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Maintenance of the "Forest Expert" model, update on data availability and parameters. Soft-linkage with the System Dynamics and TIMES models.

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Developed
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CONTENT

1. INTRODUCTION AND THE CONTEXT

1.1. Paradigm of the European Union Green Course, their impact on forest management conditions

At the end of 2019, the Green Course launched by the European Commission sets out new paradigms for the development of the European Union. The European Commission's President Ursula von der Lyon called this economy as European social market economy.[1]

The planned cardinal changes are witnessed by the idea of concluding a pact that will bring citizens together in all their diversity with national, regional and local authorities, civil society and the industrial sectors, which will work closely with the EU institutions and consultative bodies. The European Green Course actually means a review of public habits and economic freedoms, based on the need to address environmental problems. These challenges are planned to channel huge financial resources (an additional investment of 260 billion Eur is needed, representing around 1.5% of 2018 GDP) and to transform the current financial system.

The document states that the main objective of achieving the objectives is to assess the protection and recovery of natural ecosystems, the sustainable use of resources and the strengthening of human health. This can be achieved by transforming the principles of the functioning of the current financial market. The private sector will play a key role in financing the green reshuffle. In addition, the European Commission will review the Financial Disclosure Directive in order to ensure adequate management of environmental risks and their mitigation capabilities and to reduce related transaction costs. The Commission will also support the efforts of companies and other stakeholders to develop standardised natural capital accounting practices at EU and international level. This is done to make it possible for third parties to take over the rights of easements on property assets. “Tax greening” is also expected. In order to avoid the risk of “greening”, standards will be introduced that will become mandatory for all market participants (e.g. FSC Forest Certification System), as well as a mandatory audit system. Building on the 2030 Biodiversity Strategy, the Commission will develop a new EU Forest strategy that will cover the full forest cycle and promote the many services provided by forests.

The European Commission's Sustainable Growth Financing Plan foresees a transformation of the European financial system, overstating the emphasis of funding from maximising financial value to an integrated value approach, where business financing depends not only on the possibilities of increasing financial value but also on assessing social and environmental impacts (D.Scoenmaker, W.Schramde)[i] (see table below. 1.1.)

1.1. table

Sustainable Financial Framework (SF)

SF Type	Value created	Factor ranking	Optimization	Time limit
Funding as usual (Finance as usual)	Value of shares	F	Max F	short term

[1]https://ec.europa.eu/commission/sites/beta-political/files/political-guidelines-next-commission_en.pdf

SF 1.0	Value of shares specified	F > > S and E	Max F taking into account S and E	short term
SF 2.0	Value of shares according to "triple bottom line" TBL *	I = F + S + E	Optimize I	Medium term
SF 3.0	Value of total benefits	S and E > F	Optimize S and E subject to F	Long term

F = financial value; S = social impact; E = environmental impact; I = integrated value, SF 1.0. Maximize F by exposing small S and E limits.

** TBL - Triple bottom line (or otherwise specified as TBL or 3BL) is an accounting system with three parts: social, environmental (or ecological) and financial. Some organizations have adopted A TBL system to assess their performance in a broader perspective to create more business value.*[2]

The traditional banking business is the provision of long-term loans financed by short-term deposits. Banks have developed borrower-checking and surveillance technologies to reduce asymmetric information between the lender and borrower.

This supervisory function allows banks to assess social and environmental risks as part of the credit risk management process. Banks can also analyze industry-wide sustainability trends and discover best practices.

Two key approaches to integrating sustainability into lending are identified: risk-based and value-based. The risk-based approach examines whether environmental, social and management (ESG) factors affect credit risk in a way that is not included in the current credit risk assessment and verification methodology. Using a value-based approach, stakeholders, such as depositors or investors for clients, can take care of ESG factors for non-monetary reasons.

The EU is creating a Green Classification, a taxonomy aimed at helping investors and companies to use more information when taking decisions in environmentally friendly activities. The EU Green Classification focuses on the growth of financial markets by refocusing capital flows on assets that would contribute to sustainable development and allow market participants to invest in sustainability with greater confidence and easier. Together with Estonia and Lithuania, Latvia needs to develop a common capital market in order to be strong and to function more successfully. The financial sector needs to move in and into new businesses and innovation, which is in some ways a competition mandate.

The European Union Taxonomy Regulation (TR)[3] will govern the principles of sustainable resource management and will be supplemented by delegated acts containing detailed technical test criteria to determine when economic activity can be considered sustainable and to meet the requirements of the Taxonomy Regulation. The European Commission set up a Sustainable Financial Technical Expert Group, which was tasked with drawing up recommendations in a number of thematic directions, including the technical screening criteria for taxonomy for climate change mitigation objectives and adaptation.

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https://en.wikipedia.org/wiki/Triple_bottom_line[2]
[3]https://eur-lex.europa.eu/legal-content/LV/TXT/HTML/? uri = CELEX: 32019R2100 & from = EN

Delegated acts containing technical screening criteria will be developed in two phases: The first technical test - Criteria for actions that contribute significantly to climate change mitigation or adaptation will be adopted by the end of 2020 and will enter into force by the end of 2021. The second set of technical screening criteria for economic performance, which contributes significantly to the other four environmental targets, will be adopted by the end of 2021 and take effect by the end of 2022.

By 1 June 2021, the European Commission will adopt a delegated act specifying how corporate disclosure obligations should be applied in practice. The delegated act will take into account the differences between non-financial and financial companies.

Further development of the taxonomy will be managed by the European Commission through the establishment of a Sustainable Financial Platform. In addition, a group of experts from the Member States will participate in the advisory capacity.

The Green Taxonomy Regulation sets out six environmental objectives:

(1) climate - mitigation,
(2) adaptation to climate change,
(3) water and sustainable exploitation and protection of marine resources,
(4) transition to a circular economy,
(5) prevention and control of pollution,
(6) protection and restoration of biodiversity and ecosystems.

The achievement of environmental objectives must not focus on anyone specific, ignoring others.

