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Timber flows and stocks, comparison of the monetary valuation methods

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Introduction

Development work on the methodology for timber flows and stocks, comparison of the monetary valuation methods was supported by Eurostat development grant[1].

This article, prepared by Statistics Estonia and the Estonian University of Life Sciences for the UN London Group, examines methods for valuing timber stocks and flows. It aims to align Estonia's newly established forest accounting

[1] Work has been carried out and financed under the Eurostat development grant „ Development of the environmental accounts 101197994 — 2024-EE-EGD"

with the **European Forest Accounts (EFA)** [2], the **SEEA Central Framework (SEEA CF)**[3], the **SEEA Ecosystem Accounting (SEEA EA)**[4], and the **System of National Accounts (SNA)** [5]. Article explores methodological choices, their implications, and raises questions for the London Group on Environmental Accounting.

European Forest Accounts has become a standard in European Union countries starting with the routine reporting in 2025. Statistics Estonia together with the researchers has been actively developing and refining its approaches to the valuation of timber assets, in line with the principles of the EFA, based on the principles of the SEEA CF.

This work builds on ongoing national efforts, as well as exchanges with international partners through the Eurostat Forest Working Group, targeted expert seminars, and collaboration under a Eurostat development grant[6]. The assessment covers four principal EFA related valuation approaches—two variations of the stumpage value method, resource rent method and a net present value (NPV) method,- each offering distinct strengths and limitations in reflecting the economic value of Estonia's forest resources. The implications of the methodological approaches are discussed, covering the detailness of the data, discount rates, asset lifetime. In addition to stock valuation, Estonia is also evaluating two alternative approaches for calculating timber flows (both for felling and increment), as differences in these estimates raise important questions about consistency with asset accounts and the broader SNA framework.

Valuation of timber is essential for economic reporting and also for understanding its broader environmental contributions. To ensure reliable and comparable timber asset and flow data, valuation methods grounded in SEEA EA have likewise been explored. Importantly, the analysis should ideally refer to the same timber stock across all valuation approaches to ensure comparability of results, although this goal may not yet have been fully achieved.

Methodological choices have direct implications for alignment between SEEA CF, SEEA EA, and SNA 2008 and 2025 standards, contributing to ongoing international harmonization efforts. Methodological choices greatly influence asset values and their comparability across time and countries. Factors and parameters affecting results are discussed, and key questions are raised for the London Group.

The analysis shows that timber stock valuations may vary widely depending on assumptions on input data aggregation and discount rates. Overall, robust timber stock and flow assessments depend on methodological choices, data quality and institutional cooperation. Because international standards allow methodological flexibility, harmonization, methodological clarity and transparency remain national responsibilities. Stronger collaboration between compilers of forest, ecosystem, and national accounts, supported by formalized workflows and consistent terminology, improves coherence and comparability.

Questions (to the London Group)

1. Is the uniform application of the timber flows and accounts methods across the accounts important?
2. Given the methodological flexibility currently within SEEA and SNA, how can coherence and harmonization of timber valuation be achieved without undermining the value of country-specific approaches?
3. Does selecting a particular method affect the scope or applicability of the results?
4. How do assumptions regarding discount rates and asset lifetimes influence the comparability of timber valuations across accounting frameworks (EFA, SEEA CF, SEEA EA, SNA), and what criteria should guide their selection?

[2] „European forest accounts handbook", Eurostat, 2024 edition, European forest accounts handbook - 2024 Edition

[3] System of EnvironmentalEconomic Accounting 2012— Central Framework , United Nations New York, 2014, https://seea.un.org/sites/seea.un.org/files/seea_cf_final_en.pdf

[4] System of EnvironmentalEconomic Accounting – Ecosystem Accounting, United Nations, New York, 2024 https://seea.un.org/sites/seea.un.org/files/documents/EA/seea_ea_f124_web_12dec24.pdf

[5] System of National Accounts 2025, For Statistical Commission endorsement, 2025. https://unstats.un.org/unsd/nationalaccount/snaupdate/2025/2025_SNA_Combined.pdf

[6] Work has been carried out and financed under the Eurostat development grant „2024-EE-EGD"

Estonian Forestry, main features and institutional setup

Estonia is one of the most forest-rich countries in Europe, about 51–52% of Estonia's land area is forested, and this share has been growing since the 20th century due to natural regeneration and afforestation. The dominant tree species are Scots pine (*Pinus sylvestris*), Norway spruce (*Picea abies*), and birch (*Betula* spp.), while alder (*Alnus* spp.) and aspen (*Populus tremula*) also occur to a lesser extent.

Roughly half of forests are privately owned, the rest being state-managed predomonantly through the State Forest Management Centre (RMK). Table 1 provides a detailed overview of the distribution of forest ownership across various ownership groups.

Table 1. Distribution of forest land area by ownership categories[7]

Ownership category	**Area, ha**	**Share, %**
State Forest Management Centre	1 076 521	46
Physical persons	633 508	27
Juridical persons	521 864	22
Other state forest land	106 741	5
Forest land subject to privatization	1 320	0.1
Total	2 325 646	100

According to a study[8] commissioned by the Ministry of the Environment, Estonia had 104,311 private forest owners at the end of 2019 (Forinfo, 2019). Of these, 98 **thousands** (94.3%) were individuals and **6 thousands** (5.7%) were legal entities. The average size of private forest ownership was 10.7 hectares, with individuals holding an average of 6.6 hectares and legal entities an average of 78.6 hectares.

