a	n/a	1.92	0.00	100.53
3	Other land with tree cover available for wood supply *1	n/a	n/a	n/a	n/a	n/a	n/a

As justified above, the number of transactions with forest is higher compared to the number of transactions with unforested wooded land. Based on the last years' data, it would be possible to use the share of the land in the value of forest. In years 2019-2022, the share of land value in the median price of transactions was 33.5%. The share was found by dividing the median value of the transactions with forest land without timber by the median value of the transactions of forest (forest land with timber) for the years 2019-2022. Taking into account the aforementioned proportion and the median price of forest transactions 3,946 euros per ha in 2019, the value of the land is 1,322 euros per ha.

Table 9. Prices of the forest land

	Forest land sold, thousand ha	Monetary value, million	Median price	Average price, euro/ha
2013	49	116.6	1875	2361
2014	59	141,1	1854	2376
2015	49	118,1	1842	2419
2016	47	110.7	1737	2365
2017	47	124,1	2051	2661
2018	41	151.9	2958	3747
2019	37	140,5	3116	3848
2020	14	63,1	4163	4843
2021	6	36,6	5578	6445
2022	6	50,6	7323	8695

*- Source Land Board, 2023

2.2.3 Alternative 3, A1b: assessment of wooded land value, land expectation value

Theoretically, the land expectation value (LEV) according to Faustmann´s method[17] which shows value of a forest as a sum of discounted net cash flow over an infinite time period. LEV as the modelled value of the land depending on the future costs could be calculated for different plots and then aggregated at the national level. However, being theoretically feasible, this approach has not applied in Estonia.

[17] Introduction to Forestry, Forest Policy and Economics » 3. The Faustmann Model (Part I) (archive.org)

Table 10. Faustmann's formula

$$B_u = \frac{A_u + \sum_{x=o}^{u} D_x (1+i)^{u-x} - C(1+i)^u}{(1+i)^u - 1} - \frac{v}{i}$$

Bu – land expectation value
u – rotation period
Au – net revenue from regeneration felling at the age u.
Dx – net revenue from maintenance felling at age x
C – cost of forest cultivation
v – annual administrative costs
i - interest rate

Since the profitability of forestry is low, the interest rates used in forestry are also relatively low. According to various data, the interest rates used in forest management for assessing values and calculating losses are in the range of 1.5-5.5%[18].

When calculating the present value of the future income and expenses of the growing forest, a discount rate is used, the value of which is the arithmetic average of the interest rates of the 12 calendar months preceding the evaluation published in the statistical report of Bank of the Estonia "Interest rates of loans granted to Estonian non-financial companies by activity areas" in the long-term loans line "Agriculture, forestry and fisheries", but not less than 2 percent and not more than 4 percent[19].

In order to implement the method on total national level, it is necessary to carry out special research. The development of the stands in different site types with different quality class should be modelled, the costs and incomes of forest management estimated, and the present value of future cash flows should be calculated. Different forest site types with different quality class have different expectation value.

Examples which describe the difference between LEV due to the forest site type and quality class show the big difference of more than twenty times for different forest types are presented in Table 11. Forest land expectation value based on Faustmann´s method of (€/ha). Quality class has the highest influence on the land expectation value. When using the prices and management costs data of 2022 and 3% interest rate, the land expectation value of III quality class mixed birch-spruce stand in Oxalis drained swamp was 112 euros per ha. At the same time, the LEV was 1,813 euros per ha for I quality class spruce stand in Aegopodium site type and 2,309 euros per ha in Oxalis-Myrtillus I quality class birch stand. In certain cases, on site types with low quality class (IV-Va) and management with long rotations, the land expectation value could even be negative.

[18] Kask T., Kevvai, A. 2008. Evaluation the Standing Forest as a Biological Asset. Master thesis, Estonian Business School. 58p. In Estonian
[19] Regulation of the Government of the Republic "Procedure for extraordinary valuation of immovable property"

Table 11. Forest land expectation value based on Faustmann´s method of (€/ha)

Forest site type	Tree species	Value (€/ha)
Oxalis drained swamp	Birch, Spruce	112
Calamagrostis-alvar	Spruce	374
Aegopodium	Spruce	1813
Oxalis-Myrtillus	Birch	2309

2.2.4 Alternative 4, A1b: assessment of wooded land value, taxation value method

Theoretically also the taxation value could be used for the assessment of wooded land value. In 2022, the Land Board carried out a regular land assessment and estimated a tax rate for different land categories. The base value of forest land is the average price of transactions with bare forest land. Transactions were verified by comparing historical satellite images and transaction dates to ensure that the pool of transactions used in the analysis consisted of only clear-cut areas. Based on sales transactions, the base value of forest land is 1883 €/ha.

Considering the quality factor is necessary because not all lands have equal value. The quality factors reflect the productivity of the respective forest plot compared to the average forest land, considering the forest site type, the quality of the forest land and land improvement (drainage).

2.3 Discussion on valuation methods for wooded land

Four approaches were analyzed and feasibility of the relevance of the methods was discussed also from the viewpoint of the establishing methods in the upcoming handbook for the compilation of forest accounts. In addition, also the valuation was analyzed from the viewpoint on how to reach the best results with current data available.

Theoretical background and feasible methods for Estonian forest accounts so far in the valuation of forest land(unforested) were analyzed and discussed both in bilateral meetings between Statistics Estonia and various experts in a field: Professor Paavo Kaimre (Estonian University of Life Sciences), Carl Obst on the theoretical background and with representatives of Statistics Slovenia and also with Eurostat representatives of forest accounts on webinars and bilateral discussions.

The results were also presented to relevant experts and stakeholders in Estonia. For the valuation of the forest land one of the approaches is argued and suggested based on the methodological maturity and data availability. The proposal is to use the median price of transactions when assessing the value of unforested land available for wood supply for the compilation of the Table A1b presented in Table 6. Alternative 1. A1b Wooded land, area of wooded land calculated on the bases of the transactions with unforested land, in million euros, 2019.

This decision is based on the assumption that forest land available for wood supply is normally valued on the basis of market transactions, either directly or as a ratio of known values of forest real estate. Problems. A sufficient number of transactions with forest land is important precondition to obtain reliable results. Unfortunately, the number of transactions with unforested forest land in Estonia is quite small (317 transactions totally in 2019), several times smaller than the number of transactions (1415 in 2019) made with forest. To solve the problem, it is possible as an alternative to use the data of transactions made with forest and calculate the share of land in the value of the forest as a real estate.

The calculated total value of wooded land is sensitive to the changes in the annual transaction prices which sometimes can be rather drastic. To avoid volatility in estimated total value of wooded land, it is

possible to use an average median price of a longer period. The use of longer period data should reduce the impact of small number transactions and sometimes with biased prices to the total value of wooded land.

Assessing the value of wooded land not available for wood supply (FNAWS) is significantly more challenging than estimating the value of forest that is used for wood supply, because there are no data publicly available on such transactions. Therefore, the “second best” principle and median transaction price FAWS was used to estimate the value of FNAWS was applied.

Inconsistency is observable with the value of the forest land in non-financial asset in national accounts as the valuation of the forest land in NA covers also the value of the timber (8 800 million euros). National accounts in non-financial assets uses the average price of all the transactions in Land Board that are made with the forest land as the basis and does not subtract the value of timber.

Question is open how to perform the valuation of the other wooded land if there is no basic statistics separately available for this category of the forest land.

Land expected value has been considered promising method for future to analyse from the viewpoint of the EFA forest land value methods. However, for the basic data for the specific forest types need additional studies. Also, the issue while negative value appears needs further analyses.

3 Compilation of EFA table A2a: Timber on wooded land (1000 m^3 over bark)

Current chapter provides an overview of the data sources for the compilation of the tables on timber assets (Table A2a) applied methods, overview of the process of the compilation, links to international reporting's (JFSQ and GFRA). The issues related to the application of the EFA definitions of timber stocks are highlighted.

Predominant issues were related to the internal inconsistencies between the definitions while compiling the balance on timber assets and flows. Problems arising from the basic characteristics of the used data sources and in data processing rules were discussed. Detailed overview and feedback are given on the compilation of each variable in a balance.

The chapter handles in detail the estimation of the of the flow categories ("net annual increment", "removals" and "irretrievable losses") which use different fractions of timber. Net annual increment is calculated only for stemwood; removals and irretrievable losses include stemwood and non-stemwood. It is questionable whether the initial idea of calculation the closing stock from opening stock and flow items is achievable. Issue of the compilation of the balance is handled methodologically as starting and the final assets are independent estimates and not the result of a balance sheet calculations. Estimates of changes added to the initial state do not add up to the final asset. It is described how the situation could be solved: for example, the difference is allocated to the balancing entry and then the balancing entry is attributed proportionally to forest land subcategories according to the opening timber stock distribution. In addition, the question was raised about the inclusion into the re-classification category the decrease of the deadwood as a result of the decaying.

Provided approach for timber asset account allows the annual reporting on table A2a with actual estimates for timber on forest land and other wooded land. Simple assumptions were used for distribution of flow items in case of forest land sub-categories. To the possible extent the reporting kept coherence with other international reporting routines (FRA, Forest Europe, JFSQ).

3.1 Data sources for the table A2a: Timber on wooded land in physical units

National Forest Inventory (NFI) is the primary information source for the table A2a (see also section 4.2.1). NFI provides following EFA timber related data:

1. volume of timber on different categories of wooded land;
2. increment of growing stock on forest land;
3. felling volumes as a basis for removals' estimates.

Data for timber stocks' subcategories of forest land and other wooded land according to the availability for wood supply are based on NFI plot data as well. Locations of the sample plots are compared to the nature protection GIS layers from the Estonian Nature Information System EELIS (see section 4.2.2).

Estimate of removals is combined expert estimate based on felling statistics from NFI, expert estimate about the removals from outside the forest land and expert estimate about the removals of non-stemwood from forest land. Estimation is based on the approach used in "Wood balance of Estonia"[20]. The expert estimate is basis for the data reporting on removals in Joint Forest Sector questionnaire.

[20] https://keskkonnaportaal.ee/sites/default/files/Teemad/Mets/Puidubilanss%202020.pdf

3.2 Methodology for the table A2a: Timber on wooded land in physical units

3.2.1 Comparison of the definitions applied for the table A2a and source data (NFI, FRA; JFSQ)

This chapter outlines the definitions in the source data (NFI, FRA; JFSQ) and provides the comparison with the definitions applied for the compilation of table A2a: Timber on wooded land in physical units

Timber stocks are reported for forest land and other wooded which follow the FRA (UNFAO – Forest Resources Assessment) definitions (see section 4.2.2). The definition of timber stock in the SEEA Central Framework is as follows*: timber resources are defined by the volume of trees, living or dead, and include all trees regardless of diameter, tops of stems, large branches and dead trees lying on the ground that can still be used for timber or fuel. The volume should be measured as the stem volume over bark at a minimum breast height from the ground level or stump height up to the top. Excluded are smaller branches, twigs, foliage, flowers, seeds and roots*[21].

According to the SEEA definition the timber stock include:

- growing stock;

FRA process defines growing stock as follows[22]: *Volume over bark of all living trees with a minimum diameter of 10 cm at breast height (or above buttress if these are higher). Includes the stem from ground level up to a top diameter of 0 cm, excluding branches. Explanatory notes:*

1. Diameter breast height refers to diameter over bark measured at a height of 1.3 m above ground level, or
above buttresses, if these are higher.
2. Includes laying living trees.
3. Excludes branches, twigs, foliage, flowers, seeds, and roots;

- Dead standing and lying trees or parts thereof which have utilisation value as timber or fuel.

FRA definition for deadwood:

All non-living woody biomass not contained in the litter, either standing, lying on the ground, or in the soil. Dead wood includes wood lying on the surface, dead roots, and stumps larger than or equal to 10 cm in diameter or any other diameter used by the country.

Explanatory note: The country may use another threshold value than 10 cm, but in such a case the threshold value used must be documented.

It is important to note that both growing stock and deadwood are reported on a similar basis in the specific reporting frameworks: either only above-ground stem-wood (like wood volume in FRA or MCPFE reporting) or above-ground and below-ground stem-wood with non-stem-wood (like biomass estimates in FRA reporting or GHG LULUCF sector reporting).

In forest accounts the usability of timber is in focus, therefore the only stem-wood is reported for both growing stock and deadwood. Below-ground woody biomass has almost no use so far. Branches of trees and undergrowth is being used to a limited extent as source of forest chips used in energy sector.

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[21] https://unstats.un.org/unsd/envaccounting/seearev/seea_cf_final_en.pdf
[22] https://www.fao.org/3/I8661EN/i8661en.pdf

There is only limited data available about the harvested non-stem-wood volumes and figures are based on expert estimates and partial statistics. The non-stem-wood estimates are based on biomass conversion and expansion factors not on direct measurements. Stock increment figures are also based on stem-wood measurements/calculations, this is another reason to choose the stem-wood reporting approach.