The European Green Course also sets new conditions for the protection of biodiversity, reflected in the 2030 Biodiversity Strategy[4]. The main objective of the strategy is to restore all global ecosystems by 2050, providing flexible and adequate protection. The world must commit itself to the principle of net benefit: “give nature back more than it received”. The world should commit to stopping the extinction of the species and minimizing its impact. In order to move biodiversity towards recovery by 2030, natural protection and renewal should be stepped up. This should be done by improving and expanding protected areas and by developing an ambitious ***EU natural recovery plan:***

- Develop a coherent trans-European natural network in Europe. Establishment of ecological corridors at European level.
- The extension of protected areas is an economic obligation. Studies on the assessment of marine systems that each euro invested in protected marine areas would return at least €3. The benefits of Natura sites are estimated at 200-300 billion eur per year.
- Not less than 30% of land and 30% of the sea must be protected!
- Not less than 10% of land and 10% of the sea area must be strictly protected! The EU will develop criteria for eligibility for protected areas.
- In particular, the protection of old forests in Europe needs to be strengthened. The reduction in resource extraction should not be offset by resources from other regions.
- Forestry affects soils. Soil conservation is one of the challenges.

[4]https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12096-EU-2030-Biodiversity-Strategy

- In addition to the strict protection of all remaining EU primary and forest forests, the EU needs to increase the quantity, quality and resilience of forests, particularly against fires, drought, pests, diseases and other hazards, which are likely to increase with climate change. Keeping their functions in both biodiversity and climate must keep all forests in good health. More resilient forests can support a more resilient economy. Forest plays an important role in providing materials, products and services. Forestry plays a key role in the bioeconomy.
- The European forestry strategy 2021 should include broader biodiversity protection and climate change mitigation ambitions.
- An additional 3 billion trees should be planted in Europe by 2030.
- Forest management should be based on forest management plans. Plans should be mandatory for public forest management, their share should be increased in the private sector. The EU will develop guidelines for forest management close to nature.
- Developing a common European forest information system to provide a better picture of the overall health status of Europe's forests.
- Review the EU Renewable Energy Directive to ensure the preservation of biodiversity.
- Establishing new sustainability criteria for the production of forest biomass for energy production 2021.
- Create a new framework for European Biodiversity Management.
- Establish, within the framework of the EU Taxonomy, a framework for demonstrating the effects of biodiversity by establishing criteria.
- In order to meet the needs of this strategy, including Natura 2000 and green investment priorities for infrastructure, at least EUR 20 billion per year should be earmarked for natural expenditure. This will have to attract private and public funding at national and EU level, through different programmes in the next EU long-term budget. Moreover, as a natural recovery will make a major contribution to climate objectives, it is an important part of the EU budget of 25%.
- According to Invest, the EU will be a dedicated Natural Capital and Circular Economy Initiative to mobilise at least €10 billion over the next 10 years, based on public/private mixed funding. Nature and biodiversity are also a priority of the European Green Deal Investment Plan. In order to help free up the necessary investments, the EU must ensure that long-term investments are sound and help to integrate the sustainability of the financial system. A sustainable financial taxonomy in the EU will help drive investment towards an environmentally friendly recovery and development in nature-friendly solutions. The provisions of the Taxonomy Regulation will be introduced in 2021, which will establish a uniform classification of economic activities for sustainable action in the protection and recovery of biodiversity and ecosystems. The principles will be included in the Sustainable Finance Strategy, which has been commissioned for review this year.
- The EU Commission will continue to advance the establishment of a tax system and an evaluation system that will include environmental costs and compensation for loss of diversity. This will affect national fiscal systems, shift costs to “user and polluter pays”.
- The value of nature will be evaluated. Methods, criteria and standards to assess biodiversity, value of services and sustainability will be adopted in 2021

The European Green deal will introduce significant changes to Latvia's forest resources management system. In order to model potential impacts and develop an integrated approach to the strategic planning processes for forest resources, the “Meža eksperts” data processing software is developing a more advanced model of decision-making support processes.

2. “FOREST EXPERT”MODEL

2.1. Development of the process the data processing software

In order to assess the expected results of the European Green Course, the National Development Plan NAP2027[5] and the Latvia 2030 Strategy[6] and to prepare proposals to improve the efficiency of forest management, the following job challenges were identified:

1. To corroborate the methodology for evaluating forest biological assets and natural capital and to assess the value of Latvian forest biological assets in monetary terms,
2. The inclusion of the 6 objectives of the Green Taxonomy Regulation in the models of the “Meža eksperts” data processing software. Establish a Product Environmental Footprint (PEF) Assessment algorithm according to EU climate transition benchmarks (climate - mitigation and adaptation to climate change).
3. Create a system of criteria and indicators, as well as algorithms for modelling forest resource dynamics according to 3 scenarios:
    a. Current regulatory framework and forest management approach
    b. The most economically viable forest management model
    c. Forest management model identified by the European Green Course
4. Prepare proposals to improve the efficiency of forest management and to improve the regulatory environment.

2.2. Methodology

Project Methodology:

1. Develop a decision-making support system by a “Meža eksperts”, including equation parameters and algorithms based on the latest scientific knowledge
2. Requesting, processing and preparing the data of the State Forest Register for the performance of calculations (State forests, other forests, total)
3. Harmonising the basic values of the economic indicators for forest management (discount rate, wood price indexing, harmonising alternative modeling scenarios, 6 environmental targets, etc.)
4. Dynamics of changes in the state of forest resources and its impact on the capital value of forests
5. Impact of aid measures included in changes to regulatory enactments on forest capital value
6. Assessing options for improving the efficiency of forest management and discussing proposals.

The overall decision support system is shown in Figure 1.2.1.

[5] https://www.pkc.gov.lv/lv/attistibas-planosana-latvia/nationalised-attistiba-plans/nap2027
[6] https://www.pkc.gov.lv/lv/valsts-attistiba-planosana/latvia-longspeigas-attistiba-strategia