The forestry and wood industries **altogether** constitute a significant component of Estonia's economy, accounting for an important share of exports. The sector encompasses forest management and logging, wood processing, as well as pulp, paper, and bioenergy production. The contribution of the forest and wood sector to total added value was 4.4% in 2022 and 3.9% in 2023. The largest share of the sector's sales revenue and value added is generated by enterprises engaged in mechanical wood processing, which account for 65% of sales revenue and 53% of value added. In 2022, the sector employed approximately 28 **thousand** individuals, representing 4.2% of total employment. Exports have consistently played a central role in the Estonian wood industry, constituting nearly two-thirds of total sales. In 2022, wood and wood products accounted for 10.8% of total exports.

The estimation of the monetary value of timber requires data on timber prices and logging costs. Since RMK regularly collects and publishes such information, these data serve as the primary basis for describing the state and dynamics of the timber market. RMK sells timber to enterprises from the roadside in the form of assortments: sawlogs, pulpwood, firewood, and wood chips. The proportions of these assortments vary somewhat across years; on average, sawlogs constitute 45% of timber sold, pulpwood 30%, firewood 17%, and wood chips 8%. The majority of timber is sold under long-term contracts, while the remainder is marketed primarily through auctions. Timber buyers are predominantly enterprises engaged in wood processing. Comparable data on timber sales from private forests are, however, incomplete. In general, private forest owners dispose of timber either as standing stock or as assortments delivered to the roadside.

[7] Estonian Environment Agency. 2025. Yearbook Forest 2023. https://keskkonnaportaal.ee/sites/default/files/Teemad/Mets/Mets%202023.pdf

[8] Forinfo. 2019. Eesti erametsaomandi struktuur ja kasutamine 2019. aastal. [Structure and use of private forest ownership in Estonia in 2019]. Tartu. 66 p.

Insight to the application of EFA (SEEA CF) methods

Comparison of the EFA methods results

The EFA handbook outlines four methods for estimating the financial value of a timber stock: the net income method, age constant method, stumpage value method, and consumption value method. These methods were tested for assessing the timber stock, including one, which is not described in the EFA manual. Results are available in report: "Description of the methodology and methodological issues for forestry account"[9].

The comparison of the monetary value of the stock and flow of timber at the end of 2022 using different methods is outlined In Table 2. The monetary value of the timber stock calculated using different methods at the end of 2022 shows that highest value is given by the stumpage methods, while the lowest is provided by the resource rent method. The value of timber calculated using the net income method falls between these two extremes.

Table 2. Comparison of timber stock valuation results based on EFA, Estonia 2022

Method		***Monetary value, million euros***				***Prices, euros per m3***	***Comment***
	Opening stock	***Closing stock***	***Average price, euro***	***Remo-vals***	***Net incre-ment***		
Stumpage value method I (EFA manual)	***25 349***	***24 567***	*63,46*	*762*	*514*	*63.46*	*Stumpage price is based on State Forest Management Centre data of road-side prices and wood procurement costs*
Stumpage value method II (EFA)	***24 218***	***23 471***	*60,63*	*728*	*491*	*60.63*	*Stumpage price is based on State Forest Management Centre data and modelled harvesting costs; differences by tree species and assortments were considered*
Net income/Resource rent/Net present value (EFA)	***14 861***	***20 639***		*762*	*514*	*Stumpage prices by tree species*	*Net income method, discount rate was 2.3% in 2022 and 3.2% in 2021.* *A similar rate was applied by the State Forest Management Centre in 2022 for the valuation of biological assets.*
Unit resource rent method (national approach)	***7 450***	***13 267***	*34,27*	*762*	*514*	*34.27*	*It is based on the timber sales revenue and forest management costs of state forest based on 10 years scenarios*
Age constant method (EFA)		*Not available*					*Age class coefficients are absent in Estonian forestry practise*
Consumption value method (EFA)		*Not available*					*Data on the stumpage prices of timber for different age classes are missing*

Stumpage price method

The stumpage price method is widely used due to its simplicity. It estimates the timber value by multiplying the average market price of standing timber with the available timber volume.

Stumpage price refers to the value of standing timber (trees still on the stump) before it is harvested. It is essentially the price paid by a buyer to the landowner for the right to cut and remove the timber. Stumpage price method reflects

[9] "Description of the methodology and methodological issues for forestry account", D1.1.Description of the methodology and methodological issues for forestry account.pdf, Statistics Estonia, Project name: Development of the forestry, environmental subsidies and ecosystem accounts, Project acronym: 2022-EE-EGD, 101113157 Methodological report, December 2024, Tallinn

the market value of unharvested timber as observed actual transactions in standing timber or by adjusting roadside pickup prices for logging (felling and transportation to the roadside) costs.

Table 3 Advantages and disadvantages of the stumpage price method

Advantages of stumpage price method	***Limitations of stumpage price method***
Data accessibility *Uses observable market prices.*	*Ignores the costs* *Does not account for forest management expenses in addition to procurement costs.*
Low complexity *Straightforward multiplication with physical inventory data.*	*Static view* *Does not reflect long-term economic value or changes in forest structure.*
Consistency *Provides annual estimates with low variance.*	*Market distortion risk* *Can be affected by short-term supply/demand shocks.*

Two approaches to calculate the average stumpage price

When calculating the monetary values for EFA tables using stumpage value method, two distinct approaches for determining the average stumpage value were applied. The first approach employs market information provided by the State Forest Management Centre (RMK), while the second follows the historical preferred method of the National Accounts (NA).