The estimate for the **Net annual increment** follows the approach provided by EFA framework i.e., *the average annual volume growth of live trees, calculated from the stock of live trees (growing stock) available at the start of the year minus the average annual mortality*.

The estimate for the **Removals** follows the definition of EFA and Joint Forest Sector Questionnaire[23]: *The volume of all trees, living or dead, that are felled and removed from the forest, other wooded land or other felling sites. It includes unsold roundwood stored at the forest roadside. It includes natural losses that are recovered (i.e., harvested), removals during the year of wood felled during an earlier period, removals of non-stem wood such as stumps and branches (where these are harvested) and removal of trees killed or damaged by natural causes (i.e., natural losses), e.g., fire, windblown, insects and diseases. Please note that this includes removals from all sources within the country including public, private, and informal sources. It excludes bark and other nonwoody biomass and any wood that is not removed, e.g., stumps, branches and treetops (where these are not harvested) and felling residues (harvesting waste). It is reported in cubic metres solid volume underbark (i.e., excluding bark). Where it is measured overbark (i.e., including bark), the volume has to be adjusted downwards to convert to an underbark estimate.*

Joint Forest Sector Questionnaire includes removals' estimates with and without bark i.e., under- and overbark. It must be noted that forest accounts' framework is meant to capture all harvested woody biomass i.e., stem-wood and non-stem-wood, including deadwood.

The definition of **Irretrievable losses** according to the SEEA framework *includes felling residues, all fellings from windthrow that cannot be removed from the forest, as well as timber lost through forest fires*. There is no national definition/data for irretrievable losses comparable to EFA definition. Felling residues can be assessed indirectly as a share from total felling volume (comparison of volume of felled trees to the wood removals volume (direct measurements of harvested sortments), theoretical sortmentation of felling volume or simple fixed share. The approach in present study is to provide expert estimate as close as possible to the EFA definition. The general approach to felling residues must be on a similar basis with removals. If removals include the harvest of non-stem-wood, then felling residues should account the non-stem wood (mostly branches) left in the forest during the harvest. Relevant woody biomass must be included into the Irretrievable losses' estimate. There is no data available about the timber volume of storm and fire damages which remains in the forests. Provided figure in table A2a is expert estimate based on knowledge of removed timber on non-forest land (including non-stemwood), total removed stemwood and felling residues on forest land.

3.3 Data compilation of EFA table A2a, timber on wooded land, in physical units

NFI provides **annual estimates for opening and closing stock for timber on forest land and other wooded land** (see Table 13, Table 14). Every NFI sample plot is assigned with status of land category including the designation to FRA forest and other wooded land. Timber volume estimates are based on measurements on sample plots of:

[23] https://unece.org/sites/default/files/2022-04/jq2021def-e.pdf

1. tree diameters at breast height (1,3 m) and average diameter of lying deadwood;
2. tree heights and lengths of deadwood logs;
3. assessment of tree species.

Those measurements are converted into volume estimates according to the volume calculation models for each sample plot. Growing stock and deadwood estimates are calculated separately. Deadwood volume estimates are calculated separately for standing and laying deadwood. Timber stock estimate is the sum of growing stock and standing and lying deadwood. Forest accounts' approach excludes deadwood which have lost the quality for timber or fuelwood (decayed/rotten snags and notches). Those sortments of deadwood may be reported in the context of ecosystem services having important value for biodiversity. Data of sample plots are generalised to the whole territory of Estonia (every sample plot represents ca 156 ha of land).

There exist also other possibilities to calculate the timber volumes:

1. stand-wise forest inventory data from National Register for Accounting the Forest Resources; this source has no full coverage of forest land, estimates are not based on measurements but on visual assessment (typically this approach underestimates the volume by 15-20%);
2. remote sensing data combined with ground measurements may provide possibilities for better temporal or geographic analysis but not the more accurate estimates. Mostly the remote sensing data (ALS, satellite images and other similar) need ground references for the validation and calibration of the system. In Estonia the best ground reference data come from NFI sample plots. Modelling of the ground and remote sensing data adds extra complexity to the process where it is difficult to provide error estimates for the results.

NFI is so far the best continuous and cost-effective timber estimation system available on a national scale at present.

Timber estimates for **subcategories of forest land and other wooded land according to the availability for wood supply** are based on NFI plot data (see section 2.2) for description about the allocation into sub-categories). Timber volume data of sample plots are generalized to the whole territory of Estonia by the categories of forest land.

Trees are measured also on the other Estonian land categories on NFI sample plots. This gives the possibility to estimate the volume on **other wooded land**, which usually remains outside the forest land-use. As FRA forest land and other wooded land categories are assigned to NFI sample plots during the fieldworks there is no need for re-categorization from Estonian land-use categories. That means there is no extra uncertainty from re-categorization of land-use categories. Certain subjectivity exists in the assignment of plots to different land-use categories. This may add extra uncertainty in case of the phenomena with relatively low occurrence (with small total area) like other wooded land. For example, the single big tree on OWL sample plot may increase substantially the timber volume estimates for 5 years (see Table 12; especially the big fluctuation of the average timber stock per ha). Therefore, the estimates of OWL must be treated with care as the relative error at 95% confidence level is high. It needs further analysis whether it is meaningful to use modelling of the OWL yearly estimates and time-series to avoid big changes due to the high variability.

Table 12. Area and timber volume on other wooded land in 2006–2021 according to NFI

	Area (1000 ha)		Timber* (1000 m^3)		Timber* per ha (1000 m^3/ha)	
Year	OWL	OWL_AWS	OWL	OWL_AWS	OWL	OWL_AWS
2021	101	75	2434	2303	24	30
2020	101	75	2137	2007	21	27
2019	100	76	1580	1462	16	19
2018	98	75	1431	1296	15	17
2017	97	77	1483	1288	15	17
2016	97	78	1503	1307	15	17
2015	102	83	1610	1401	16	17
2014	103	85	1812	1596	18	19
2013	107	90	1901	1709	18	19
2012	108	91	2150	2060	20	23
2011	118	97	2415	2318	20	24
2010	128	106	3354	3239	26	30
2009	108	89	2926	2866	27	32
2008	87	69	2508	2454	29	35
2007	63	49	1826	1789	29	36
2006	36	29	1295	1264	36	43

* Includes growing stock, standing, and lying deadwood
OWL – other wooded land, OWL_AWS – other wooded land available for wood supply
Source: Estonian Environment Agency, NFI2021

Net annual increment of growing stock is calculated using the annual estimates of Gross Annual Increment from NFI. Increment estimates are based on models which rely on periodic re-measurements of permanent sample plots after every 5 years. Net annual increment is calculated subtracting annual mortality from Gross Annual Increment. Present NFI methodological approach does not provide the annual mortality rates. During the Forest Europe (aka MCPFE) 2020 reporting process the average annual mortality was calculated for the period of 2000-2018: 2,2 million m^3 for FRA forest land and 1,8 million m^3 for FRA forest land available for wood supply. Those mortality rates were used to calculate the Net Annual Increment for table A2a (see Table 15). Methodological update is needed to produce the annual mortality rates from NFI for single years.

Net annual increment is based on the increase of volume of stemwood of live trees. This is not exactly comparable to opening/closing stock and removals' estimates which include deadwood according to the accepted definitions. By the logic of the table A2a the opening stock and flow items must produce the closing stock figure. It needs further analysis, whether the changes in deadwood are properly accounted by the flow items.

Net annual increment indirectly covers the increase of deadwood stock (mortality). Part of the dead trees are being felled during the reporting year and accounted in removals. Those trees may have died in reporting year or earlier years. There is also process of decaying which results in loss of commercial quality of wood (either for timber or fuelwood) and in reduction of deadwood volumes. It is questionable whether present forest accounts' approach covers all changes in deadwood.

Removals' estimates can be used without further calculations from JFSQ reports. JFSQ report is compiled every year by Estonian Environment Agency for 2 previous years (Table 16). JFSQ reports timber both underbark and overbark. Estonian Wood Balance estimation approach is the basis for removals' estimates. Removals' estimates are expert estimates based on data of felling volumes, estimates of amounts of harvested non-stemwood from forest land and estimates of harvested timber

from outside the forest land. Those estimates include unknown uncertainty. Total removals volume is distributed to forest land available for wood supply and other land with tree cover available for wood supply. Removals from FNAWS are considered zero, although it is possible that there may occur removals due to the nature restoration projects or infrastructure developments. There is no data available now to report removals on other wooded land. Considering the stock of OWL, the removals' volumes from there are insignificant. It is possible to generate those figures from NFI but the relative error of the estimate is very big.

According to the definition **Irretrievable losses** include felling residues, all fellings from windthrow that cannot be removed from the forest, as well as timber lost through forest fires. There is no national definition/data for irretrievable losses comparable to EFA's. The general approach to felling residues must be on a similar basis with removals. If removals include the harvest of non-stem-wood, then felling residues should account the non-stemwood (mostly branches) left in the forest during the harvest. Relevant woody biomass must be included into the Irretrievable losses' estimate. Provided figure in table A2a is expert estimate based on estimates of total removed timber, total felled stemwood and felling residues. Felling residues are not measured during the NFI fieldworks. It is possible indirectly estimate the non-stemwood of felled trees. 16% of stemwood volume was used to estimate the non-stemwood of felled trees. The removals of branches are recorded on the NFI plot level but not the volume. Irretrievable losses were calculated adding non-forestland removals' volume and total volume of felled trees on forest land (including non-stemwood), then subtracting total removals' volume. It is assumed that non-forestland removals' estimate includes non-stemwood.

There is no data available about the timber volume of storm and fire damages which remains in the forest. Estonian Environment Board carries out assessment of damaged areas after the owner has submitted the forest damage notification. Mostly it is done if there is and interest to harvest the wood from damaged forest areas and forest management regulations prohibit the felling (either the stand is too young for final felling or sanitation felling volume exceeds the limit allowed to harvest without felling notification). Environmental Board specialists assess the damage in forest and give the resolution of possible fellings (relevant data is published in statistical Yearbook Forest[24]). This source underestimates the actual damaged areas. Often the areas are just harvested if regular felling is possible. Many areas remain without assessment if there is no interest to harvest from the damaged areas. There is also no information about the volume actually cut from the damaged sites. National Forest Inventory provides the estimate about the total damaged areas including the total area affected by the wind damages. Ca 100 000 ha of forest land had wind damages. Unfortunately, it will not give the time of occurrence of the damages (not possible to assign the damage to specific year) and volumes of damaged trees and removals. The volume of burnt timber is also insignificant as the burnt area is small (in average less than 100 ha during the last decade[25]). Mostly those volumes are smaller than general uncertainty level of total removals' estimate. In case of bigger storm damages, it may be necessary to carry out additional research to estimate this fraction. In normal circumstances the provided removals' estimate should cover the volume of unharvested storm-felled and burnt trees.

Balancing item Opening and closing stock of timber are based on area estimates in table A1a. See section 2.2 for reasons of discrepancy in total forest land area estimates and for need to use the balancing item. The imbalance transfers over to table A2a. Extra discrepancy may arise from the

[24] Yearbook Forest 2021, chapter 5. Condition of forests;
https://keskkonnaportaal.ee/sites/default/files/Teemad/Mets/Mets2021.pdf
[25] Yearbook Forest 2021, chapter 6. Forest fires;
https://keskkonnaportaal.ee/sites/default/files/Teemad/Mets/Mets2021.pdf

different approach to volume estimates (inclusion of non-stemwood in case of removals and irretrievable loss) and accounting of deadwood. This causes the situation where closing stock will not sum up from the opening stock plus net annual increment minus removals and irretrievable losses. The difference in timber stock is attributed to the "Balancing item" category in table A2a. The balancing item of timber on forest land was distributed for subcategories of forest land proportionally to the share of subcategory from the total opening stock. There is no data available to distribute the balancing item to subcategories of forest land in another way. This maybe the research question in further development of reporting methodology.

Statistical re-classification (+/-) Re-classification of the timber on total forest land area does not have the content already theoretically as the reclassifications should be covered by flow items ("Net annual increment", "Removals" and "Irretrievable losses"). In case of the timber on sub-categories of forest land area the re-classification is possible as there exist the opening and closing timber stocks for Forest available for wood supply and Forest not available for wood supply (distribution based on the forest categories according to protection status). The reclassification is justified as there is an on-going process of creation of new and re-valuation of existing protection regimes (change in protection status). The area and thereby the timber volume of strictly protected forest land has steadily increased i.e., the areas which formerly belonged to the FAWS category were moved to FNAWS category as a consequence of legal process. The re-classification was calculated as a final step after the opening/closing stock, flow items and balancing item were filled in the table. It is also question whether to include into re-classification category the decrease of the deadwood as a result of the decaying.

3.4 Results for the compilation of the table A2a: Timber on wooded land and relations to other international reportings

Current chapter outlines five tables related to the compilation of the timber assets in physical units. Table 13 and Table 14 show the timber stock estimates for forest land, its' subcategories and other wooded land by the components of the timber stock i.e., growing stock and deadwood fractions. Table 15 illustrates the net increment calculation according to the gross annual increment and average annual mortality in case of forest land and its' subcategories. Table 16 is a combined table from several JFSQ reports showing the volumes of removals and the breakdown into sortments which have direct connection to supply use tables (C tables). Table 17 displays the EFA table A2a for the year 2019. The interrelations between the tables are marked in bold in tables and marked with asterisks and explained.