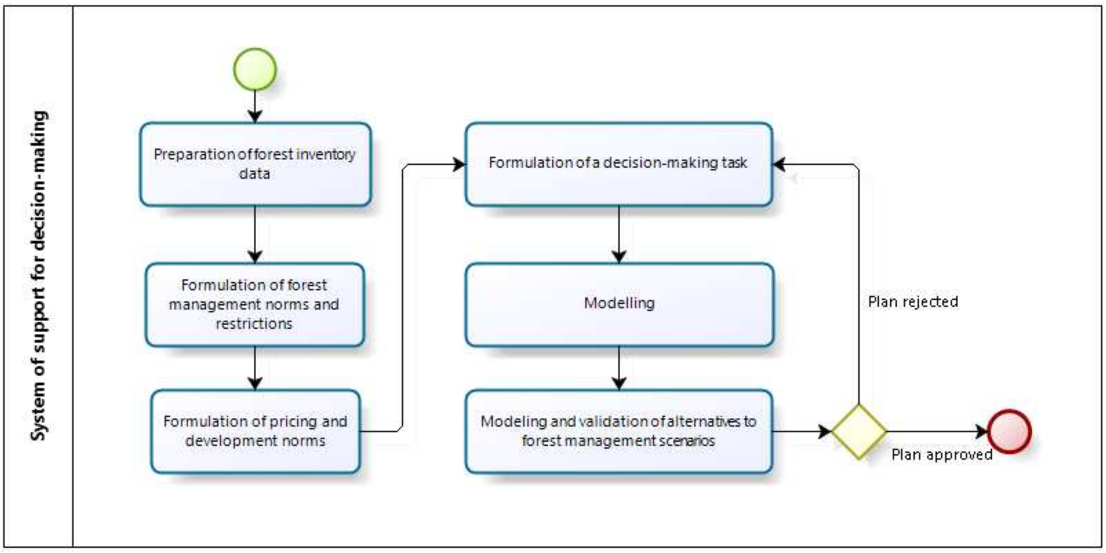


Figure 1.2.1. System of support for decision-making

A linear optimization algorithm has been created to complete the Integrated Forest Management Planning tasks. The aim is to optimise annual felling volumes in the long term in line with the target indicators. The optimal annual felling volume results in enforceable economic orders, major felling and forest renewal, as well as the amount of harvesting felling. In order to find the optimal management scenario, the optimization task needs to process different alternative scenarios for economic activity for each unit of land. In each scenario, one or more conditions of economic activity are changed, such as the felling of the main felling time... The second variable parameter is the intensity and execution time of the stock hoarding felling. The third variable parameter may be the choice of a renewable species. In accordance with the principles of the EU Green Taxonomy, limiting and variable values are not only covered by the conditions for maximising profit and capital value, conditions for harvesting round timber, but also the conditions for storage and reduction of CO2, the impact of economic activity on employment and the characteristics of protecting biodiversity. Optimization scenarios are identified according to the objectives set (see Table 1.2.1).

Table 1.2.1

Optimization Scenarios

Scenario	Variable	Variable Value
1	Year of execution of main felling	G.C.V. + - 20 years
2	Not to carry out an economic activity	First period (5 years)
3	Stock felling effort	- 10%
4	Year of collection felling	+ -5 years
5	Selection of renewable species by AAT	Species by AAT
6	Alternative choice of renewable species	Alternative species

These scenarios may also include a combination, such as a stock felling effort of +10% and a year of execution of +5 years.

Tackling the global optimization task

The objective of the global optimization task in forest management planning is to maximise the net present value. The mathematical recording of the task is shown in formula 1.1.

$$\sum_{n=0}^{N}\sum_{p=0}^{P}\sum_{c=0}^{C} x_{n,p,c} \times TTV_{n,p,c} \rightarrow \max \qquad (1.1.)$$

where,

x - auxiliary variable (switch)
n - index of sections
N-Number of sections
p-period index
P - number of periods
c- scenario index
C-Number of scenarios
s - species index
k - stock to be cut
kGC - the main stock to be harvested
kKKC- stock to be cut in care felling
o- assortment index
TTV - net present value

The following variables are used to create a global optimization task:

The section index (n) describes a particular section, such as index 1 corresponds to the first section from the set included in the optimization task. The number of areas included is directly linked to the speed of the optimization task.

Scenario index (c). The scenario describes what actions will be carried out with the section throughout the programming period and depends on the values of all other compartment characteristics.

Number of scenarios (C). Looking at global optimization options, a number of scenarios were examined, allowing you to create an optimization task with a larger number of combinations and solutions. The scenarios described are shown in Table 1. For each scenario, a set of values was prepared for all scheduling periods, indicating the size of its nature for each period according to this option. Scenario index (c) indicates which of the variants of the previous set of scenarios to use in the case.

The period index (p) indicates which scheduling period value is being viewed. The length of one programming period depends on the assumptions made at the time of the task: the period may be 5 years, 10 years or any other value. It is important to choose the length of the period that is significant in the overall cycle of forest management, for example, if the breakdown in periods is carried out at 1 step of year, resulting in a very large total number of periods and relatively small value changes between them.

The number of periods (P) indicates the total number of periods that are included in the optimization task.

The amount of stock to be removed in the (k) description. For the purpose, the variable k is used with indexes n, p and c ($k_{n,p,c}$)indicating that it is the amount of stock to be removed corresponding to the amount of the stock of a particular section scenario during the given scheduling period.

The net present value (TTV) describes the value of the forest property. It may be used for the determination of the market value of the property, for the determination and analysis of economic activity and potential financial flows.

Stock to be felled (kGC).

Stock to be felled (kKKC).

Species index (s).

Number (S) of species.

Assortment index (o).

2.3. Limits

The global optimization of forest management planning has four types of limitations: limits on value type, intermediate periods, threshold values, and scenarios. A first-type restriction imposed by forest management practices (the section may be cut or uncut) indicates that the variable x, which can be interpreted as the intensity of the action to be carried out, has only two possible values of 0 or 1.

The second type limits indicate the permissible value changes between scheduling periods. The use of these limits makes it possible to influence overall fluctuations in results. Intermediate period limits may be drawn up in such a way as to describe changes in permissible values between two specific periods or to form a sub-commitment system between all periods.

The third-type limits allow threshold values to be determined, for example, by indicating that the stock of an assortment of species must not be more than or less than a certain value.

The fourth type limits require that only one scenario may be executed for one section throughout the programming cycle. If no such limit is defined, the task solution is likely to include the felling of a section during the first decade, after the first scenario and the second decade following the second scenario, which cannot be realised.