Both approaches make use of RMK's roadside price data for timber assortments by different tree species. RMK publishes monthly roadside storage prices of timber by assortments, as well as the weighted average roadside storage price calculated on the basis of assortment volumes, which in 2022 was 74.4 euros per m³. In the first approach (stumpage price 1), RMK's actual wood procurement costs were deducted from the weighted average road-side price of all timber assortments.

In the NA approach (stumpage price 2), procurement costs were estimated using models. Specifically, in NA, harvesting costs are calculated through a model that accounts for the average stand characteristics by tree species and age class, from which the average stem volume of harvested trees is derived. Geographic Information System (GIS) map layers are employed to determine the average hauling distance. The result is a logging cost, representing the service price (felling + hauling) by timber assortment and species, specified separately for RMK and other owners. The modeled logging cost for each assortment is subtracted from its average intermediate storage price, thus obtaining the assortment stumpage price in both RMK's and other owners' forests.

The logging volume data from the Environment Agency include grey alder and black alder pulpwood; however, pulpwood for these species does not exist in practice. Consequently, these volumes are recorded as fuelwood, and the fuelwood price is applied. For the "Other" species category, the fuelwood price for hardwood species is used. In the case of aspen small logs, the pulpwood price is applied as the estimated value.

In 2022, the average stumpage price calculated on the basis of RMK timber sales data was 63.46 euros per m³ (stumpage value I), while in NA it was 60.63 euros per m³ (stumpage value II). These prices were applied to calculate the value of the net increment, harvested timber flows and stocks.

From two stumpage price approaches currently the second is more preferred if the aggregation of the individual prices and quantities into a general average is feasible. Tree species are divided into seven and those were allocated to 5 assortments. Net increment and fellings were allocated to assortments based on harvest of each category. Harvesting cost for each tree species and assortments were calculated using a model developed in NA.

Still necessity for improvements and updates of used assumptions are seen. It is also important to further analyze which timber assortments are included in the calculations as it may affect the average value remarkably.

Using more detailed information and division into assortments in method 2 gives lower stumpage prices of assortments. The difference arises from the slightly different calculation of different assortments and their unit prices. The weighted average price calculation by RMK includes, for example, the quantities of aspen and birch logs, which are not taken into account by NA. In recent years, residues have also had a real market price, but it is excluded from NA's calculation.

Table 4 Comparison of stumpage price 1 and stumpage price 2

	Stumpage price I	**Stumpage price 2**
Roadside price	*Weighted average value from RMK* ***77.41 euors per m³***	*Values separately available by tree species and assortments* *Range:****137.7 – 38.8 euors per m³***
Logging costs	*Average value available from RMK* ***13.95***	*Values separately available by tree species, owner and assortments calculated using a model dveloped in NA* *Range:* ***25-9.7***
Stumpage price	*A single stumpage price calculated: roadside price – harvesting costs* ***63.46 euors per m³***	*Values by tree species, owner and assortments: roadside price – harvesting costs* *Range:* ***125 – 21 euors per m³***
Value of removals	*Stumpage price * removals in physical units* ***762 million euros***	*Stumpage price * removals considering tree species, owner and assortment* ***728 million euros***
Value of increment	*Stumpage price * net increment in physical units* ***514 million euros***	*Stumpage price * net increment considering tree species, owner and assortment (using shares from harvest)* ***491 million euros***

When comparing the prices obtained with methods 1 and 2, we identified where the main differences in average stumpage prices occur. Certain birch assortments are considerably higher in method 1, while fuelwood and waste assortments fall below the average.

Unit resource rent

In the present study, in addition to the stumpage price method, we tested the application of the unit resource rent.

Resource rent (RR) represents the net surplus generated from timber production after deducting all production costs, and thus reflects the contribution of timber as natural capital to the economy. The unit resource rent is defined as the resource rent per unit of resource extracted (*SEEA Central Framework*, para. 5.157).

The unit resource rent measures the overall return to the economic owner of a resource per unit of output. Its estimation requires subtracting all relevant costs from the value of output, including the user costs of produced capital. For forest resources as a whole, such costs encompass cultivation expenditures and other silvicultural operations.

Based on data from the 2022 annual report of the State Forest Management Centre, average forest management income amounted to 80.17 euros per cubic metre of harvested timber, while the estimated average cost was 45.90 euros per cubic metre. Consequently, the calculated unit resource rent was 34.27 euros per cubic metre.

Analogously to the stumpage price method, the unit resource rent was multiplied by the physical timber flows and the volume of the timber stock. Because the unit resource rent is lower than the stumpage price, its application results in lower monetary values for both timber flows and timber stocks compared to the stumpage price method.

We examined the use of the unit resource rent value as applied in the valuation of the biological assets of the Estonian state forest. However, since this approach is neither referenced in the EFA Manual nor recognised in the *SEEA Central Framework* as appropriate for the valuation of timber reserves, we decided to discontinue its further application.