Table 13. Timber on forest land in 1999–2021 according to NFI (1000 m³)

Year	Timber on forest land (1000 m³)											
	Total forest land				Forest land available for wood supply				Forest land not available for wood supply			
	Growing stock	Standing deadwood	Lying deadwood	Timber total	Growing stock	Standing deadwood	Lying deadwood	Timber total	Growing stock	Standing deadwood	Lying deadwood	Timber total
2021	474 476	14 980	21 614	511 070	372 614	10 904	15 903	399 422	101 862	4 076	5 710	111 648
2020	482 915	14 744	21 761	519 419	384 913	10 966	16 348	412 228	98 001	3 778	5 412	107 191
2019*	492 095	15 002	21 694	**528 791**	396 521	11 412	16 720	**424 653**	95 574	3 589	4 974	**104 138**
2018**	494 257	14 830	21 567	**530 655**	405 693	11 507	17 067	**434 267**	88 564	3 323	4 501	**96 388**
2017	499 545	14 980	21 475	536 000	413 227	11 576	17 355	442 157	86 318	3 404	4 120	93 842
2016	497 899	14 869	21 596	534 365	419 468	11 826	17 810	449 104	78 432	3 043	3 786	85 261
2015	497 188	15 858	21 485	534 530	426 048	12 840	18 358	457 245	71 140	3 018	3 127	77 285
2014	493 380	16 204	21 386	530 970	430 481	13 381	18 602	462 464	62 899	2 824	2 784	68 506
2013	488 096	16 226	21 099	525 421	427 041	13 480	18 249	458 770	61 055	2 746	2 849	66 650
2012	478 660	16 216	19 659	514 535	422 047	13 601	16 873	452 522	56 613	2 614	2 785	62 012
2011	470 785	16 205	18 222	505 211	419 275	13 732	15 787	448 794	51 509	2 473	2 435	56 417
2010	461 000	15 896	16 242	493 137	413 657	13 712	14 073	441 442	47 342	2 184	2 169	51 695
2009	454 880	15 346	15 642	485 868	406 583	13 189	13 546	433 318	48 297	2 157	2 096	52 550
2008	448 846	15 111	14 088	478 044	402 733	13 002	12 278	428 013	46 112	2 109	1 810	50 031
2007	447 609	15 228	13 323	476 160	402 051	13 298	11 791	427 141	45 558	1 929	1 532	49 019
2006	442 938	14 704	12 742	470 384	399 345	12 929	11 361	423 635	43 593	1 775	1 381	46 749
2005	437 434	13 613	11 537	462 584	394 497	11 865	10 138	416 500	42 937	1 749	1 398	46 084
2004	436 072	13 655	9 764	459 492	395 425	11 930	8 429	415 785	40 647	1 726	1 335	43 707
2003	428 304	13 468	9 178	450 950	391 752	11 775	8 112	411 639	36 551	1 693	1 066	39 310
2002	425 199	12 540	8 960	446 699	389 282	10 822	7 795	407 898	35 917	1 718	1 165	38 801
2001	426 920	12 392	8 356	447 669	391 414	10 537	7 212	409 163	35 506	1 856	1 144	38 506
2000	430 724	13 810	8 766	453 300	391 631	11 770	7 657	411 057	39 093	2 040	1 109	42 243
1999	417 180	13 738	8 064	436 951	379 512	11 886	7 885	399 283	37 668	1 853	179	39 700

* 2019 figures were used as closing area for 2019 in table A2a

** 2018 figures were used as opening area for 2019 in table A2a

Source: Estonian Environment Agency, NFI2021

Table 14. Timber on other wooded land in 2006–2021 according to NFI (1000 m^3)

year	Timber on other wooded land (1000 m^3)							
	Other wooded land available for wood supply				Total other wooded land			
	Growing stock	Standing deadwood	Lying deadwood	Timber total	Growing stock	Standing deadwood	Lying deadwood	Timber total
2021	2107	62	134	2303	2230	67	137	2434
2020	1799	81	128	2007	1922	85	131	2137
2019*	1293	88	81	1462	1386	92	102	1580
2018**	1141	82	72	1296	1252	85	94	1431
2017	1112	71	104	1288	1236	74	173	1483
2016	1150	44	112	1307	1271	46	186	1503
2015	1253	33	115	1401	1377	35	199	1610
2014	1435	45	115	1596	1583	47	182	1812
2013	1509	67	133	1709	1631	68	202	1901
2012	1816	91	153	2060	1903	92	155	2150
2011	2014	92	212	2318	2109	94	213	2415
2010	2877	168	194	3239	2989	169	196	3354
2009	2528	147	191	2866	2587	149	191	2926
2008	2156	129	170	2454	2207	131	170	2508
2007	1592	102	94	1789	1627	104	94	1826
2006	1150	94	20	1264	1179	95	20	1295

* 2019 figures were used as closing stock for 2019 in table A2a

** 2018 figures were used as opening area for 2019 in table A2a

Source: Estonian Environment Agency, NFI2021

Table 15. Increment of growing stock on forest land in 1999–2021

	Increment of growing stock on forest land (1000 m^3)								
	Total forest land			Forest land available for wood supply			Forest land not available for wood supply		
Year	GAI	M*	NAI	GAI	M*	NAI	GAI	M*	NAI
2021	16222	2200	14022	13474	1800	11674	2748	400	2348
2020	16516	2200	14316	13823	1800	12023	2694	400	2294
2019	16806	2200	14606	14162	1800	12362	2644	400	2244
2018	16788	2200	14588	14323	1800	12523	2465	400	2065
2017	16787	2200	14587	14404	1800	12604	2382	400	1982
2016	16614	2200	14414	14451	1800	12651	2162	400	1762
2015	16394	2200	14194	14483	1800	12683	1912	400	1512
2014	16055	2200	13855	14408	1800	12608	1647	400	1247
2013	15768	2200	13568	14153	1800	12353	1615	400	1215
2012	15393	2200	13193	13906	1800	12106	1488	400	1088
2011	15074	2200	12874	13740	1800	11940	1334	400	934
2010	14750	2200	12550	13525	1800	11725	1225	400	825
2009	14501	2200	12301	13237	1800	11437	1264	400	864
2008	14292	2200	12092	13083	1800	11283	1209	400	809
2007	14317	2200	12117	13103	1800	11303	1214	400	814
2006	14284	2200	12084	13111	1800	11311	1172	400	772
2005	14222	2200	12022	13054	1800	11254	1168	400	768
2004	14191	2200	11991	13085	1800	11285	1106	400	706
2003	14017	2200	11817	13018	1800	11218	999	400	599
2002	13901	2200	11701	12923	1800	11123	978	400	578
2001	13944	2200	11744	12975	1800	11175	969	400	569
2000	13915	2200	11715	12850	1800	11050	1065	400	665
1999	13907	2200	11707	12787	1800	10987	1120	400	720

* Average annual mortality over the period of 2000-2018, there is no annual mortality estimates available for separate years

GAI – gross annual increment, M – annual mortality, NAI – net annual increment

Source: Estonian Environment Agency, NFI2021

Table 16. Timber removals in 2019–2021 as reported to Joint UNFAO/ECE/Eurostat/ITTO Forest Sector Questionnaire (JFSQ)

Product code	Product	Timber removals (1000 m^3)					
		overbark			underbark		
		2019	2020	2021	2019	2020	2021
1	ROUNDWOOD (WOOD IN THE ROUGH)*	12579	12924	11572	10987	11288	10083
1.1	WOOD FUEL (INCLUDING WOOD FOR CHARCOAL)*	4979	5117	4523	4272	4390	3888
1.1.C	Coniferous*	1621	1666	1563	1474	1515	1421
1.1.NC	Non-Coniferous*	3358	3451	2960	2798	2876	2467
1.2	INDUSTRIAL ROUNDWOOD*	7600	7807	7049	6715	6898	6195
1.2.C	Coniferous*	5038	5176	4234	4580	4705	3849
1.2.NC	Non-Coniferous*	2562	2631	2815	2135	2193	2346
1.2.NC.T	of which: Tropical*	0	0	0	0	0	0
1.2.1	SAWLOGS AND VENEER LOGS	4787	4919	4608	4270	4387	4088
1.2.1.C	Coniferous	3703	3805	3280	3366	3459	2982
1.2.1.NC	Non-Coniferous	1084	1114	1328	903	928	1107
1.2.2	PULPWOOD, ROUND AND SPLIT	2753	2828	2381	2393	2458	2054
1.2.2.C	Coniferous	1305	1341	924	1186	1219	840
1.2.2.NC	Non-Coniferous	1448	1487	1457	1207	1239	1214
1.2.3	OTHER INDUSTRIAL ROUNDWOOD	60	60	60	52	52	52
1.2.3.C	Coniferous	30	30	30	27	27	27
1.2.3.NC	Non-Coniferous	30	30	30	25	25	25

Source: JFSQ reports 2021, 2022, 2023; Estonian Environment Agency

Table 17. A2 (a) Timber on wooded land, in 1000 m^3 over bark, reference year = 2019

Code	Description	Opening stocks (December t-1) 2018	Net increment	Removals	Irretrievable losses	Statistical re-classification (+/-)	Balancing item (+/-)	Closing stocks (December t) 2019
1	Forest	530655	14606	11779	1271	0	-3420	528791
1.1	Forest available for wood supply	434267	12362	11779	1271	-6127	-2798	424653
1.2	Forest not available for wood supply	96388	2244	0	0	6127	-621	104138
2	Other wooded land	1431	n/a	n/a	n/a	149	0	1580
2.1	Of which available for wood supply	1296	n/a	n/a	n/a	166	0	1462
3	Other land with tree cover available for wood supply	n/a	n/a	800	n/a	n/a	0	n/a

3.5 Problems and challenges in the compilation of table A2a: timber on wooded land

In general, the results obtained have been considered quite satisfactory. Before the finalization of the manual, it is still too early to specify the real issues of concern for filling in timber stocks and flow data. It must be noted that relatively ambitious and detailed approach has been taken in this exercise and hence a lot of methodological issues were described.

The list of problems detected and challenges faced in the compilation of the table A2a on timber assets in physical units is displayed below. The issues are in one hand related to the assumptions in NFI methodology itself and in another hand are arising from the application of EFA definitions in Estonian context and use of various data sources or to the data processing rules.

Following part provides more detailed insight to these issues.

1. Shortcomings related to the NFI methodology:

- Estimates of opening and closing stock are based on National Forest Inventory (NFI) where according to the methodology and its application the estimates are for the whole year not for the end or beginning of the calendar year (period of fieldwork measurements is from May to October);
- NFI yearly estimates are calculated according to the measurements of the last 5 years and estimate is attributed to the last year of fieldworks; felling figures are 3-year averages;
- NFI is a sample-based inventory i.e., all estimates have statistical error which is bigger the smaller is the probability of occurrence of investigated phenomenon (especially in case of other wooded land category and flow items).

2. Issues related to the definitions and use of different data sources or the data processing rules (see for details section 2.2):

- Flow estimates (“net annual increment”, “removals” and “irretrievable losses”) refer for different fractions of timber. “Net annual increment” is calculated only for stemwood; but “removals” and “irretrievable losses” include stemwood and non-stemwood.
- It is questionable whether the initial idea of calculation the closing stock from opening stock and flow items is achievable based on currently available data and for all categories of wooded land.
- Inclusion into re-classification category the decrease of the deadwood as a result of the decaying.

Distribution of balancing item or reclassification to sub-categories of forest land is based on their relative share not on actual data (see for details section 2.2).

Data availability for “Other land with tree cover available for wood supply” according to EFA definition. There are removals outside the forest land and urban settings e.g., inland waterbodies (trees on the slopes and sides of the ditches), infrastructure (trees under the corridor of powerlines) which are not assigned with the forest-land or other wooded land label in NFI. The present narrow scope of definition for “Other land with tree cover available for wood supply” would leave ca 0,8 million m^3 unaccounted. The approach was taken to report all removed timber from non-forest lands under the Other land with tree cover available for wood supply.

There is not enough data available now to assess properly the flow items of other wooded land. The relative error of OWL estimates (phenomenon with relatively small area) may be much higher than actual changes. Further analysis is needed before those items can be reported to avoid confusing high fluctuations in stock estimates (mostly caused by extreme stock estimates on single sample plots). Removals’ figures from OWL can be considered insignificant as the total area and stocking level are very low. At the moment the OWL removals are most probably accounted under Other land with tree cover available for wood supply.

4 Compilation of EFA table A2b on the monetary values of the timber assets

4.1 Data sources for the table A2b on the monetary values of the timber assets

The compilation of the monetary values of the timber assets is based in large on the stocks and flows of timber on wooded land as it is presented in table A2a "Timber on wooded land".