Intermediate period limits

The limit on the total stock for the first and final periods is defined in formulae 1.2 and 1.3.

$$\sum_{n=0}^{N}\sum_{c=0}^{C} x_{n,p=1,c} \times k_{n,p=1,c} \leq z \times \sum_{n=0}^{N}\sum_{c=0}^{C} x_{n,p=P,c} \times k_{n,p=P,c} \quad (1.2.)$$

$$\sum_{n=0}^{N}\sum_{c=0}^{C} x_{n,p=1,c} \times k_{n,p=1,c} \geq m \times \sum_{n=0}^{N}\sum_{c=0}^{C} x_{n,p=P,c} \times k_{n,p=P,c} \quad (1.3.)$$

The coefficients z and m shall indicate the total permissible change between the first and last periods. These factors allow you to indicate both the ratio of change and the direction of change (Table 1.2.2).

Table 1.2.2

Examples and meaning of factor *z* and *m* values

Factor *m* value	Factor *z* value	Meaning
1	1	Stock to be removed in the first period must be equal to the stock to be grubbed up in the last period
0,8	1,2	In the first period, the stock must not be more than 20% higher than the last period. The stock to be grubbed up during the first period must not be less than 80% of the stock of the last period.
1	1	CO2 capture must be the same in the first and next period
0.13	0.3	Characteristics of nature protected areas should be increased

The graphical representation of the coefficients z and m is given in Figure 1.2.2

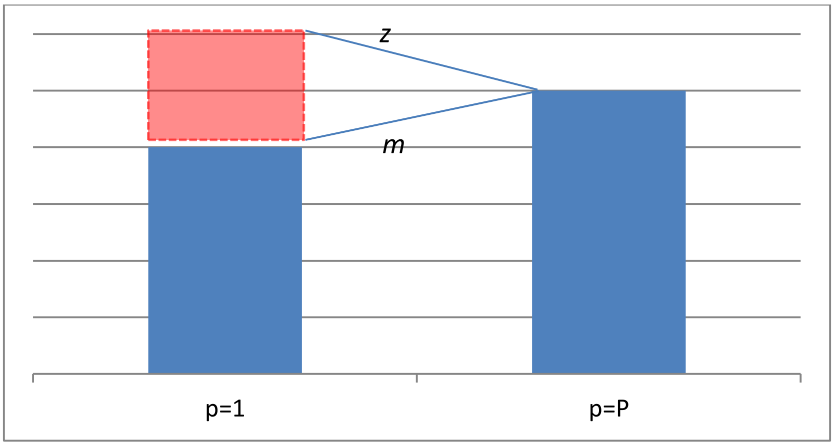


Figure 1.2.2 Relationship *between* rates z and *m*.

Including such a limit in the optimization task impacts the maximum amount of stock to be removed. Similarly, it is possible to extend such a limit not only to the total stock, but to the stock of the main felling, felling, a particular species or an assortment of species (Table 1.2.3).

Table 1.2.3

Stock limits between scheduling periods

Description	Limit
Equalising the total stock between the first and last periods	$\sum_{n=0}^{N}\sum_{c=0}^{C} x_{n,p=1,c} \times k_{n,p=1,c} \leq z \times \sum_{n=0}^{N}\sum_{c=0}^{C} x_{n,p=P,c} \times k_{n,p=P,c}$ $\sum_{n=0}^{N}\sum_{c=0}^{C} x_{n,p=1,c} \times k_{n,p=1,c} \geq m \times \sum_{n=0}^{N}\sum_{c=0}^{C} x_{n,p=P,c} \times k_{n,p=P,c}$
Equalisation of the main felling stock between the first and last periods	$\sum_{n=0}^{N}\sum_{c=0}^{C} x_{n,p=1,c} \times kGC_{n,p=1,c} \leq z \times \sum_{n=0}^{N}\sum_{c=0}^{C} x_{n,p=P,c} \times kGC_{n,p=P,c}$ $\sum_{n=0}^{N}\sum_{c=0}^{C} x_{n,p=1,c} \times kGC_{n,p=1,c} \geq m \times \sum_{n=0}^{NP}\sum_{c=0}^{C} x_{n,p=P,c} \times kGC_{n,p=P,c}$
Trimming of the harvest stock between the first and last periods	$\sum_{n=0}^{N}\sum_{c=0}^{C} x_{n,p=1,c} \times kKKC_{n,p=1,c} \leq z \times \sum_{n=0}^{N}\sum_{c=0}^{C} x_{n,p=P,c} \times kKKC_{n,p=P,c}$ $\sum_{n=0}^{N}\sum_{c=0}^{C} x_{n,p=1,c} \times kKKC_{n,p=1,c} \geq m \times \sum_{n=0}^{N}\sum_{c=0}^{C} x_{n,p=P,c} \times kKKC_{n,p=P,c}$

Description	Limit
Limit of stock to be removed for a specific species	$\sum_{n=0}^{N}\sum_{c=0}^{C} x_{n,p=1,c} \times k_{n,p=1,c,s} \leq z \times \sum_{n=0}^{N}\sum_{c=0}^{C} x_{n,p=P,c} \times k_{n,p=P,c,s}$ $\sum_{n=0}^{N}\sum_{c=0}^{C} x_{n,p=1,c} \times k_{n,p=1,c,s} \geq m \times \sum_{n=0}^{N}\sum_{c=0}^{C} x_{n,p=P,c} \times k_{n,p=P,c,s}$
Limitation of stock to be removed for an assortment of specific species	$\sum_{n=0}^{N}\sum_{c=0}^{C} x_{n,p=1,c} \times k_{n,p=1,c,s} \leq z \times \sum_{n=0}^{N}\sum_{c=0}^{C} x_{n,p=P,c} \times k_{n,p=P,c,s}$ $\sum_{n=0}^{N}\sum_{c=0}^{C} x_{n,p=1,c} \times k_{n,p=1,c,s,o} \geq m \times \sum_{n=0}^{N}\sum_{c=0}^{C} x_{n,p=P,c} \times k_{n,p=P,c,s,o}$

The change limit system for the stock to be removed can be described in the same way as the change between the first and last periods. The main difference is that such limits should be defined for all periods (*P*). As in the case of the first and last periods, these limits also include coefficients *z* and *m* indicating the direction of the change in values and the relation to the previous period (formulae 1.4, 1.5).

$$\sum_{n=0}^{N}\sum_{c=0}^{C} x_{n,p=i,c} \times k_{n,p=i,c} \leq z \times \sum_{n=0}^{N}\sum_{c=0}^{C} x_{n,p=i+1,c} \times k_{n,p=i+1,c} \quad (1.4.)$$

$$\sum_{n=0}^{N}\sum_{c=0}^{C} x_{n,p=i,c} \times k_{n,p=i,c} \geq m \times \sum_{n=0}^{N}\sum_{c=0}^{C} x_{n,p=i+1,c} \times k_{n,p=i+1,c} \quad (1.5.)$$

Threshold Value Limits

Threshold values limits (Table 1.2.4) are used to indicate the maximum or minimum value of the stock to be felled.