Table 3 Advantages and disadvantages of the unit resource rent method

Advantages of resource rent	***Limitations of resource rent***

Captures efficiency and profitability aspects.	*Sensitive to price volatility and cost accounting.*
Reflects economic rents as true asset returns.	*Difficult to operationalize annually for all forest types.*

The net income method (the NPV of expected resource rent)

The Net income method, also known as the Resource rent method, calculates the net present value of the potential income from the existing timber stock (European forest accounts handbook. 2024 edition. doi:10.2785/869482). The method models the present value of expected net revenues from timber over a given planning horizon, discounting future cash flows using a defined interest rate.

The general formula for calculating the NPV:

$$V_t = \sum_{\tau=1}^{N_t} \frac{RR_{t+\tau}}{(1+r_t)^{\tau}}$$

where V_t is the value of the asset of time t; N is the asset life: RR is the resource rent; and r is a nominal discount rate (for details see annex A5.1)

Source: System of Environmental Economic Accounting 2012— Central Framework.

The resource rent was estimated by the appropriation method (EFA guidebook, chapter 5.4.5) using data on the stumpage price.

In Estonia, the future income was calculated as the product of the total growing stock of stands within an age class and the average stumpage price of the respective tree species. Stumpage prices were determined for each tree species based on the distribution of the growing stock of mature stands into assortments. A specialized program was used for assorting. For the monetary valuation of opening stock, the stumpage price of December 2021 was applied, while for closing stock, the average stumpage price of 2022 was used.

Table 4 Advantages and disadvantages of the net income method

Advantages of the net income method	***Limitations of the net income method***
Forward-looking *Incorporates future revenues and costs.*	*Sensitive to assumptions* *Results vary with discount rate and market forecasts.*
Suitable for diverse forests *Accounts for age classes and species dynamics.*	*Data intensive* *Requires detailed projections on volumes, prices and costs.*
Aligns with asset valuation theory *Measures forest as a productive capital asset.*	

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The discount rate used was the discount rate for long-term non-interest-bearing liabilities set out in § 48(9) of the General State Accounting Rules (https://www.riigiteataja.ee/akt/13174576). The discount rate as of 31.12.2022 was 4.60%, the rate of return on equity calculated for RMK by the State Assets Department of the Ministry of Finance. To obtain the real value of the discount rate, the inflation rate for the forestry sector forecast by the Macroeconomic Policy Department of the Ministry of Finance is subtracted from it, which was 2.3% in the forest valuation carried out as of 31.12.2022. Therefore, a discount rate of 2.3% was used when calculating the monetary value of the timber stock.

Additional methods presented in EFA manual

The EFA manual describes some other methods that are used in individual countries but are not mentioned in, for example, SEEA frameworks.

Consumption value method

Assumes all timber is harvested at once, using stumpage prices differentiated by tree diameter or age. It better reflects harvestable volume value but assumes a non-realistic complete harvest.

Age constant method

Applies a uniform value per age class, smoothing valuation over time. Used in some Eastern European countries to simplify age-structured forests. Considered less representative of the economic reality, especially for varied forest age structures.

Timber asset and flows, links to the methods applied in national accounts

Timber flows in the System of National Accounts (SNA) are reflected through various transactions. SNA includes all activities that have been carried out in the economy, the most obvious flow that can be detected is the market of harvested timber. The EFA guidelines recommend calculating the value of wood in the rough based on physical quantities and roadside prices (i.e., the basic price of harvested timber), this was also done to compile EFA figures. Currently the value of **wood in the rough** as a separate good is not distinguished within the forestry activity output in the 2022 Estonian SNA. In the Estonian SNA, economic data from forestry enterprises are considered, but the linkage with physical quantities remains weak. Future integration workflows between the EFA and SNA are under development.

A similar situation applies to the **output of forest trees**. Although the SNA includes this in the total forestry output, it is not distinguished as a separate product in the 2022 values. Moreover, the methodology for calculating this item in SNA requires further development. We see that the EFA could serve as an important data source for this purpose in the future. For EFA, thecompilation instructions described in the EFA manual were followed and physical amount of net increment was multiplied with stumpage price.

Work in progress is regularly calculated by the SNA team, using physical volumes of increment and harvest broken down by wood species and harvest assortments. Mortality data is also incorporated to calculate the net increment value. All physical data are provided by the Estonian Environmental Agency, while prices are sourced from RMK. Since the value of work in progress is calculated by subtracting harvest from net increment, EFA monetary timber asset table can also be used as the basis for these calculations.