Stumpage prices were calculated using road side prices of (State Forest Management Centre/SFMC), timber prices for private forests refer for the buyer's warehouse (OÜ Tark Mets wood market reviews), distribution of felling volume into assortments is done by Estonian Environment Agency, logging and transport costs come from the Yearbook Forest 2019 compiled by the Estonian Environment Agency. In addition, variety of additional data sources were used depending on a method. All these data sources are listed alongside of the applied methods.

4.2 Methodologies for the compilation of table A2b on the monetary values of the timber assets

Net Present Value (NPV) is an accepted approach to the valuation of timber resources. Many guidance documents refer for the NPV: SEEA Central Framework, SEEA Ecosystem Accounting, the SNA and also the IEEAF[26] .

This section covers methodology and tables for three alternative approaches for the compilation of timber value:

1. Net present value of expected future revenues. The basis is the average stumpage (€/m^3) process and the predicted cash flows based on the defined long-term felling volumes.
2. Net present value of the future net income (profit) of forest management which is less than the calculations based on stumpage prices above as it deducts the costs incurred. The basis is net income per 1 m^3 of timber (€/m^3) and predictable cash flows. Method is compliant with the principles of the reporting of the value of biological assets which is in book keeping defined by legislation.
3. For the comparison also the value of timber calculated solely with the stumpage prices is given.

SEEA CF definitions for the valuation of the stocks and flows and the explanations in SEEA Central Framework chapter 5.1 were analyzed[27] as starting point, also the national methods applied in national legislation and forest economics were considered.

As also was the case of the forest land valuation the theoretical background and feasible methods for Estonian forest accounts were analyzed and discussed both in bilateral meetings between Statistics Estonia and various experts in a field: professor Paavo Kaimre (Estonian University of Life Sciences), with Carl Obst (who is in charge of the scoping of the EFA handbook) regarding the theoretical

[26] https://ec.europa.eu/eurostat/documents/3859598/5859829/KS-BE-02-003-EN.PDF.pdf/5d0687cc-d770-4183-80b5-b684a62a8917?t=1414780453000 Annex 3

[27] https://seea.un.org/sites/seea.un.org/files/seea_cf_final_en.pdf

background and with representatives of Statistics Slovenia and also on webinars and bilateral discussions with Eurostat representatives of forest accounts.

The results were also presented to relevant experts and stakeholders in Estonia.

In this chapter the methods will be outlined and discussed. National approach for the valuation of the net present value for the biological resources has been suggested by some experts as most relevant. The assumptions pro and cons are discussed and we have also started the discussion on:

1. which revenues and costs to include in the calculation,
2. what assumptions to use in terms of future flows,
3. which discount rate to use.

The linkages to the ecosystem accounts asset and timber provisioning service valuation are discussed as well.

4.2.1 Alternative method 1: Net present value of expected future revenues

The net present value of future sales revenues (Table 18) has been used to calculate the value of the opening and closing stocks. By multiplying the forecasted[28] long-term annual harvesting volume 10.2 million m^3 by the average stumpage price, we get sales revenue that repeats year after year (annuity).

*Table 18. A2 (b) Alternative 1. Timber on wooded land, in million euros, Net present value of expected future revenues Reference year = 2019**

Code	Description	Opening stocks (December 2018)	Net increment	Removals *3	Irretrievable losses	Revaluation (+/-)	Statistical reclassification (+/-)	Balancing item (+/-) *2	Closing stocks (December 2019)
1	Forest	9037.20	319.80	304.72	32.88	7.29	-158.51	-72.38	8795.80
1.1	Forest available for wood supply	9037.20	319.80	304.72	32.88	7.29	-158.51	-72.38	8795.80
1.2	Forest not available for wood supply	0.00	0.00	0	n/a	n/a	0.00	0	0.00
2	Other wooded land	38.04	n/a	n/a	n/a	3.85	n/a	0.0	41.89
2.1	Of which available for wood supply	33.53	n/a	n/a	n/a	3.85	n/a	0.0	37.38
3	Other land with tree cover available for wood supply *	n/a	n/a	20.70	n/a	n/a	n/a	n/a	n/a

*Average stumpage price in 2018 = 26,58 €/m^3; Average stumpage price in 2019 = 25,87€/m^3

The monetary values of the timber flows in reference year (currently 2019) are calculated by multiplying the volume of the timber flow by the stumpage price.

Stumpage price data of different tree species and assortments were used to calculate the weighted stumpage price of one m^3 of removed timber.

For the state forests, the road-side price data are available from the State Forest Management Centre (SFMC) https://www.rmk.ee/puidumuuk-1/puidumuuk. For private forests, the data on buyer's yard prices are available from Private Forest Management Centre (www.eramets.ee/uuringud-ja-statistika/hinnainfo).

[28] Valgepea, M., Raudsaar, M., Karu, H., Suursild, E., Pärt, E., Sims, A., Kauer, K., Astover, A., Maasik, M., Vaasa, A., Kaimre, P. 2021. Maakasutuse, maakasutuse muutuse ja metsanduse sektori sidumisvõimekuse analüüs kuni aastani 2050. https://doi.org/10.15159/eds.rep.21.01

Information on distribution of removals into assortments comes from the National Forest Inventory (NFI). Environment Agency has provided this data for Statistics Estonia for compiling National Accounts.

Average logging costs were subtracted from the road-side prices to get stumpage price in state forests. To obtain the stumpage price for private forests, costs of logging and transportation were subtracted from the price of the buyer's yard. Data on average cost of logging and roundwood logistics are available in Yearbook Forest 2020[29] , compiled by the Environment Agency. In 2019, the average stumpage price was 25.87 €/m^3. In 2018, the average stumpage price was 26.58 €/m^3.

Table 19. The net present value of a perpetual annuity (a)

$$NPV = \frac{a}{i}$$

where i is the interest rate.

*With regard to the time preference, discount rates mostly range between 0 and 7% in forest management related calculations. Low interest rates are used in Estonia, usually in the range of 2-4%[30]. In this study, an interest rate of 3% was used to calculate the net present value of future money flows for the Table 20. A2 (b) Timber on wooded land, in million euros, alternative 1. Net present value of expected future revenues Reference year = 2019**

4.2.2 Alternative method 2: Net present value of expected future net income

The discounted net revenue method (of expected future net income) is used in Estonia to calculate the balance sheet value of the biological assets in state forests. The assessment of biological assets is regulated by Appendix 8 of the Minister of Finance's Regulation No. 105 of December 11, 2003, "Instructions for Public Sector Financial Accounting and Reporting". There is no uniform methodology for assessing the value of the biological assets of privately owned forests. Since the volume of growing stock managed by the state forest districts constitutes 50.6% of the total growing stock, it is appropriate to use this methodology for all Estonian forests. Results are displayed in Table 20. A2 (b) Timber on wooded land, in million euros, alternative 2. Net present value of expected future net income Reference year = 2019

[29] Environment Agency. 2020. Yearbook Forest 2020
[30] Kaimre, P. 2002. Economics of forestry. Estonian Agricultural University. 197p

Table 21. A2 (b) Alternative 2. Timber on wooded land, in million euros, Net present value of expected future net income Reference year = 2019

Code	Description	Opening stocks (December 2018)	Net increment	Removals *3	Irretrievable losses	Revaluation (+/-)	Statistical reclassification (+/-)	Balancing item (+/-) *2	Closing stocks (December 2019)
1	Forest	5128.10	142.16	135.46	14.62	-1970.79	-70.46	-32.18	3046.75
1.1	Forest available for wood supply	5128.10	142.16	135.46	14.62	-1970.79	-70.46	-32.18	3046.75
1.2	Forest not available for wood supply	0.00	0.00	0	n/a	n/a	0.00	n/a	0.00
2	Other wooded land	16.46	n/a	n/a	n/a	n/a	1.71	0.00	18.17
2.1	Of which available for wood supply	14.90	n/a	n/a	n/a	n/a	1.91	0.00	16.81
3	Other land with tree cover available for wood supply *	n/a	n/a	9.20	n/a	n/a	n/a	n/a	n/a

*- Net income per m^3 in 2018 = 18,25 €/m^3; Net income per m3 in 2019 = 11,50 €/m^3

The assessment of the value of timber stock is based on the future harvesting volumes, which take into account the steady and eternal forest use. The forecasted average cash flows of forest management are discounted to present value. The fair value of timber stock is found as the difference between the forecasted annual forest management revenues (MR) and forest management costs (MC), divided by the difference between the discount rate (I) and the inflation rate (P).

The formula for calculating the balance sheet value (BSVF) of the state forest is:

$$\mathrm{BSVF} = \frac{\mathrm{MR} - \mathrm{MC}}{\mathrm{I} - \mathrm{P}}$$

As in the previous alternative, the long-term annual harvesting volume of wood is assumed to be 10.2 million m^3 of timber per year.

The discount rate (I) as of 31.12.2019 was 4.85%, the rate of return on equity calculated for SFMC by the State Property Department of the Ministry of Finance. In 2019, the inflation rate (P) in the forestry sector was 1.0%[31] . The inflation rate takes into account the ten-year average inflation rate forecast in the forestry sector.

$\mathrm{BVSF} = \frac{11{,}5*10200000}{0{,}0485-0{,}01}$ =3.048 billion euros

In the first column of the Table 20. A2 (b) Timber on wooded land, in million euros, alternative 2. Net present value of expected future net income Reference year = 2019), the value of timber as of 31.12.2018 is presented. In 2018, the discount rate (I) was 5.86% and the inflation rate (P) in the forestry sector was 2.23%.

The values of the timber flows of the reference year are calculated by multiplying the volume of the physical flow by the net income per one m^3.

To calculate the balance sheet value of biological assets, SFMC data on timber sales revenue and costs of forest management are used. This data are available in annual report for the year 2019[32]. The estimated average forest management income per 1 m^3 of timber for the next 10 years was 54.30

[31] Riigimetsa Majandamise Keskus. 2020. Majandusaasta aruanne 2019
[32] Riigimetsa Majandamise Keskus. 2020. Majandusaasta aruanne 2019

euros, the estimated average cost of forest management per 1 m^3 of timber 42.80 euros. The expected net management income of one m^3 of wood is 11.50 euros.

Values of the biological current and fixed assets (Table 21) in state forest (SFMC) and private forest fluctuate quite a lot. Following table provides an overview. However, lot of small forest owners do not report the value of the biological assets.

Table 22. Values of the biological current and fixed assets, million euro

	Biological current assets in state forest, SFMC*	Biological fixed assets in state forest, SFMC*	Biological current assets of forestry enterprises, excluding SFMC**	Biological fixed assets of forestry enterprises, excluding SFMC**
2017	41	3 200	60	478
2018	49	1 100	70	464
2019	24	640	89	1 015
2020	30	750	65	696
2021	39	910	70	903
2022	59	210	60	478

*- State Forest Management Centre, annual reports 2017-2022

**- Statistics Estonia, financial indicators of the forest sector (EM009: Enterprises' assets, liabilities and equity by economic activity and number of persons employed)

4.2.3 Alternative method 3: The value of timber on wooded land calculated with stumpage prices

The volume of timber stock and timber flows calculated using stumpage prices are presented in Table 22. A2 (b) Timber on wooded land, in million euros, alternative 3. Stumpage, Reference year = 2019*. The values of the timber assets and flows presented in table A2a were multiplied by the average stumpage price calculated for 2019.

*Table 23. A2 (b) Alternative 3. Timber on wooded land, in million euros, Stumpage prices, Reference year = 2019**

Code	Description	Opening stocks (December 2018)	Net increment	Removals *3	Irretrievable losses	Revaluation (+/-)	Statistical reclassification (+/-)	Balancing item (+/-) *2	Closing stocks (December 2019)
1	Forest	11542.80	319.80	304.72	32.88	-308.35	-158.51	-72.38	10985.77
1.1	Forest available for wood supply	11542.80	319.80	304.72	32.88	-308.35	-158.51	-72.38	10985.77
1.2	Forest not available for wood supply	0.00	0.00	0	n/a	n/a	0.00	n/a	0.00
2	Other wooded land	38.04	n/a	n/a	n/a	-1.06	n/a	0.00	40.87
2.1	Of which available for wood supply	33.53	n/a	n/a	n/a	n/a	4.29	0.00	37.82
3	Other land with tree cover available for wood supply *	n/a	n/a	20.70	n/a	n/a	n/a	n/a	n/a

**Average stumpage price in 2018 = 26,58 €/m3

4.3 Comparison of the results of timber asset valuation

Two of the timber valuation alternatives presented in this report (alternative 1 and alternative 2) are quite similar in nature: in both cases the net present value of forecasted future cash flows is calculated. In the first alternative the average stumpage price of timber and the forecasted annual felling volumes are used. In the second case the net income per one cubic meter of timber was used. The net income was obtained when forest management costs were subtracted from the timber management income.