Table 1.2.4

Stock limits with limit value

Description	Limit
Limits the total stock of the species to be felled.	$\sum_{p=0}^{P}\sum_{c=0}^{C}\sum_{n=0}^{N} x_{n,p,c} \times k_{n,p,c,\boldsymbol{s}} \leq v$
Limits the total stock of the species to be felled	$\sum_{p=0}^{P}\sum_{c=0}^{C}\sum_{n=0}^{N} x_{n,p,c,\boldsymbol{s,o}} \times k_{n,p,c,\boldsymbol{s,o}} \leq v$
Limits the total stock of species to be felled for a specified period (s)	$\sum_{c=0}^{C}\sum_{n=0}^{N} x_{n,\boldsymbol{p=i},c} \times k_{n,\boldsymbol{p=i},c} \leq v$
Limits the total stock of species to be felled for a specified period (s)	$\sum_{c=0}^{C}\sum_{n=0}^{N} x_{n,\boldsymbol{p=i},c,s,o} \times k_{n,\boldsymbol{p=i},c,s,o} \leq v$

In the same way as the table 1.2.4 describes the limits on the threshold values of the total stock, it is possible to indicate them separately for both grooming felling and major felling.

Scenario limits

The scenario limits are described in formula 1.6.

$$\sum_{p=0}^{P}\sum_{c=0}^{C}\sum_{n=0}^{N} x_{n=i,p,c} = P \ (1.6.)$$

Defining the limits on the global peak task for linear optimization is a complex task, since one section can only execute one scenario and this scenario should be executed throughout all forecasting periods.

Double linear optimization is used to calculate (optimize) the maximum felling volume for all periods in the first step, avoiding major fluctuations in felling volumes between periods (Figure 1.2.3).

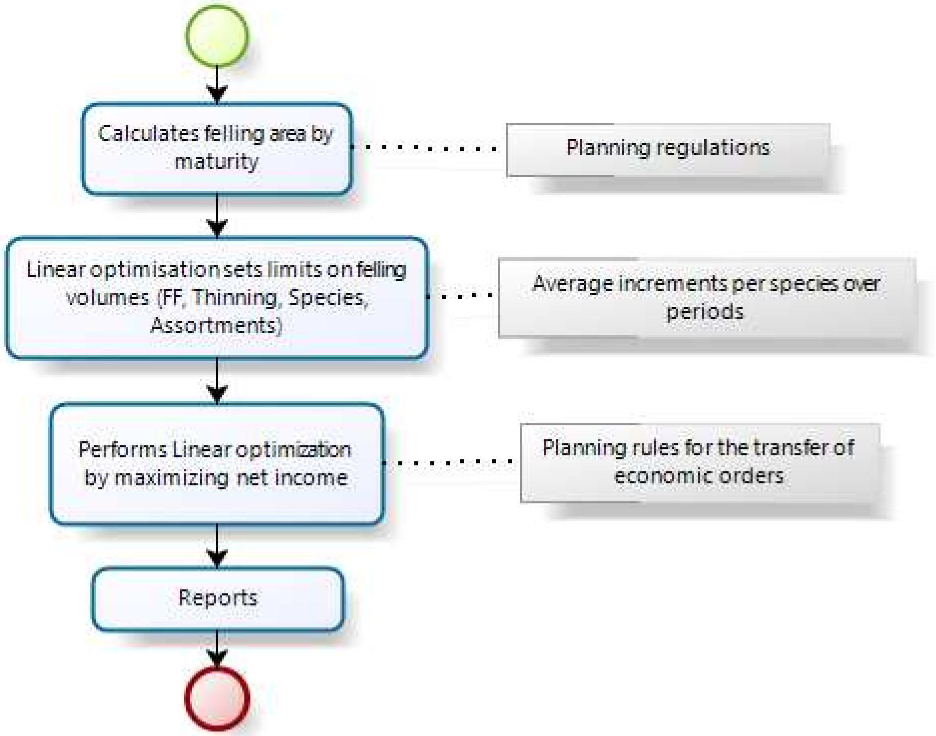


Figure 1.2.3 Generalized local optimization process

At the next stage (Figure 1.2.4), optimization is performed by selecting the sections to meet the previously installed conditions more effectively.