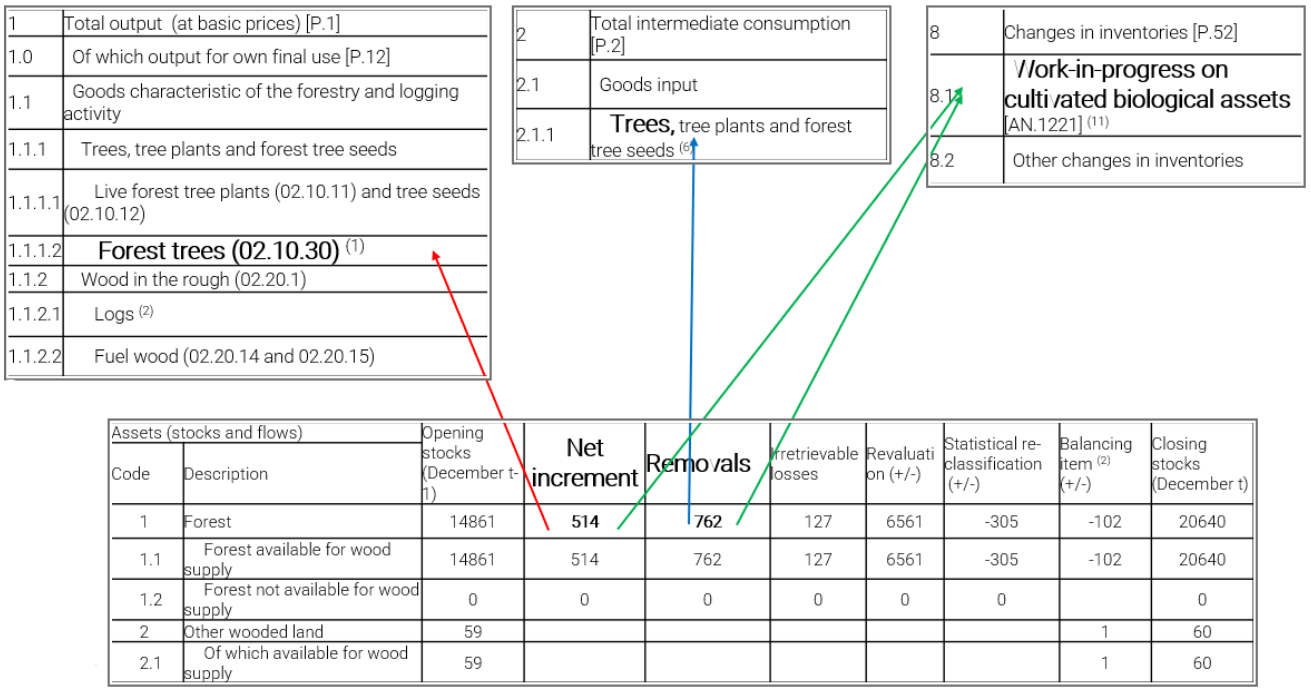
Results for various timber-related values can be found in Table 5. The values that are not visible in SNA were calculated based on the EFA guidelines. These values also depend on the calculation methodology of the stumpage price. The table presents separate values, as two different stumpage price calculation methods were tested in the project.

Table 5. Transactions with timber in SNA, million euro

Transaction	***Calculation formula***	***Value 2022 stumpage price I (based on RMK averages)***	***Value 2022 stumpage price II (based on NA model)***	***SNA***
Output of wood in the rough	*Harvested timber * roadside price*	*934*	*702*	*Included in P.1 (output) of forestry (NACE A.02)*
Output of forest trees	*Net increment of standing timber * stumpage price*	*514*	*491*	*Included in P.1 (output) of forestry (NACE A.02)*
Work in progress	*Net increment – harvest (calculated with stumpage price)*	*-248*	*-174*	*SNA 2008 – under inventories (AN1221)* *SNA 2025 – under biological resources (AN33)*

As EFA aims to provide connected information of timber and forestry related physical and monetary data it is important to ensure comparable bases to compile different EFA tables. Figure 1 shows connections between table A2b "Timber balance on wooded land, euros" (below on figure 1) and B1"Economic aggregates of forestry and logging" (upper three components on figure 1), it is seen that it's crucial to make transparent agreement regarding the method, assumptions and bases should be used to calculate stumpage price. Value of net increment in Table A2b is used as input for output of product "Forest trees" in Table B1. Value of harvest in Table A2b is input for values of intermediate consumption of "Trees" and work-in-progress on cultivated biological assets (that is calculated as net increment – removals).

Figure 1. Connections between Table A2b "Timber balance on wooded land" and Table B1 "Economic aggregates of forestry and logging"



General insights to the future application of OECD guide for measuring natural resources

To value timber resources OECD draft guide for measuring natural resources in the national accounts (OECD (2025), Draft Natural Resource Compilation Guide) recommends using observed market transactions, which gives many choices to choose from. The guideline describes stumpage price, the net income, the consumption value and the age constant methods, these are also aligned with EFA guidelines.

§ 411 says that the consumption value method is the only method that considers that timber would have higher value the bigger it grows and is conceptually preferred method. However, in the Estonian context, the application of this method is not feasible due to the absence of relevant data. The net income method can be considered as an improved stumpage price method that distinguishes between stocks of different age classes and values them with the stumpage price of mature timber. This method is feasible in Estonian case.

It is stated in the OECD guide (§ 413) that stumpage price method being the lowest demanding on data availability is recommended as default method, it is also most widely used among countries and gives therefore comparable results. While this method is applicable in the Estonian context, it tends to overestimate asset value. Other earlier mentioned methods depend on the availability of more complex data and are considered as more advanced methods.

SNA 2025 does not prescribe specific valuation methods to estimate the value of work-in-progress but overall valuation principles are (3.60): "Transactions are valued at the actual price agreed upon by the transactors. Exchange values, or the observed market prices, are thus the basic reference. In the absence of observed market prices (2025 SNA A4.3), it is recommended to apply prices for similar goods, services and assets, or market equivalent prices".

Another asset that SNA includes from forestry is the value of forest land that is not discussed in this paper.