In the first alternative, the 3% interest rate which is pretty common in forestry related economic calculations was used for discounting. In the second alternative, the rate of return on equity calculated for SFMC by the State Property Department and the inflation rate were used. Results for the value of the timber stock differ almost threefold: in the first case, the value of the closing stock of the forest used for wood supply was 8795.80 million euros, while in the second case it was 3046.75 million euros. The difference is caused mainly by the difference between stumpage price and net income per one m^3 of timber.

The present value of the future net income could be the preferred option for estimating the value of the timber stock, because in this case, in addition to the expected wood related income, the actual management costs are also taken into account. Management costs can vary significantly between ownership groups. Therefore, the costs incurred by different forest owners must be specified in the further evaluation.

In addition to the difference in price and net income, the result is to a smaller extent influenced by the interest rate used to calculate the present value.

The value of the timber stock calculated by the average stumpage price is significantly higher than the values obtained by the first two methods. Multiplying the stock volume by the stumpage price gives an overestimated result. Main reason for overestimations are due to the non-availability of wood for harvesting and removal currently even theoretically. In addition, there are many young trees in the forests that cannot be cut yet and thus have no market value at the moment.

4.4 Consistency with National Accounts

Comparison of the A tables B subtables timber flow and stocks variables was done to respective categories in National Account. In National Account the monetary value of the net increment of the timber stock is calculated per calendar year by subtracting deadwood from gross increment and removals from net increment. Physical values are multiplied with stumpage prices considering wood species and assortments. NFI data on increment and removals by different assortments and wood species are used as well. In the 2019 NA calculation, the increase of the monetary value of the growth was 15.06 million euros. In the EFA tables, it is 15.08 million euros when using methodology of net present value of future revenues and 6.7 million euros with the methodology of the net present value of future net income. Forest growth value calculated in NA can be calculated subtracting removals from net increment in EFA table A.2b. Since both the national accounts and the first alternative of current work on table A2b use the average stumpage price, the results are also very similar as expected. Since the net income from forest management used in the second method is 2.25 times less than the stumpage price, the difference between net growth and removal is also 2.25 times smaller.

4.5 Comparison of the EFA results with Ecosystem Accounts on the bases of timber provision service and asset valuation

Currently Estonian ecosystem accounts have accounted for the supply of the timber as ecosystem service which is not dependent on forest type (available/not available for wood supply, timber from other wooded land). Linking of the forest accounts and ecosystem accounts on the level of the wood provision ecosystem service is still in progress in ecosystem accounting guidelines documents and also in current EFA guidelines. In addition, the monetary valuation principles for the wood provision ecosystem service have not been agreed upon yet and only physical flows are accounted in the scope of the timber provision in the proposal for the amendment of regulation at current stage.

Alternative approach 2 for timber valuation follows SEEA-2012 section 5.378: Resource rent on timber resources can be derived as the gross operating surplus from the harvest of timber resources less the value of the user costs of produced assets used in the harvesting process.

In the development of ecosystem accounts in Estonia[33] both the service value and the value of standing timber (stock) was estimated. First dead wood was subtracted from gross increment. The value of the total net growth was obtained by multiplying the various net increments by their stumpage prices and summing up across all the tree species. This approach for stock valuation is close to the stock valuation of the first alternative but has a slightly different value due to inclusion of the deadwood.

When compiling monetary table Table A2b, the revaluation is applied, which is in accordance with SEEA CF 2012[34] clause 5.374: "most of the changes in the stock relate directly to changes recorded in the physical asset account; but there are also entries relating to the revaluation of timber resources, which are recorded when the prices for timber change during an accounting period." Timber prices in 2018 and 2019 were remarkably different which led to the need for revaluation.

SEEA-2012 states that not all timber resources are available for harvest because of forest legislation and/or for environmental and economic reasons. It is recommended that the volume of timber resources that cannot be harvested would be separately identified and not form a part of the overall calculations of the value of timber resources. Following the aforementioned principle, FNAWS stock value is estimated as 0 in our analysis.

4.5.1 Insight from ecosystem accounts perspective on the applicability of the methods for assessing timber provisioning service in monetary terms

Calculating the monetary value of timber provision as one supply service of the forest ecosystem is basically possible using all three proposed methods. All three methods are based on the market price of timber as a supply service output, which is typical for finding the monetary equivalent of ecosystem supply services. But which of the three methods described above would best align with accounting for ecosystem provisioning services? When accounting for ecosystem provisioning services, it must be kept in mind that it is important to adhere to methodological uniformity with provisioning services of other ecosystems.

Apart from the forest, the second major ecosystem that provides provisioning services is the agricultural ecosystem. The methodology used in Estonia for calculating the financial equivalent of the supply service of agricultural ecosystems (agricultural production) is based on the market price of agricultural production[35]. With such an approach, the question inevitably arises of how to distinguish the component of the contribution of the ecosystem in the market price of the service (agricultural produce) from the contribution of the economy ("Two Languages or Two Narratives: Comparison of the Selected Market Price and Revealed Preferences Valuation Methods to the Stated Preferences Method"*). This question is complex and theoretically unresolved so far. Thus, (at least initially) the supply service of agricultural ecosystems is taken to be proportional to the market value (market price) of the production.

Of the methodologies proposed to find the financial value of the supply service of the forest ecosystem, "**Value of timber calculated solely with the stumpage prices**" corresponds to this best. If the supply

[33] Statistics Estonia. 2021. Methodological report. Development of the ecosystem accounts.189p
[34] United Nations et al. 2014. System of Environmental Economic Accounting 2012— Central Framework
[35] https://www.stat.ee/sites/default/files/2021-07/D1.1%20Final%20methodological%20report.pdf

service cycle of agricultural ecosystems (from sowing to harvest) is typically 1-2 years, in the case of forests it is considerably longer, being proportional to the trees becoming ripe for cutting. Thus, the time factor is much more important in the assessment of forest supply services compared to agricultural ecosystems.

The time factor is taken into account by applying asset valuation methodology "**Net present value of expected future revenues**", which takes into account the much longer cycle of forest management compared to agriculture. The essence of the method consists in the present value of the cash flows predicted on the basis of the average stumpage, that is, as the name of the methodology suggests, the present value of future income. The fact that it does not distinguish the contribution of the ecosystem from the contribution of the economy to the market value of wood can be considered a drawback of the method. Thus, the deficiency is methodologically similar to the supply service of agricultural ecosystems.

The "**Net present value of the future profit"** method, which considers the net profit from the wood, would seemingly solve this problem. Unfortunately, this method also raises questions that need to be solved. If you look at the value of assets calculated using this method, it is striking that the differences in the value of assets during a 10-year period (Table 20) differ many times. Such volatility would not be recommended in official statistics. Second, one must rake into account the nature of profit in the economy. As we know, the profit depends on both the economic situation in the market and the economic policy decisions of the (timber) companies. For example, in some cases the companies could reduce profit to optimize taxes. The influence on the value of the removal from forest is one issue but it should have essentially nothing to do with the value of the ecosystem service. And how does the financial value of the forest supply service show in practice when the company's profit is negative in some years, i.e. if the company is in loss. Looking from the perspective of ecosystem accounting, this alternative suits best with residual value concept (SEEA EA, chapter 9.36)[36] which is suggested in case where the prices (and associated values) are embodied in market transactions. As according to this concept profit can be seen as the residual value if all manmade costs are subtracted from revenue, residual value concept equals the contribution of the ecosystem with the gained profit.

Thus, it seems that from the ecosystem point of view the least controversial is to calculate the monetary value of the timber provisioning service and assets of the forest ecosystem by applying **"Net present value of expected future revenues".**

4.6 Problems of the compilation of EFA monetary tables on assets and flows

The main issue in the process of the compilation of EFA monetary tables on assets and flows was that the overall methodology has not yet been agreed upon among the countries of concern. In another hand our testing results and discussions can provide input to the establishment of the EFA definitions. If the common position of the member states crystallizes, it is possible to focus on the adaptation and

[36] https://seea.un.org/sites/seea.un.org/files/documents/EA/seea_ea_white_cover_final.pdf
o value and resource rent methods: The residual value and resource rent methods95 estimate a value for an ecosystem service by taking the gross value of the final marketed good to which the ecosystem service provides an input and then deducting the cost of all other inputs, including labour, produced assets and intermediate inputs (see formula from the SEEA Central Framework below). Depending on the scope of the data (e.g., pertaining to a specific location or to the activities of an industry as a whole), the estimated residual value provides a direct value that can be recorded in the accounts or can be used to derive a price that may be applied in other contexts. The relevant considerations in deriving a price are described in the SEEA Central Framework (annex 5.1).

implementation of the selected methodology and the use of a suitable dataset or the acquisition of the necessary data.

Our analyses has discovered following issues of concern:

In the case of the net income method, the methodology of assessing monetary value of the state forest stock was also applied for the valuation of the private forests. This means that the cost and price data of the state forest management were also transferred to private forests. It is generally known that compared to state forest management organization, operating costs are lower in private forests. Therefore, it would be necessary to specify the costs of private forest management, which can be done with the help of relevant studies.

Since the monetary value estimation is done for one year, the price and cost information of the same year is used. On the wood market, however, prices are quite volatile, and this volatility is also transferred to the value of the timber stock. To ensure some stability, we could think about using long-term average prices and costs.

The most common approach is to estimate the net present value (NPV) of the standing timber based on the resource rent expected to be earned over the time remaining until the timber is harvested. In order to calculate the value of all stands and summarize the results into total value for Estonia, it is necessary to have the updated inventory data of the stands. Unlike the state-owned forest, not all private forests are inventoried. According to the Estonian Environmental Agency, about 70% of private forests are covered by inventory data up to 10 years old, at least 12% of private forests are not inventoried at all.

In current work, a long-term forecast of felling volumes is used which, however, may change due to nthe actual volume of timber harvesting. The actual annual removals may change the nature (specie composition, age) of the remaining stock. It is necessary to monitor this regularly and take into account in the estimations.

5 Compilation of the EFA tables B1, B2 and B3

5.1 Table B1 - Economic aggregates of the forestry and logging industry

First step to fill the table was analyzing available data in National Accounts (starting *from this* chapter NA) supply and use tables. All variables except subcategories of output, subcategories of intermediate consumption (except FISIM that was available from NA*),* and employment could be filled in using readily available NA data.

In order to make distinction between different goods and services of output data from monetary supply table was used. Monetary supply table contains information of all products and services that has been supplied in an accounting year and also which institutional sector and NACE was the producer. It was possible to separate 1.1.1.2 Forest trees, 1.1.2.2 Fuel wood and 1.1.4 Non-wood products. Products 1.1.1.1 Live forest tree plants, 1.1.2.1 Logs and 1.2 Services characteristic of the forestry and logging activity were aggregated under single product in monetary supply table. In order to separate these three different products data from EKOMAR that include more detailed information about revenues, were used. So, in order to distinguish different products aggregated in supply table the share of revenues of different products of NACE 02 from EKOMAR were multiplied with the aggregated value. Difference between total output and subcomponents was filled in row 1.3 Other products from connected secondary activities and it formed 12% of total output.

Row 1.0 Output for own final use (P.12) was also available from NA but it has to be considered that the methodology is very simplified and should be improved. The methodology uses assumption that the average amount of wood used for own final use is 13 m^3/year in an agricultural household. Total physical amount of wood used for own final use is calculated by multiplying total number of agricultural households from agricultural statistics with 13 m^3. Monetary price is calculated using market price of previous period and price index of wood and to estimate the monetary value of own final use monetary price is *multiplied* with total physical amount.

To fill components of division 2. Intermediate consumption monetary use table was used. Monetary use table contains information about which institutional sector and NACE has used which product or service, intermediate consumption and final consumption are separated. Monetary NA use table consisted most of the necessary subcomponents of intermediate consumption, but it was not possible to separate 2.1.3 Fertilizers and soil improvers from 2.1.4 Plant protection products. FISIM was available from NA. Product 2.3 Other goods and services used as inputs was calculated as difference between total intermediate consumption and subcomponents that was possible to separately identify. Other goods and services used as inputs formed 37% from total intermediate consumption. As the share is quite large then further analyze of other subcategories of intermediate consumption is needed.

Results of table B1 can be seen in Table 23.