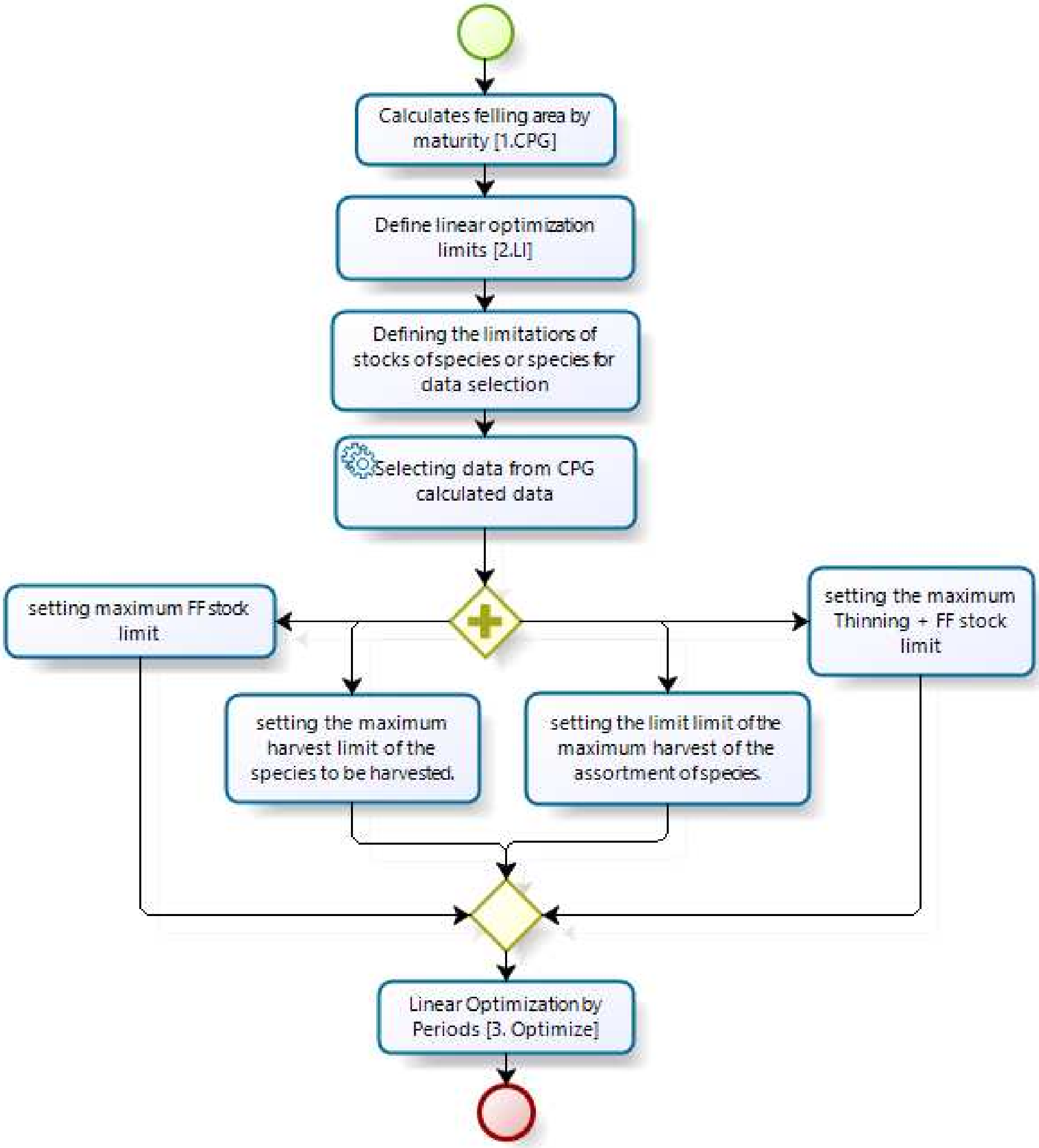


Figure 1.2.4 Local optimization process

The local optimization process shown in Figure 1.2.4 consists of 2 steps that address individual linear optimization tasks:

- between the planning periods with a linear optimization task, the maximum felling rate is determined;
- in each programming period, linear optimization is performed by maximising **MAX_Koef based** on the limits assigned.

Linear optimization peak factor

<u>If the order is to carry out the main felling, then:</u>

Sr_koef = Max (A/GCV, D/GCD);

Re_koef = Max (rente_uz_ha period)/annuity;

If the order is to carry out the felling of the stock, then:

Sr_koef = G/G_PAL

Re_koef = 1;

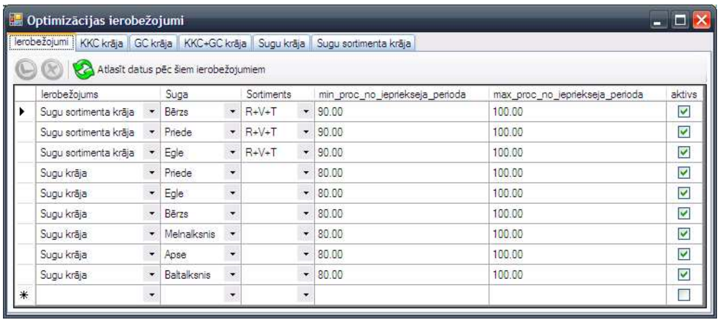
Max_koef = SR_Koef * (1 - **k**) + RE_Koef * **k**;

where **k** is a user-defined constant in interval **0. 1 [Normative - > Planning Parameters - > No 11].**

If **k = 0**, only **SR_Koef** is taken into account, but if **k = 1** then only **RE_Koef** is executed.

Such a solution does not guarantee finding global optimism, but it provides a sub-optimal result, which makes it possible to achieve better results in forest management compared to the methods used to date.

A prototype program designed for the realisation of the local optimization algorithm and the testing of the Local Optimization algorithm that allows you to create a set of limitations (Figure 1.2.5) and perform the two optimizations described above.



Ierobežojums	Suga	Sortiments	min_proc_no_iepriekseja_perioda	max_proc_no_iepriekseja_perioda	aktivs
Sugu sortimenta krāja	Bērzs	R+V+T	90.00	100.00	☑
Sugu sortimenta krāja	Priede	R+V+T	90.00	100.00	☑
Sugu sortimenta krāja	Egle	R+V+T	90.00	100.00	☑
Sugu krāja	Priede		80.00	100.00	☑
Sugu krāja	Egle		80.00	100.00	☑
Sugu krāja	Bērzs		80.00	100.00	☑
Sugu krāja	Melnalksnis		80.00	100.00	☑
Sugu krāja	Apse		80.00	100.00	☑
Sugu krāja	Baltalksnis		80.00	100.00	☑
					☐

Figure 1.2.5 Defining restrictions

Figures 1.2.4 and 1.2.5 show the main shape of the test programme. Figure 1.2.5 shows a set of limitations that the user draws up in the form of a table showing its type, an assortment of species to which it will apply, a minimum, maximum percentage compared to the previous period.

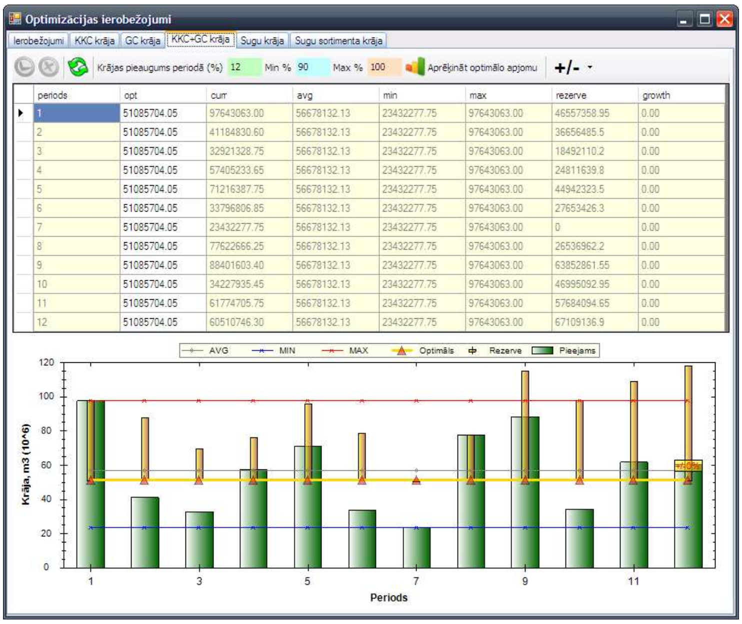


Figure 1.2.6. Optimized felling limit

The first optimization task is executed after setting up the limit set, which allows you to align felling volumes by period according to the limits described above. The optimization result is indicated in the table and graphics shown in Figure 1.2.6, if the user result is satisfied, a second optimization may be performed, otherwise changing the parameters may be repeated first.