Timber accounting in SEEA EA applications

SEEA EA was developed as a complementary framework to the SEEA CF but the two generally differ in how they connect the environment to the economy. The SEEA CF begins with the economy, focusing on how economic sectors use individual natural resources such as timber as inputs into production. SEEA EA views the environment "through the lens of ecosystems in which the various biophysical components (including individual resources) are seen to operate together as a functional unit; thus, ecosystem assets are environmental assets viewed from a systems perspective". This means that the same forest, described in the SEEA CF as a stock of timber, in the SEEA EA forest is seen as an ecological entity that yields timber to the economy (Edens et al., 2022).

Methods derived from SEEA EA national application and methodological and Eurostat's feasibility study on monetary valuation of ecosystem services" Methodological and feasibility study on monetary valuation" (Eurostat feasibility study) [10], have been analysed and applied in order to compare the main indicators to be derived from the SEEA EA and EFA (SEEA CF) frameworks.

Timber flow is a provisioning ecosystem service: forests transform nutrients, water, and solar energy into merchantable wood that enters the economy as roundwood and processed products. In SEEA-EA terms, its value is most appropriately reflected through exchange values observed in markets (harvested output at basic prices) and the resource rent attributable to the timber resource (the return to the natural asset after deducting production costs and normal returns to produced capital and labour).

Publishing both flow (annual) and asset (stock) indicators clarifies: the current contribution of forests to the economy, and the sustainability/wealth embodied in standing timber.

The observations indicate several standard valuation lenses used in forest accounts:

Stumpage price measures with numerical extracts 514 million euro (stumpage value of net increment), 762 million euro (stumpage value of removals) indicating, respectively, prices/valuations for increment and harvest volumes.

Output at basic prices (production) with cost structure to derive resource rent: the sheet lists components from SNA such as Output 1308 million euro; Intermediate consumption 928 million euro ; compensation of employees 131 million euro ; other taxes less subsidies 14 million euro ; depreciation 62 million euro ; return to capital ~1.6 million euro, yielding a residual resource rent 171 million euro. These are consistent with the resource rent method used in SEEA-EA. By considering the whole A02 division of the NACE, to whose main activity this ES contributes, we can isolate the resource rent embodied in this activity's output market value, i.e. the income transfers attributable to the property right on the ES. It amounts to 171 million in Estonia.

Annuity value: 86 million for Estonia— annualised value of the timber asset using the land value annuity method (EU feasibility approach). This converts a capital value into an equivalent annual flow given an assumed discount/annuity rate. Important: is to treat the annuity as an alternative flow measure, not additive to resource rent residual value (avoid double counting).

The table below outlines the range of the values and reference to the methods that were covered in the scope of the timber provisioning ecosystem service.

Table 6 The value of timber as an ecosystem service

Methods for provisioning services	***Reference***	***Comment***	***Value, million EUR, 2022***
Stumpage value	*SEEA EA chapter 10.56*	*SEEA EA refers back to SEEA CF "The SEEA Central Framework describes alternative approaches to the valuation of timber resources (paras. 5.383 and 5.384)"*	***514** (Stumpage value of net increment)*

[10] Methodological And Feasibility Study On Monetary Valuation, Revised annotated draft
Eurostat – Unit E2, Meeting of the Task force on ecosystem accounting 26-27 February 2025, Environment Meetings - Library

			762 *(Stumpage value of removals)*
Resource rent (residual value) *Forest activity*	***SEEA EA chapter*** *10.56* *Eurostat feasibility study, ch 4.3*	*Estonian case:* ***Output at basic prices 1308*** *Less intermediate consumption 928* *Less remuneration of employees 131* *Less other taxes less subsidies on production 14* ***Gross operating surplus 235*** *Less specific subsidies on extraction* *Plus specific taxes on extraction* *Less depreciation 62* *Less return to capital used in production 1,6* ***Resource rent*** *171*	***171***
Forest land annuity method	*Eurostat feasibility study, chapter 4.3*	*Wood provision value (euros)=Average value of forest land (FAWS) (euros)× discount rate (r)(2,3 %)Wood provision value euros=Average value of forest land FAWS euros× discount rate (%)*	*86*
Stumpage value method where FAWS consider increment and FNAWS consider removals	*Eurostat feasibility study, chapter 4.3*		*514*
Stumpage value method where: FAWS consider increment and (FNAWS and other land use tree cover) consider removals	*Eurostat guidance based on physical supply, coherent with old SNA approach*[11]		*565* *514 + 51 (0,8 million x stumpage price)*

Timber ecosystem service asset value

The existing timber stock represents the accumulated outcome of ecosystem services (ES), forming a reserve of ecosystem services available for use. Its market value can be interpreted as the portion of ecosystem services appropriated by forest owners through time—either naturally or through institutional arrangements that enabled forests to be used for wood supply—and which has not yet been harvested. In principle, this value reflects the amount owners could receive if they converted the timber into cash by harvesting it all in a single year. In this sense, the stock measures the wealth of forest owners. For Estonia, the closing timber stock in 2022 was estimated at 20,6 billion euros. Naturally, it would be unrealistic to assume that such a large-scale harvest could occur without significantly lowering market prices[12].