Table 24. Table B1 Economic aggregates of the forestry and logging industry, 2019

Code	Description	Million NAC
1	**Total output (at basic prices) [P.1]**	**955.9**
1.0	Of which output for own final use [P.12]	**9.4**
1.1	Goods characteristic of the forestry and logging activity	**706.8**
1.1.1	Trees, tree plants and forest tree seeds	17.4
1.1.1.1	Live forest tree plants (02.10.11) and tree seeds (02.10.12)	2.3
1.1.1.2	Forest trees (02.10.30) *1	15.1
1.1.2	Wood in the rough (02.20.1)	**685.8**
1.1.2.1	Logs *2	651.6
1.1.2.2	Fuel wood (02.20.14 and 02.20.15)	34.2
1.1.4	Non-wood products (02.30) *3	3.6
1.2	Services characteristic of the forestry and logging activity *4	131.2
1.3	Other products from connected secondary activities in the local KAU *5	117.9
1.4	Other products (*)	
2	**Total intermediate consumption [P.2]**	**642.7**
2.1	Goods input	**264.3**
2.1.1	Trees, tree plants and forest tree seeds *6	205.5
2.1.2	Energy, lubricants *7	43.4
2.1.3	Fertilisers and soil improvers	15.4
2.1.4	Plant protection products and pesticides *8	
2.2	Services input	**139.5**
2.2.1	Services characteristic of the forestry and logging activity *4	121.1
2.2.2	Regular maintenance and repair of equipment *9	3.2
2.2.3	Maintenance of buildings (*)	27.1
2.2.4	Financial services (FISIM) [P.119]	-11,8
2.3	Other goods and services used as inputs (*)	238.9
3	**Gross value added (at basic prices) [B.1g]**	**313.2**
3.1	Consumption of fixed capital [P.51c]	49.3
3.2	**Net value added (at basic prices) [B.1n]**	**264.0**
3.2.1	Other taxes on production [D.29]	7.8
3.2.2	Other subsidies on production [D.39]	-3.8
4	**Factor income**	**252.4**
4.1	Compensation of employees [D.1]	126.6
5	**Net operating surplus [B.2n] and Mixed income [B.3n]**	**125.8**
5.1	Net property income [D.4] *10	-6.6
5.2	**Net entrepreneurial income [B.4n]**	**119.3**
6	**Gross fixed capital formation (excluding deductible VAT) [P.51g]**	**96.0**
Code	Buildings, structures and land improvements	32.0
6.2	Machinery and equipment	60.5
6.3	Plant resources yielding repeat products	0.1
6.4	Other GFCF(*)	3.0
7	**Net fixed capital formation (excluding deductible VAT) [P.51n]**	**46.7**
8	**Changes in inventories [P.52]**	**6.2**
8.1	Work-in-progress on cultivated biological assets [AN.1221]*11	15.1
8.2	Other changes in inventories (*)	-8.8
9	**Capital transfers (net) [D.9]**	11.3
10	**Total labour input** [L] **(in 1000 harmonized AWU) *12**	**6.2**
	Total labour input in 1000 national AWU	6.2
	Number of working hours per year in national AWU	1 800.0

All subcategories of gross value added are available from NA except 5.1 Net property income which is calculated on institutional sector level in NA, in order to fill the value EKOMAR data was used, and the value was calculated using following variables: interest received - interest and rent paid.

Gross fixed capital formation and changes in inventories and necessary details for filling the table are available from NA.

Work-in-progress includes transactions of ESA code AN.1221 that consist of net growth (total increment minus dead wood and minus harvested timber) of timber that is calculated by NA using physical data from the Environmental Agency and monetary data from State Forest Management Centre. Different price depending on the wood species and assortments are considered. This variable includes also other changes in inventories that are classified under AN.1221 in NA.

Other changes in inventories include all other changes in inventories except work in progress (ESA code AN. 1221) – changes of inventories of materials and supplies, finished goods and goods for resale.

Capital transfers are not calculated in NA on NACE level and additional information of transfers given in forestry activity were analyzed. Detailed information of transfers was received from Environmental Agency and when analyzing the data it was possible to identify capital transfers from current transfers.

In order to calculate labor data from labor statistics were used. As employment in full-time units (FTU) is available only on NACE A level and not on NACE 02 it was first necessary to calculate the share of employees in NACE 02 from NACE A then the share was multiplied with NACE A in FTU.

5.2 Table B2 - Output of the forest and logging industry by type

All necessary data to fill table B2 are available from table B1 and NA. It was not possible to separate non-market activity as the management of state forests are done by an enterprise which is recorded under corporations' sector under NACE 02 and is classified as market activity in NA, non-market activity is not recorded under NACE 02 in NA. Results are presented in Table 24.

Output of households are calculated in NA using data from Estonian Tax and Customs Board that has information in which monetary amount self-employed entrepreneurs that are active on NACE 02 have sold timber.

Table 25. Output of the forest and logging industry by type, 2019

Code	Description	31	32	33	99	41
		Own final use [P.12]	Market	Non market	Total	*of which:* Households [S.14]
2	Output (at basic prices) [P.1]	9.4	946.6	0.0	955.9	31.5

5.3 Table B3 - Monetary supply and use table of the wood in the rough

All necessary variables are available from monetary supply-use tables but in order to separate logs from tree seeds and services that are aggregated under single product group in monetary supply-use tables shares from EKOMAR were used. In order to calculate total supply and use of wood in the rough logs, fuel wood and fuel wood for own final consumption were summed up. Results can be seen in Table 25 and Table 26. It is seen that other industries are the main users of wood in the rough and NACE 02 has relatively small share in total use. The main user is manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials activity (NACE 16) but the use in small shares are seen also in other activities in NA.

Table 26. Monetary supply of wood in the rough, 2019, million euros

Description	51.0	51.1	51	61	62	63	64	65
	Forestry and logging industry (Division 02)	Other Industries (if any)	Supply of products by industries	Imports (CIF)	Total supply (at basic prices)	Trade and transport margins	Taxes less subsides on products	Total supply (at purchasers' prices)
Logs	615.5	56.1	671.6	28.9	700.5	153.0	0.9	854.4
Fuel wood	34.2	2.1	36.2	2.2	38.5	4.5	1.7	44.7
Own final use of fuel wood	9.4		9.4		9.4			9.4
Total	659.0	58.2	717.2	31.1	748.3	157.5	2.6	908.4

Table 27. Monetary use of wood in the rough, 2019, million euros

Description	51.0	51.1	51	71	72	73	74
	Forestry and logging industry (Division 02) (if any)	Other industries	Use of products by industries	Final Consumption	Capital formation	Exports (FOB)	Total use (at purchasers' prices)
Logs	129.3	516.1	645.4		31.8	177.2	854.4
Fuel wood	0.0	9.2	9.2	9.6	2.3	23.6	44.7
Own final use of fuel wood				9.4			9.4
Total	129.3	525.3	654.6	18.9	34.1	200.8	908.4

5.4 Future improvements of tables B

Necessary improvements refer for the own final use, especially regarding the non- agricultural use. Currently used methodology is very simplified and needs to be improved and also consider own final use of others in addition to agricultural households that are considered in the moment.

Also, other goods and services used as inputs under intermediate consumption in table B1 should be further analyzed as it makes up large share of total intermediate consumption. Further analysis should reveal if it is possible to separate additional components of intermediate consumption.

5.5 Analyses of consistency between A2b and B1 tables

Both tables A2b and B1 include net increment of forest. In table B1 it is seen as the work in progress and removals are subtracted from net growth. The value should be comparable if removals are subtracted from net increment in table A2b. As national accounts data are used to fill the value in table B1 then the analyses described in paragraph Consistency with National Accounts can be applied also here to describe the consistency for tables A2b and B1.

One question when filling table B1 remains. The output of forest trees in table B1 is quided by Eurostat as follows: "*Forest tree output includes the net increment of timber in cultivated forests (02.10.30) and sales of timber from uncultivated forests. The value of forest trees is usually indicated in stumpage prices for standing timber*." NA monetary supply table includes also net growth of forest that is equal with work-in-progress value. But which value should be used in table B1 output section – net increment value from table A2b or net growth of forest from NA supply table. When the value should be taken from table A2b then the output of NACE 02 would not be comparable with NA data. The net growth of forest from NA was used in this grant project to fill Table B1.

6 Compilation of the C tables: Physical supply and use of wood in the rough

6.1 Data sources for the physical supply and use of wood in the rough

During compilation of Physical supply and use of wood in the rough tables C1a and C1b of EFA questionnaire the Eurostat guidelines "European Forest Accounts Explanatory notes 2021"was taken as a basis. Mentioned guidelines suggest that data on timber reported must be coherent with the data on timber provided at European and international level (Forest Europe, FAO, UNECE, and OECD) including Joint Forest Sector Questionnaire.

Eurostat collects data for the EU and EFTA countries and exchanges data with its partner organizations in the Inter-Secretariat Working Group on Forest Sector Statistics (UN ECE, FAO and ITTO) and publish data on Eurostat websites. Eurostat's database tables contain timeseries of data in harmonized format, therefore Eurostat database data were used for compilation of physical supply and physical use tables of EFA.

Two different data sources were used for compilation of "Physical supply and use of wood in the rough" tables C1a and C1b:

1) Eurostat database:
    - Table "Roundwood removals by type of wood and assortment" (referred later as Eurostat's Table 1) https://ec.europa.eu/eurostat/databrowser/view/FOR_REMOV/default/table?lang=en
    - Table "Roundwood, fuelwood and other basic products (referred later as Eurostat's Table 2) https://ec.europa.eu/eurostat/databrowser/view/FOR_OWNER/default/table?lang=en
2) Estonian monetary supply and monetary use tables for 2017, 2018 and 2019

Next data were used straight from Eurostat's Table 1(see chapter 7.1 datasources):

- Fuel wood removals of coniferous wood - over bark
- Fuel wood removals of non-coniferous wood - over bark
- Industrial coniferous roundwood removals - over bark
- Industrial non-coniferous roundwood removals, except tropical wood - over bark

Eurostat's Table 2 was used for next data:

- Import of fuelwood (including wood for charcoal) coniferous
- Import of fuelwood (including wood for charcoal) non-coniferous
- Export of fuelwood (including wood for charcoal) coniferous
- Export of fuelwood (including wood for charcoal) non-coniferous
- Import of industrial coniferous wood
- Import of industrial non-coniferous roundwood, except tropical wood
- Import of industrial tropical wood
- Export of industrial coniferous wood
- Export of industrial non-coniferous roundwood, except tropical wood
- Export of industrial tropical wood
- Production of industrial coniferous roundwood
- Production of industrial non-coniferous roundwood

Physical supply and use of wood in the rough in tables C1a and C1b must be indicated over bark (EFA). As data in Eurostat's EFA table 2 refer a priori to roundwood under bark, data of Eurostat's Table 2 were recalculated from under bark to over bark before using these data. Coefficients for recalculation were derived from Eurostat's Table 1(see chapter 7.1 datasources), comparing under and over bark data of same item. Coefficients used for recalculation were presented in the Table 27.

Table 28. Coefficients used for recalculation from under bark to over bark

	Removals	Coniferous		Removals	Non-coniferous	
	Over bark	Under bark	Over/Under	Over bark	Under bark	Over/Under
2017	1 691	1 537	1.100001	3 503	2 919	1.199999
2018	1 805	1 641	1.099999	3 738	3 115	1.200000
2019	1 621	1 474	1.099997	3 358	2 798	1.200001
2020	1 666	1 515	1.099997	3 451	2 876	1.200001
2021	1 574	1 431	1.099999	3 260	2 717	1.199999

From Estonian monetary supply and monetary use tables the next data were used:

- Supply of fuel wood (1.A.024)
- Supply of fuel wood, produced for own final use (1.A.024O)
- Supply of wood in the rough, except fuel wood (1.A.022)
- Use of fuel wood (1.A.024)
- Use of fuel wood, produced for own final use (1.A.024O)
- Use of wood in the rough, except fuel wood (1.A.022)

Physical supply and use of wood in the rough in tables C1a and C1b were compiled for years 2017-2021. In order to be in compliance with other EFA tables, only data for 2019 were discussed in the next chapters. Data for 2017, 2018, 2020 and 2021 are presented in excel file annexed to this report deliverable D1.11 Data for the forest accounts module (EFA tables).

6.2 Compilation of physical supply of wood in the rough table C1a

Based on the data sources mentioned in previous chapter physical supply table for the year 2019 was compiled. The data are presented in Table 28.

Table 29. C1 (a) Supply of wood in the rough by all industries, in 1000 m^3 over bark, reference year 2019

Code	Description	51.0	51.1	51	60	99
		Forestry and logging industry (Division 02)	Other industries (if any)	Supply of products by industries	Imports	Total supply
1.1.3	Wood in the rough (02.20.1)	11 847.01	731.99	12 579.00	387.58	12 966.58
1.1.3.1	Logs	7 093.03	506.97	7 600.00	356.95	7 956.95
1.1.3.1.1	Coniferous wood (02.20.11)	4 701.94	336.06	5 038.00	239.79	5 277.79
1.1.3.1.2	Non-coniferous wood, except tropical wood (02.20.12)	2 391.10	170.90	2 562.00	117.14	2 679.14
1.1.3.1.3	Tropical wood (02.20.13)	0.00	0.00	0.00	0.01	0.01
1.1.3.2	Fuel wood	4 753.98	225.02	4 979.00	30.63	5 009.63
1.1.3.2.1	Fuel wood of coniferous wood (02.20.14)	1 547.74	73.26	1 621.00	9.02	1 630.02
1.1.3.2.2	Fuel wood of non-coniferous wood (02.20.15)	3 206.24	151.76	3 358.00	21.61	3 379.61

Column 51 “Supply of products by industries” in physical supply table C1a was populated straight with data from Eurostat’s Table 1 “Roundwood removals by type of wood and assortment”. As names of the indicators in Eurostat table and Forest Accounts table C1a do not exactly match, correspondence between indicators is presented in Table 29.