2.4. Forest management modelling scenarios

The next phase of the project is to implement forest management modelling according to three scenarios:

- Current regulatory framework and forest management approach
- The most economically viable forest management model
- Forest management model identified by the European Green Course

Such scenarios have been selected to allow an assessment of the impact of existing legislation and restrictions on the state, value and management prospects of forest resources. The results obtained will be integrated into the energy and system dynamics model, further analysis, and will be compared with each other.

Scenarios are characterised by defined, specific and measurable objectives described in the optimization exercise with conditional indicative values. A description of forest management modelling scenarios is given in Table 1.3.1.

Table 1.3.1

Forest management modelling scenarios

Forest management model	SF Type	Value created	Factor ranking	Optimization	conditions
The most economically	Funding as usual	Value of shares	F	Max F	Maximising the capital value of

viable forest management model	(Finance as usual)				forests according to optimal conditions of economic efficiency
Current regulatory framework and forest management approach	SF 1.0	Value of shares specified	F > > S and E	Max F taking into account S and E	Maximising capital value and timber flow in the long term, in line with the current regulatory framework
Forest management model identified by the European Green Course	SF 2.0	Value of shares according to "triple bottom line" TBL *	I = F + S + E	Optimize I	Including environmental objectives of the Green Taxonomy Regulation 6 in the optimisation exercise

F = financial value; S = social impact; E = environmental impact; I = integrated value, SF 1.0. Maximize F by exposing small S and E limits.

3. FOREST EXPERT MODEL SOFT-LINKAGE WITH SYSTEM DYNAMICS AND TIMES MODEL

The modeling shall produce the following performance indicators for forest management modelling scenarios:

- **Capital value.** Describes the value, profit, production income and costs of biological assets
- **Predicted wood co-storage dynamics.** Describes the total stock of growing trees, total felling volumes and area
- **Projected felling volumes by species**. Describes the stock of growing trees, felling volumes and area
- **Forecasts for the outcome of felling volumes** of round timber. Describe the dimensions, size, value and potential market availability of timber.
- **Biomass**. Describes total biomass and the availability of biomass in energy.
- **CO_2 capture.** Describe the total emissions collection and emissions.
- **Employment**. Describes employment (full-time equivalent) in different jobs, pay, tax
- **Protected areas.** Structure of protected areas, limits on economic activity, area, stock
- **Landscape article.** Describes the species and age structure of forest landscape trees
- **Composition of tree species (number of species)** Describes the structure of the groves and the structure of biodiversity

The results are to be used in the future system dynamics modelling process. In order to improve the reliability of the results and to respect the capacity of the developed mathematical models to replicate the processes as accurately as possible, it is recommended that the current system dynamics model for modeling wood forest resources be reviewed.

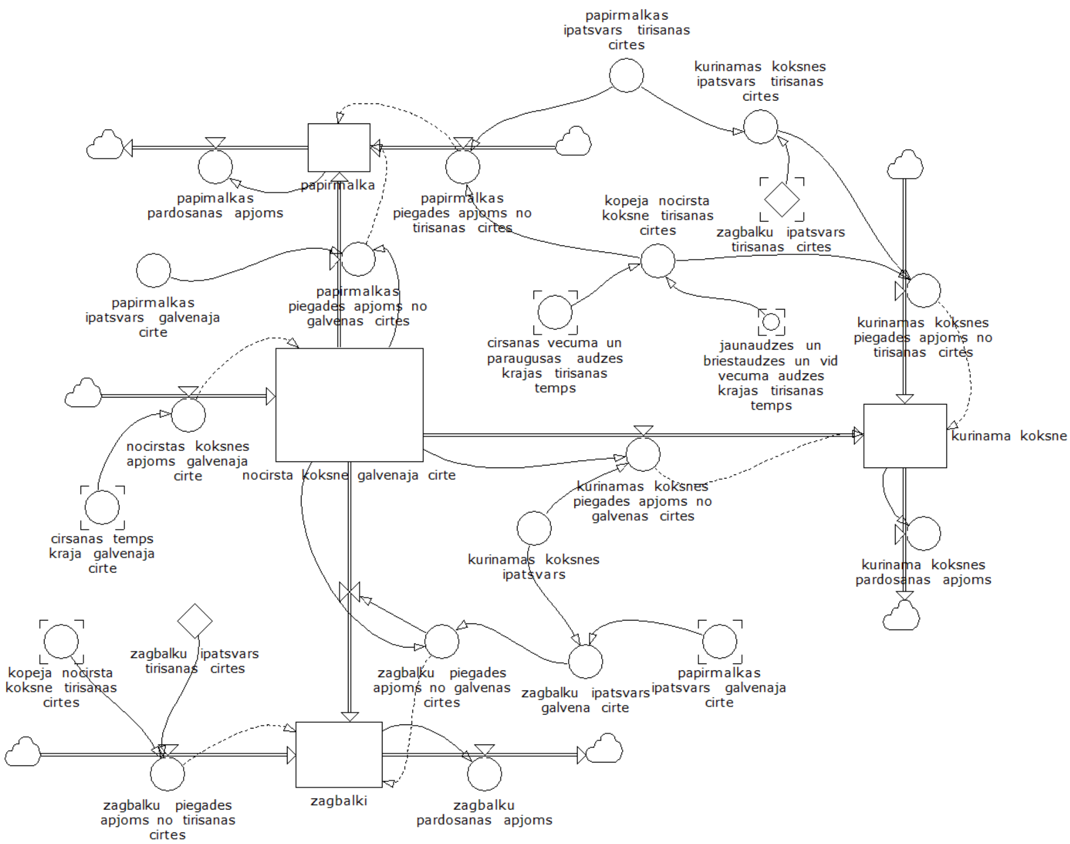


Figure 1.4.1. System dynamics model for modelling wood forest resources

In the existing system dynamic model (Figure 1.4.1), the integrated forest resource equations are proposed to be replaced by more accurate calculation results obtained by the forest expert data processing programme, enabling the results to be used in future systemdynamic models solutions. Higher precision will be provided by this computer program, mainly by means of the fact that, unlike the existing system-dynamic forest resource model:

- Analysis of real available forest resources in full detail from the VMD database
- Tree growth rate models are used
- Compliance with BOM standards for predicting timber outcomes
- Tree trunks and assortment forecasting algorithms are used
- It is possible to model forest management objectives, change conditions and compare results.