Regarding timber ecosystem service asset value, different outcomes may be obtained from the NPV calculation. In the table below, the first NPV estimates future income based on stumpage prices and disaggregates assets by tree species, assortments, and age classes. The second approach values the sustainable future harvest under the assumption that the current increment levels will be maintained (which may not be a case). The simplified NPV in the second approach (2), calculated on the basis of the stumpage value of the increment, thus incorporates an explicit sustainability assumption. This simplified look at timber asset (NPV method 2 in SEEA EA Estonian application) does not reflect timber assets life span. If tree species have indeed expected lifespan, then it can't be directly transferred to forest as such because forest is an ecosystem that renews itself. 100 years for example can be the average rotation period or felling age. Estonian forests are inventoried on the more detailed level, so more detailed information – years left until final felling (this is settled in the law) is a preferred approach to be used.

[11]Eurostat Handbook „ Ecosystem accounts“, draft of April 2025; Joint Meeting Of The Working Groups Environmental Accounts And Monetary Environmental Statistics And Accounts, Luxembourg, 15 May 2025

[12] Empirical insights into the multiple economic values of ecosystems: applications and reflections, UN London Group 2025

Table 7 Timber ecosystem service, asset value

Methods for assets valuation	*SEEA EA*	*Comment*	*Value, million eur*
NPV	*8.35-8.40; 10.44-10.54*	*Net income/Resource rent/Net present value (EFA)* *Net income method, discount rate was 2.3% in 2022*	***20 639***
Simplified NPV (based on stumpage value of increment), with sustainability assumption, current removals level correspond to sustainability threshold (2)	*Chapter 10.72*	*Based on increment value as a proxy for sustainable level removals. Asset lifetime =100; discount rate 2,3%*	*22 348*
Land value	*10.54; 11.3.3*	*Not related to timber, but forest assets*	*3 900*

A separate consideration is sustainable income. Although it was not really analyzed or included in the current assessment, it is expected to influence the results. Incorporating sustainable income would be an aspect to consider for improving the policy relevance of timber stock valuations from ecosystems and welfare perspectives. Asset life defines the period over which timber provides ecosystem service flows. While sustainability scenarios could imply infinite lifetimes, accounting practice limits them because very long horizons make NPV values negligible. In Estonia, lifetimes are set at a detailed, species-specific level, agreed upon by government and researchers, improving accuracy and reflecting real ecological conditions.

With respect to the land value of the asset "forest," it can be argued that the land itself ultimately provides the service, although the presence of trees is an essential precondition. If the land's asset value is considered in isolation, and wood provision is assumed to be its sole value component (a strong simplifying assumption), this value can be expressed as an equivalent income stream. This reflects the contribution to the owner's income from the right to use the ecosystem's capacity to produce wood, conceptually similar to land rent in crop production.[13]

For Estonia, the land beneath all forests available for wood supply (FAWS)—without the trees and other features and valued purely for its wood-producing potential at average land prices—was estimated at 3,900 million euros. Using a 2.3% discount rate, this corresponds to a current annual income stream of 86 million euros attributable to the ecosystem service as indicated above.

If SEEA CF classifies forest land into cultivated and non-cultivated categories, the SEEA EA recognises this distinction but emphasises that ecosystem services are also generated in areas not intended for human consumption.

In practical terms, this implies that when the NPV method is applied to calculate asset or service values, the choice of discount rates may vary accordingly. For instance, timber flows from protected areas may be valued using lower discount rates, as they are regarded as public goods.

Timbers other functions like binding of the carbon may also provide bases for the valuation. In addition it is worthy of mentioning that the contribution of timber to carbon sequestration can provide an additional rationale for valuation. The same timber contributes to carbon sequestration, as forests act as significant carbon sinks by storing CO_2 in biomass and soil. This climate regulation service can be monetized through carbon markets or by applying the social cost of carbon, providing an additional environmental and societal value beyond direct economic returns from timber extraction.

There seems to be no extra valuation possibilities in SEEA EA for timber ecosystem service compared to the methods derived from NA. However, the coverage and assumption may differ which may have the results on outcomes.

[13] Empirical insights into the multiple economic values of ecosystems: applications and reflections, UN London Group 2025

Discussion on relevant aspects of timber valuation

The valuation of forest timber assets and flows constitutes an integral component of sustainable forest management, ecosystem accounting, and national accounts. Various methodologies have been proposed for this purpose, including the stumpage price method, net present value (NPV), resource rent (RR) and national country-specific approaches. Each method exhibits distinct conceptual foundations, data requirements, and suitability depending on whether the primary objective is taxation, national accounting, investment analysis, or environmental sustainability.

In this work these approaches were analyses with particular attention to their application in Estonia, using the European Forest Accounts (EFA) as a contextual and methodological starting point.

Different methods and the way these are applied produce different values the comparability in space and time is important. Estimates for timber stock and flows values varied depending on:

1. Inclusion of the forest categories in different aggregates (FNAWS in different conecpts)
2. Timber assortment prices
3. Inclusion of deadwood? Specific question: of the types of the deadwood and pricing
4. Different data on management costs
5. High inter-annual variation in stumpage prices
6. Different discount rates
7. Non wood value of the timber (carbon binding) provides additional alternative for valuation
8. Whether the value is reflected in market price or sustainable income. In interpreting these values, it is important to distinguish between two perspectives. One is the market price view, where the timber stock is treated as if it could be fully harvested and sold immediately, giving a snapshot of the owners' total potential wealth. The other is the sustainable income view, which instead reflects the ongoing annual benefits that can be derived from the forest under conditions of sustainable use. The first shows the magnitude of accumulated capital, while the second highlights the steady flow of income that ecosystems can provide over time.