Table 30. Correspondence between Forest Accounts and Eurostat database tables

Code	Description	51.0	51.1	51	71	72	99
		Forestry and logging industry (Division 02) (if any)	Other industries	Use of products by industries	Final consumption and capital formation	Exports	Total use
1.1.3.20	Wood in the rough (02.20.1)	1 042.81	5 607.89	6 650.70	3 248.73	3 067.15	12 966.58
1.1.3.1.20	Logs	1 041.32	4 155.87	5 197.19	0.00	2 759.75	7 956.95
1.1.3.1.1.20	Coniferous wood (02.20.11)	802.31	3 202.01	4 004.32	0.00	1 273.47	5 277.79
1.1.3.1.2.20	Non-coniferous wood, except tropical wood (02.20.12)	239.01	953.87	1 192.87	0.00	1 486.28	2 679.16
1.1.3.1.3.20	Tropical wood (02.20.13)	0.00	0.00	0.00	0.00	0.00	0.00
1.1.3.2.20	Fuel wood	2.26	2 331.16	2 333.42	2 368.82	307.39	5 009.63
1.1.3.2.20.1	Fuel wood of coniferous wood (02.20.14)	0.74	763.47	764.21	775.81	90.00	1 630.02
1.1.3.2.20.2	Fuel wood of non-coniferous wood (02.20.15)	1.52	1 567.69	1 569.21	1 593.01	217.39	3 379.61

Column 60 “Imports” was populated with corresponding data from Eurostat’s Table 2 (“Roundwood, fuelwood and other basic products”), recalculated from under bark to over bark using coefficients indicated in Table 27.

Total supply of products (column 51 of FA table C1a) was divided between "Forestry and logging industry" (column 51.0) and "Other industries" (column 51.1) based on monetary supply table. It was assumed, that prize of wood supplied by enterprises with all economic activities and the self-employed farmers is the same and monetary distribution between forestry and other economic activities can also be used for distribution of physical units.

The monetary SUT tables are not on tree species type (coniferous, non-coniferous) level as needed in table C1a, therefore some additional assumptions were made:

- logs supplied by enterprises with all economic activities and the self-employed farmers have the same proportion of coniferous and non-coniferous trees.
- Fuel wood supplied by enterprises with all economic activities and the self-employed farmers have the same proportion of coniferous and non-coniferous trees.

The same share between coniferous and non-coniferous for logs and fuel wood were used in case of all economic activities.

The shares of economic activities M.A.02 (Forestry and logging – enterprises) and O.A.02 (Forestry – farmers) in total supply of product 1.A.022 "Wood in the rough, except fuel wood" was calculated. This share was used to calculate the share of forestry (activity 02) in total supply of logs in C1a table.

The shares of economic activities M.A.02 (Forestry and logging – enterprises) and O.A.02 (Forestry – farmers) in total supply of commodities 1.A.024 "Fuel wood" and 1.A.024O "Fuel wood, produced for own final use" on total supply of commodities 1.A.024 + 1.A.024O was calculated. This share was used to calculate the share of forestry (activity 02) in total supply of fuel wood in C1a table.

6.3 Compilation of physical use table of wood in the rough, C1b

Based on the data sources mentioned in chapter 6.1 physical use table for the year 2019 was compiled. The data are presented in the Table 30 below.

Table 31. Use of wood in the rough by all industries, in 1000 m³ over bark, reference year 2019

Code	Description	51.0	51.1	51	71	72	99
		Forestry and logging industry (Division 02) (if any)	Other industries	Use of products by industries	Final consumption and capital formation	Exports	Total use
1.1.3.20	Wood in the rough (02.20.1)	1 042.81	5 607.89	6 650.70	3 248.73	3 067.15	12 966.58
1.1.3.1.20	Logs	1 041.32	4 155.87	5 197.19	0.00	2 759.75	7 956.95
1.1.3.1.1.20	Coniferous wood (02.20.11)	802.31	3 202.01	4 004.32	0.00	1 273.47	5 277.79
1.1.3.1.2.20	Non-coniferous wood, except tropical wood (02.20.12)	239.01	953.87	1 192.87	0.00	1 486.28	2 679.16
1.1.3.1.3.20	Tropical wood (02.20.13)	0.00	0.00	0.00	0.00	0.00	0.00
1.1.3.2.20	Fuel wood	2.26	2 331.16	2 333.42	2 368.82	307.39	5 009.63
1.1.3.2.20.1	Fuel wood of coniferous wood (02.20.14)	0.74	763.47	764.21	775.81	90.00	1 630.02
1.1.3.2.20.2	Fuel wood of non-coniferous wood (02.20.15)	1,52	1 567,69	1 569,21	1 593,01	217,39	3 379,61

To calculate data for the column 51 “Use of products by industries” in physical use table C1b the next assumptions were made:

Supply of products – Export + Import = Products available for use in Estonia

Products available for use in Estonia = “Use of products by industries” (column 51)

Column 72 “Exports” was populated with corresponding data from Eurostat’s Table 2 (“Roundwood, fuelwood and other basic products”), recalculated from under bark to over bark using coefficients indicated in Eurostat Table 1 (see chapter 7.1 data sources).

Total use of products (column 51 of EFA table C1b) was divided between “Forestry and logging industry” (column 51.0), “Other industries” (column 51.1) and final consumption (71) based on monetary use table. It was assumed, that prize of wood used by enterprises with all economic activities and the self-employed farmers, households, and government sector (NACE N.O.84) is the same and monetary distribution of use of wood in rough can also be used for distribution of physical units.

The monetary SUT tables are not in tree species type (coniferous, non-coniferous) level as needed in table C1a, therefore some additional assumptions were made:

- logs used by all economic activities and the self-employed farmers have the same proportion of coniferous and non-coniferous trees.
- Fuel wood used by all economic activities, the self-employed farmers, households, and government sector have the same proportion of coniferous and non-coniferous trees.

The same share between coniferous and non- coniferous of logs and fuel wood were used in case of all users.

The shares of economic activities M.A.02 (Forestry and logging – enterprises) and O.A.02 (Forestry – farmers), households, and government sector (NACE N.O.84) in total use of product 1.A.022 “Wood in the rough, except fuel wood” was calculated. These shares were used for calculation of the shares of forestry (activities M.A.02 + O.A.02) and final consumption (activity N.O.84 + households) in total use of logs in C1b table.

The shares of economic activities M.A.02 (Forestry and logging – enterprises), O.A.02 (Forestry – farmers), households, and government sector (NACE N.O.84) in total use of commodities 1.A.024 “Fuel wood” and 1.A.024O “Fuel wood, produced for own final use” on total use of commodities 1.A.024 + 1.A.024O was calculated. These shares were used for calculation of the shares of forestry (activities M.A.02 + O.A.02) and final consumption (activity N.O.84 + households) in total use of logs in C1b table.

6.4 Compilation of physical use table for years when SUT tables are not available

Monetary Supply and Use tables for years 2020 and 2021 are not ready yet. For these years the same shares for divisions of total supply and total use of products between forestry, other economic activities, and final consumption of last available SUT (2019) were used as “benchmarks”. Benchmarks used for division of total supply and total use of products in 2020 and 2021 are presented in the Table 31.

Table 32. Benchmarks from SUT 2019 used for compilation of physical supply and use tables of years 2020 and 2021

	Forestry and logging	Other industries	Final consumption and capital formation
Total supply logs	0.933294	0.066706	
Total supply fuelwood	0.954806	0.045194	
Total use logs	0.200362	0.799638	0.000000
Total use fuelwood	0.000481	0.495755	0.503764

Physical supply and physical use tables C1a and C1b are presented in full detail and in MS EXCEL format in the file annexed to this report: deliverable D1.11 Data for the forest accounts module (EFA tables).

6.5 Results

Physical supply and Use tables for years 2017- 2021 are presented in full detail and in MS EXCEL format in the file annexed to this report: deliverable D1.11 Data for the forest accounts module (EFA tables) and displayed on the Figure 1. Physical supply and physical use tables of wood in rough 2017-2021, thousand m³.

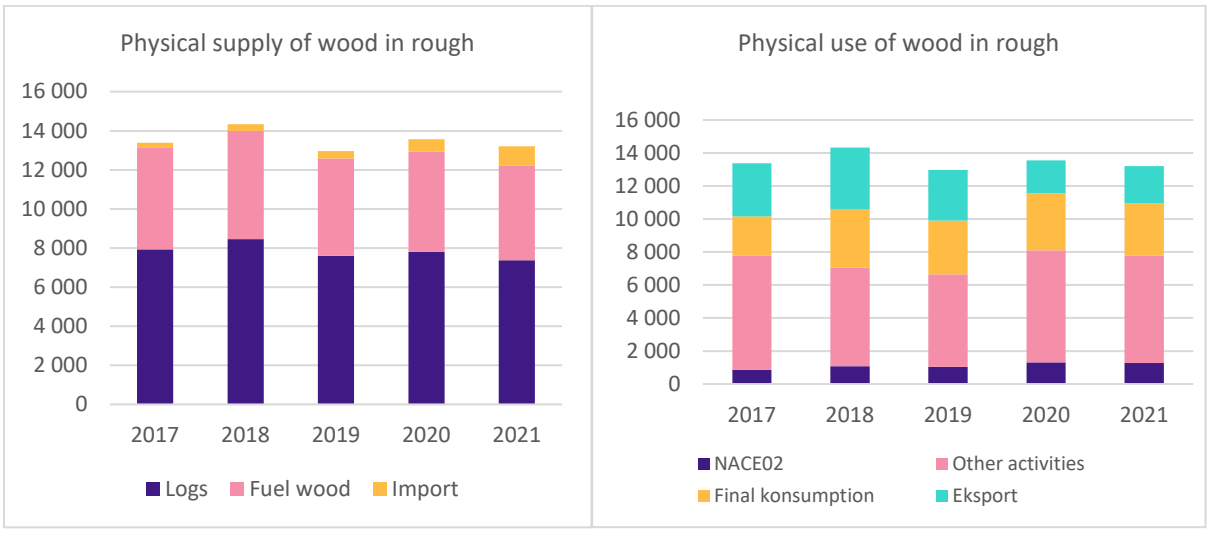

Figure 1. Physical supply and physical use tables of wood in rough 2017-2021, thousand m³

The physical supply (and use) of wood in rough has stayed rather stable over the years. Share of import in supply is small but increasing noticeably lately. At the same time share of export in use of wood in rough is decreasing. More wood in rough is used by Estonian economic activities (NACE 02 and other economic activities as well). Share of final consumption is fluctuating, which may probably be influenced by prize of fuel wood but also the climatic conditions.

6.6 Conclusions on the compilation of physical supply and use tables of wood in the rough

Data needed for population of tables physical supply and physical use tables C1a and C1b are available, which mean there are no big problems with compiling the EFA tables. The consistency between physical supply and use and respective monetary supply and use tables were handled as well.

From other hand, physical supply and use tables of wood in rough connect the data of Joint Forest Sector Questionnaire and National Accounts. This means that data quality and coverage problems in both data sources transfer to tables C also.

The main problem that arises from the National Accounts is the probable under coverage of the timber final consumption due to current undervaluation in national accounts. The estimation of households' timber use (mainly fuelwood) for own consumption of households, in addition to currently accounted agricultural holdings, is topic for future development needed for both monetary and physical use tables. Including questions about use of fuel wood to household budget survey would be one way for obtain missing data about final consumption of wood.

The main problem arising from using Joint Forest Sector Questionnaire data was pointed out by Feliks Sirkas, who gave the feedback from the perspective of compilation of the Estonian timber balance. Discussion brought up the probable case that the estimation of the physical quantity of foreign trade of wood in rough may vary in sense of reflecting the timber under bark or over bark. It was suggested that future analyses are needed as probably enterprises indicate their production and export not uniformly. As timber balance is partly the data source for Joint Forest Sector Questionnaire, which is in turn main data source for supply and use tables in physical units, the observed issues related to the over and under bark inconsistent reporting in foreign trade need certain revision in both reporting's. The future consultation with experts of foreign trade statistics and interviewing the enterprises exporting the wood in rough will be needed.

7 Consistency of Forest Accounts with Environmental Goods and Services Accounts

As Environmental goods and services account (EGSS) covers environmental protection and resource management activities it also includes services that are made to protect and regenerate forests. Both accounts also include output of producing fuel wood. The consistency of the methods, coverage and figures of Forest Accounts with EGSS were briefly reviewed. Monetary output is covered in the Forest Accounts in table B1 where is shown output of NACE 02 including forest protection and regeneration services. As these activities are part of other activities in both accounts these values does not distinguish in the final tables but can be compared when making more in depth analyses.

Production of fuel wood in EGSS is seen as part of the renewable energy production having relations to the C1 tables in EFA. Also the production of fuel wood as a separate activity is calculated in EGSS and important data source for calculating the output is monetary supply and use table that is also used as a data source to compile table B1 in forest accounts therefore the values should be the same for NACE 02. EGSS for 2019 has not been updated with the data of the latest monetary supply and use table yet but it will be for the next data transmission in the end of October and then the output of fuel wood in forest accounts and in EGSS should be the same.