The forest management class model of the data processing programme “Forest expert” is shown in Figure 1.4.2.

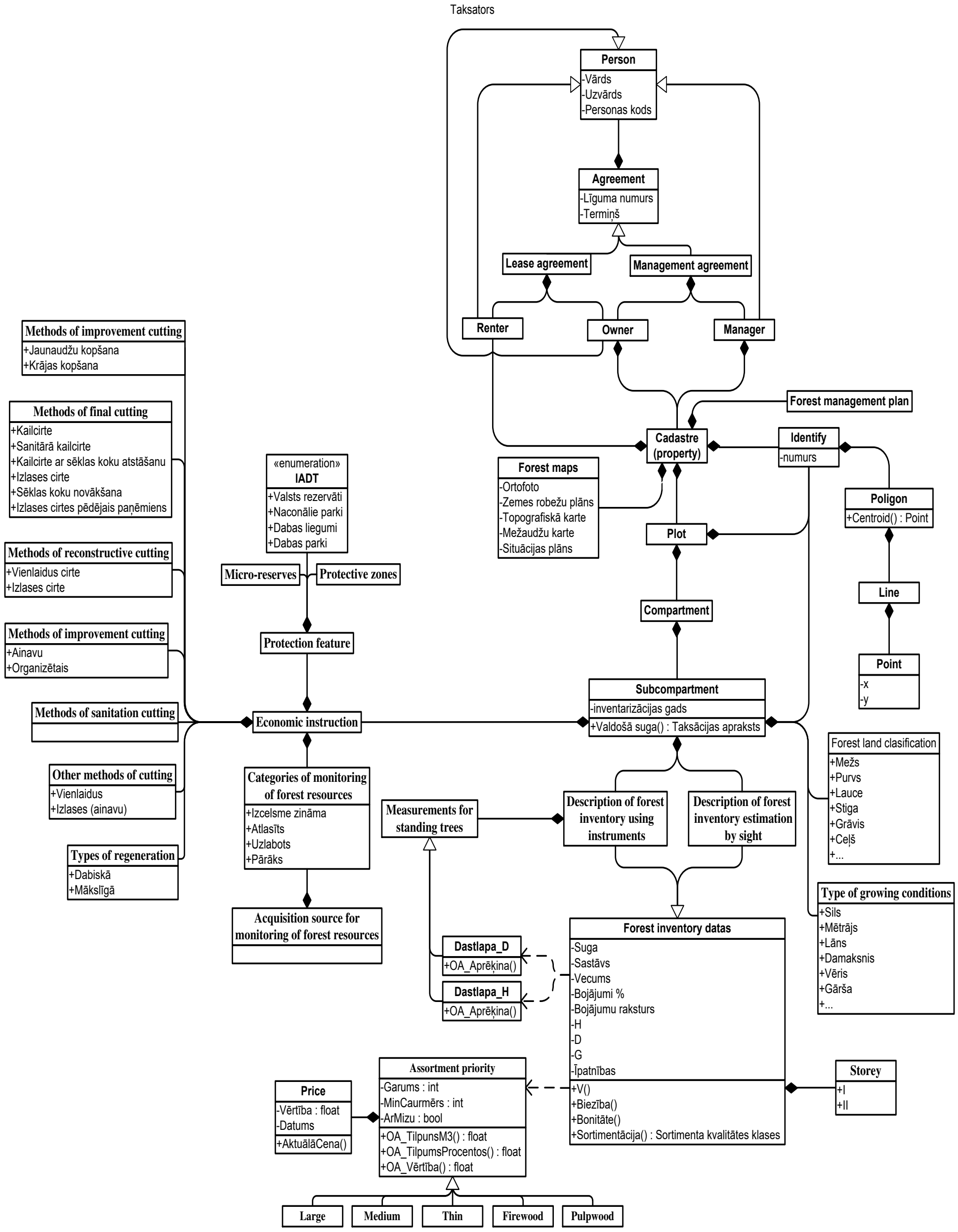


Figure 1.4.2. Forest management class model

When analyzing system dynamics and Forest expert solutions for the most convenient data exchange format, a Microsoft Excel data format was selected. In this file, a single working sheet will be provided for each scenario calculated by the Forest expert. From this worksheet, the system dynamics model will take the necessary data fields. For this purpose, the results of the Forest expert calculations will be summarised in the table data structures, Table 1.4.1 for the system dynamics model and Table 1.4.2 for the Times model. Wood and paper wood may be assessed as energy wood according to the tasks of future calculations.

Table 1.4.1

Description of the data structure of the system dynamic model

Data field name	Data Type	Unit of measure
Year	Integer	-
Species	Text	-
Fat logs	Integer	m3
Middle logs	Integer	m3
Thin logs	Integer	m3
Wood	Integer	m3
Paper wood	Integer	m3
Felling residues	Integer	m3
Biomass from dry branches	Integer	m3
Biomass from green branches	Integer	m3
Biomass from needles	Integer	m3

Table 1.4.2

Description of the data structure of the Times model

Data field name	Data Type	Unit of measure
Year	Integer	-
Wood	Integer	m3
Paper wood	Integer	m3
Felling residues	Integer	m3
Biomass from dry branches	Integer	m3
Biomass from green branches	Integer	m3

LITERATURE

- Consolidated results for annual tax by type of resource;
- D.Scoenmaker, W.Schramde. Principles of Sustainable Finance. Oxford University Press 2019 p 374. ISBN 987-0-19-882660-6