As both asset life and discount rate influence resulting NPV value[14] this has been handled in more detail in below subchapters.

Asset life implications

In the NPV method, asset life (or period length) represents the expected period over which an ecosystem asset can provide ecosystem service (ES) flows. While in sustainability scenarios ecosystem service use could, in theory, mean an infinite asset life. Accounting practice typically limits it because NPV values become negligible over long periods. In the NPV method which has been used for Estonia's current study asset lifetimes have been determined on a very detailed level and have been generally agreed by government and researchers.

Determining asset life specifically for different timber species, rather than using a generic figure, improves valuation accuracy and aligns with ecosystems conditions and expected use patterns.

[14] UNEP et al., 2017: United Nations Environment Programme, United Nations Statistics Division, Convention on Biological Diversity, 2017. SEEA Experimental Ecosystem Accounting: Technical Recommendations. Consultation Draft - V4.1: 6 March 2017. Project on Advancing Natural Capital Accounting Funded by NORAD.)

Discount rates implications

The discount rate selection is important as it converts future timber flows into present values.

Fundamentally there are private and social discount rates. The former is used by private companies to calculate the cost of capital. The latter are used for projects and policies that impact society at large that reflect society's time preference for deriving benefits.[15]

Lower discount rates:

- Reflects a low time preference, suitable for intergenerational equity and ecosystem integrity (climate-oriented or sustainability-focused approaches)
- Increase the present value of long-term flows
- Appropriate for public goods or state-owned resources where private market dynamics are less relevant
- May overstate asset values in market-oriented contexts

High discount rates:

- Reflects a market-oriented rate, with higher opportunity cost of capital, suitable for private-sector decision-making
- Prioritize short-term economic returns
- Reflect market-based opportunity cost of capital
- May underestimate the value of slow-yielding or regenerative resources like timber or biodiversity

Currently in Estonia three options for discount rates are relevant. In EFA calculations 2,3% was applied as national discount rate for year 2022 data. OECD manual suggested 2% and SEEA EA manual suggest 2% (for example Appendix A10.1, Application of the NPV method for valuing ecosystem assets and changes in ecosystem assets) and 5% (chapter 12.2 Building connections with welfare values).

The application of the NPV method for the valuation of timber assets necessitates careful consideration of the discount rate, which may vary according to context. For instance, timber yields from protected areas may be assigned lower discount rates, reflecting their status as public goods. In another hand SEEA EA manual indicates that just ecosystem services may have different discount rates. Timber is indeed ecosystem service that has market price and is traded actively. We suggest that timber asset value from protected areas/ land not available for wood supply can be calculated with different discount rate as it carries social benefit in it. Timber cannot be harvested protected areas and standing timber creates other ecosystem services there – ie wellbeing for humans, habitats for other species. This can be used as a proxy to calculate monetary value from forest ecosystems from protected areas because so far it is seen that regulating and cultural services have rather limited options to calculate monetary value and quite often left out for their complexity.

Table 8. Sensitivity analysis of discount rates when calculating the NPV (in million euros) of timber stock.

Discount rate, %	***NPV of the timber stock***
1	*25 052*
2	*21 481*
3	*18 978*
4	*17 163*
5	*15 808*

[15] Karp, L., Traeger, C. (2023). Discounting. Encyclopedia of Energy, Natural Resource, and Environmental Economics, https://doi.org/10.1016/B978-0-12-375067-9.00150-9.

Summary

The analysis revealed variations in timber stock value estimates, highlighting the sensitivity of different valuation methods to underlying assumptions and data inputs. Key factors driving these differences included the choice of timber assortment prices. Variability in available data on management costs further contributed to discrepancies across methods. Inter-annual fluctuations in stumpage prices also influenced all valuation approaches.

The choice of discount rate was another important factor, affecting the present value of timber stocks and potentially contributing to differences between results.

For Estonia in 2022 two discount rates were used. But it was suggested that rates may also differ by context—for example, timber in protected areas may warrant lower discount rates to reflect their public-good nature.

Each framework provides the opportunity to evaluate wood assets and flows on the basis of a spectrum of valuation methodologies. The breadth of this choice implies that, where different options are selected from among the available methodologies, the resulting estimates may not be directly comparable, even though the applied methods are not mutually inconsistent.

Consequently, the harmonization of approaches, the determination of methodological preferences, as well as the assurance of internal consistency and transparency, remain matters to be addressed within each individual country.

So, as the international standards allow remarkable volatility of the methods in each standard, the study highlighted the necessity of stronger collaboration between the compilers of timber related data based on European Forest Accounts (EFA), ecosystem accounts (SEEA EA; Eurostat feasibility study) and System of National Accounts (SNA) on country level.

Formalizing joint workflows and data exchange processes would improve coherence, comparability, and transparency. Lessons learned also emphasized that consistent terminology and definitions are critical to ensure for reliable communication of results.

Overall, the analysis demonstrates that methodological choices, data quality, and collaboration are key to producing robust timber stock assessments, with sustainable income remaining a crucial area for further development.