ANNEX 1. Minutes of the final seminar on the development of forest accounts

Final seminar on the development of Forest Accounts

Tallinn

Tatari 51/hybrid

June 6, 2023

Conclusions/minutes

Participants: Statistics Estonia (Kaia Oras, Grete Luukas, Argo Ronk, Helen Saarmets, Margarita Lipijäinen, Tauri Miggur, Kätlin Aun), Estonian Environment Agency (Taivo Denks, Mati Valgepea, Madli Linder, Krisela Uussaar), Ministry of the Environment (Meelis Seedre, Leno Kuura), Estonian University of Life Sciences (professor Paavo Kaimre), ELME team/Tartu Univesrity(Raul Rosenvald), Üllas Ehrlich (Tallinn Technical University), State Forest Management Centre (Veiko Eltermann, Olavi Andres,), Ministry of Economic Affairs and Communications of Estonia (Marika Kõlvart), Lembit Maamets

Kaia Oras gave an overview of forest accounting framework from the viewpoint of the planned amendments of the regulation 691/2011 on environmental economic accounting. In addition to general framework of the forest accounts reporting, also the links to other standards like UN SEEA EA and national accounts (SNA and EA) were handled. Proposed amendment of the regulation regarding forest accounts, Annex VII, was presented in more detailed.

Kaia Oras highlighted the steps and the progress on the compilation of the tables, co-operation between the statisticians, forestry scientists and experts community and stakeholders, and the work carried out in developing and adapting the definitions and concepts. Kaia noted that the work with the definition on international level is still in progress and this aspect has an influence on current work. Depending on the outcomes of the work the decision that would be made in the Eurostat task Force may influence future revision of the statistics in this area.

Forest and timber assets, calculations in physical units, table A1a and A2a , calculations in monetary units, methods and results

Mati Valgepea (Estonian Environment Agency) introduced the compiled tables on forest land balance (Table A1a) applied methods, gave and overview of the process of the compilation, data sources available, links to international reporting's (JQSQ IPCC (LULUCF) and GFRA). In his presentation Mati first introduced the principles of the National Forest Inventory (NFI) which is the primary information source for the tables A1a and A2a. Mati discussed also the shortcomings of NFI for calculation of EFA detailed breakdowns. He also dealt with the issues related to the applicability of the EFA definitions with the existing data sources and other international forest definitions. Predominant issues were related to the application of the definitions while compiling of the balance on timber assets and flows. For example, flow estimates ("net annual increment", "removals" and "irretrievable losses") use different fractions of timber. Net annual increment is calculated only for stemwood, but removals and

irretrievable losses include stemwood and non-stemwood. Problems arising from the different data sources, or the data processing rules were discussed. In addition, the inclusion into re-classification category the decrease of the deadwood as a result of the decaying was also raised. It was emphasized that before the finalization of the manual and setting of the quality criteria it is still too early to specify the final issues of concern for filling in timber stocks and flow data. Mati considered the results obtained quite satisfactory in given circumstances.

Forest and and timber assets, calculations in monetary units, table A1B and A2b, calculations in monetary units, methods and results, comparison of methods

Professor Paavo Kaimre (Estonian University of Life Sciences) presented the compiled tables on forest land and timber assets in monetary units. At first Paavo gave an overview of the theoretical background and efforts in Estonia so far in the valuation of forest land and pointed out that there are both theoretical and practical approaches feasible. Four alternatives for the calculation of the value of the wooded land was handled and were discussed. As land available for wood supply is normally valued on the basis of market transactions, either directly or as a ratio of known values of forest real estate, therefore, the proposal was to use the median price of transactions when assessing the value of forest available for wood supply in the Table A1b. Question was discussed and remained open how to value the forest land not available for wood supply (not traded).

For the valuation of the timber assets three approaches were discussed. Methodological specifications, assumptions and differences of three approaches were handled. Discussion highlighted that the selection of the methods is always associated with the accompanied semantics. The two timber valuation alternatives presented in this report were considered to be quite similar in nature: in both cases the net present value of forecasted future cash flows was calculated. In the first alternative the average stumpage price of timber and the forecasted annual felling volumes are used. In the second case the net income per one cubic meter of timber was used. It was proposed but remained open if the present value of the future net income could be the preferred option for estimating of the value of the timber stock. Arguments were that in this case, in addition to the expected wood related income, the actual management costs are also taken into account. So, net income approach was proposed as a candidate for the most suitable method for the compilation of the timber assets and flow tables. In the discussion regarding the methods of valuation of timber assets the alternative to apply just the stumpage process for the stocks and flows was proposed by some of the participants. Assumptions were discussed: the arguments why not to support stumpage prices related value of the stocks were related to the non-availability of wood for harvesting and removal currently (even theoretically) and in addition, there are many young stands in the forests that cannot be cut yet and thus have no market value at the moment. Also, the methodological materials suggest the stumpage price based valuation could be considered as a starting point for forest assets valuation but for the stocks addition net present value adaptations and cost components need to be considered as well.

The assumptions for the selection of the appropriate method, related semantics and relevant parameters in the calculations (discount rates etc) were handled. The influence of the high variability of the timber prices on the asset opening and closing stock values in the net income method was argued and the option of using average prices for the stocks calculation was discussed.

It was discussed if the timber on the forest land, which is not available for the wood supply could have the monetary value. The semantics of these figures and methods to be applied were

considered “work in progress”. Reflection of the dead wood in assets and flows were discussed as well.

The tables, methods and data sources for the compilation of the economic indicators for forestry activity, Table B1, B2, was done by Grete Luukas. The data sources and respective categories in national accounts and basic enterprise statistics were introduced. Assumptions for the derivation of more detailed necessary breakdowns were described.

Supply and use tables for wood in rough in monetary units, (B3A and B3B) were presented by Grete Luukas. Coherence between supply and use tables for raw wood, in monetary units, (B3A and B3B) with the table B1 and B2 were outlined. Coverage of the timber final consumption category was considered as one of the categories which needs future improvements (as the category is currently undervalued in national accounts, comprising only agricultural holdings use of the fuel wood for own consumption). Possible data sources for the estimation of households’ timber use was discussed and the need for the carrying out of the household budget survey dedicated separate module for a single year in near future was highlighted.

Supply and use tables of wood in rough in physical units, C1a and C1b were presented by Eda Grüner. Data sources and the methodology for the compilation of the supply and use tables in physical units were described. The consistency between physical supply and use and respective monetary supply and use tables were handled as well. Discussion brought up the probable case that the estimation of the physical quantity of foreign trade of wood in rough may vary in sense of reflecting the timber under bark or over bark. It was suggested that future analyses are needed as probably enterprises could indicate their production and export not uniformly.

The feedback and overview from the perspective of compilation of the Estonian timber balance was given by Feliks Sirkas. He also gave the comments on the tables of supply and use in physical units. As timber balance is partly the data source for Joint Forest Sector Questionnaire, which is a main data source in another hand for supply and use tables in physical units, C1a and C1b, the observed issues related to the over and under bark inconsistent reporting need certain revision in both reporting’s.

Future analytical needs and methodological cooperation of topics of forest accounting were discussed by project team and participants. Plan for the possible improvements in the methods, contribution to the handbook and testing of various approaches in coming year and the co-operation with other NSI-s was discussed.

The issue of poor translation of the technical terms to Estonian language of the of draft proposed text of the amendment of the regulation regarding forest accounts, Annex VII, was highlighted. It was concluded that the work with Estonian definitions should start as soon as possible.

The discussion

Discussion regarding balances of forest land and timber assets was raised and was focused on the methods for the valuation of the forest assets in physical units. The issues for the future’s methodological advancement of the forest assets were pointed out. It was agreed that if the alternative data sources for the asset valuation will become available these data sources will be analyzed by Statistics Estonia as well.

It was discussed that round table (involving all concerned parties) on the methodology and the valuation of forest assets could be organized by the Ministry of Environment in September 2023. Ministry of Environment acknowledged that the EFA is useful for the policy analyses. Ministry of Environment thanked project team who has done a remarkable effort in analyzing methodology and available data for the EFA compilation. Ministry of Environment congratulated project team for the compilation of the first round of the tables and setting up a discussion for a for the results.

The consistency between the monetary valuation of timber resources in ecosystem accounts and European Forest accounts was discussed. To use of the concept and the definition of the potential supply from the ecosystem accounts was suggested for the timber assets by the representative of Environmental agency and Tartu University. Representatives of the Tartu University suggested that the stumpage prices could be the best option to calculate timber supply in monetary units in order to reach the compliance with the ecosystem mapping and assessment which is carried out currently in Estonia (Estonian Environment Agency and respective team of scientists).

It was agreed that assets have their specific meaning and methods in environmental economic accounted (SEEA CF) which could not be directly transferred to ecosystem accounts as the ecosystem Accounts methods rely on the SEEA EA. It was still considered important that the coherence between forest and ecosystem accounts is obtained and described.

Tallinn, 21.06.2023

Kaia Oras

ANNEX 2. Conclusions of the intermediate seminar on the development of forest accounts

Intermediate seminar on the development of forest accounts

Online

August 31, 2022

Conclusions/minutes

Participants: Statistics Estonia (Kaia Oras, Grete Luukas, Argo Ronk, Helen Saarmets, Kätlin Aun), Estonian Environment Agency (Mati Valgepea), Ministry of the Environment (Meelis Seedre, Leno Kuura), Estonian University of Life Sciences (professor Paavo Kaimre)

1. In-depth discussion with partners regarding accounting tables for forestry accounting

Mati Valgepea, Feliks Sirkas and Madis Raudsaar, i.e Estonian Environment Agency experts, gave an overview of the methods proposed for physical accounting tables for forest area and timber stock data:

Mati Valgepea described the results and analyzed the feasibility of the compilation rules. He described the NFI 5 year cycle of the estimates as input for the filling of the Forest land balance, Table A1a in ha-s. The definitions for the international reporting were described as well. NFI details were showed and described. It was also noted that Estonian land use classifications are not in one to ne correspondence. IN addition to FRA definitions LULUCH definitions were described as well. Difficulties to valuate the stocks in the beginning and end of the year were and the nature/definition/concept for the “balancing” item was discussed and if the balancing item could be summed up from the subcategories.

Difficulties for other wooded land stock beginning and end of the year were discussed, if some of the item of the balance would be voluntary.

The need for the quality criteria and compilation guidelines and the connections between the tables for EFA were discussed. The need for these quality documents was stressed for all tables f EFA:

Methods for a stock of forest land Table A2a, ha, were discussed, and it was acknowledged that problems faced in A1a table were amplified to other tables as well.

It was discussed that it is e possible to fill the tables with existing data and the second phase of the project would focus for the addition methodological issues. It was discussed what would be the amount of residual work?

The issue of statistical reclassification was also discussed and future use of the remote sensing data was discussed as well.

The details of other wooded land and other land with wood cover were analyzed and the details were considered to be very complicated to be compiled.

Forest definition in Estonia nationally and internationally was questioned

2. Paavo Kaimre: financial accounting tables regarding forest area and stock indicators and described that he has used the land transaction prices from Land board data for forest area (available for wood supply) and timber price based on state forest management center (1m^3 of the timber minus current costs on forest management). It was discussed if these very straightforward calculations would oversimplify the results. If to look at the balance flow items it was discussed what could be adequate

method there. Forest land balance sheets, Table A1b, euro and Stock of forest land Table A2b, euro were considered sufficient at current stage.

Statistics Estonia said that they will look for the work and methods of other countries in order to discuss how to proceed and which methods could be a step further in advancing of the methods.

Statistics Estonia asked the feedback on earlier introduced preliminary calculations regarding forestry economic indicators and supply use tables. These tables on forest management indicators in Table B1 and B2, Supply table B3A, eur, use table B3b, eur were presented by Grete Luukas and missing indicators on forest indicators have been analyzed earlier.

Mati Valgepea provided the feedback on tables Eda compiled/presented on physical supply and use table C1a, m^3 Use table C1b, m^3, which were initially filled in based on JFSQ and respective guidelines. These tables were also sent with methodological notes for comments and additions beforehand. Mati Valgepea analyzed and gave feedback on the methods how at Statistics Estonia has introduced the industry breakdown based on supply and use.

It was discussed how to improve the results that were already compiled. The description of the methodology in English was asked for and was agreed that will be written in coming month.

If alternative methods, data and data sources would be available (including references to additional data sources), Statistics Estonia would greatly appreciate such feedback. Data sources and a reference to the initial methodological approach are referred in the tables. Feedback is welcomed.

Discussion: It was considered that the first round of the methods is satisfactory. The macro relevel asset valuation was considered a new step further and consider to discover the land asset in national accounts. Evaluation of the methods for biological assets was considered to be a worthwhile new step.

Tallinn, 08.09.2022

Kaia Oras