TALLINN UNIVERSITY OF TECHNOLOGY
SCHOOL OF ENGINEERING

Department of Civil Engineering and Architecture

STRATEGIC ENVIRONMENTAL ASSESSMENT (SEA) AND ENVIRONMENTAL IMPACT ASSESSMENT (EIA) AS IMPLEMENTED IN THE FOREST CLEARING IN THE EXAMPLE OF THE RAIL BALTIC PROJECT

KESKKONNAMÕJU STRATEEGILINE HINDAMINE (KSH) JA KESKKONNAMÕJU HINDAMINE (KMH) RAADAMISE KÄSITLUSES RAIL BALTIC PROJEKTI NÄITEL

MASTER THESIS

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AUTHOR'S DECLARATION

Hereby I declare, that I have written this thesis independently. No academic degree has been applied for based on this material. All works, major viewpoints and data of the other authors used in this thesis have been referenced.

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List of abbrevations and symbols

EIAEMSA - Environmental Impact Assessment and Environmental Management System Act

EIA- Environmental Impact Assessment at the activity license level

SEA - Strategic Environmental Assessment

NCA - Nature Conservation Act

PA - Planning Act

SPD - Strategic Planning Document

UN - United Nations

SDA - Sustainable Development Act

FA - Forest Act

CP- County plan

DBH – Diameter at breast height

RB-Rail Baltic

RBE- Rail Baltic Estonia

RMK- State Forest Management Centre

Introduction

All human activities have an impact on the environment, be it big or small. The environmental impact of some activities can be significant. This means that the impact may exceed the expected environmental tolerance of the affected area, cause irreversible changes in the environment or endanger human health and well-being, cultural heritage or property. In order to prevent significant environmental impacts, the effect of such activities is already assessed in the planning process (Keskkonnamõju hindamine, 2020).

In order to get an overview of anthropogenic environmental changes, it is necessary to monitor its changes over time and the contribution of industrial since the mid-20th century, when it was started to pay attention to environmental changes. At the beginning of my research, I discuss the emergence and development of environmental problems in the 20th century in general. Undoubtedly, global changes also affect the Estonian living environment, industry and economy.

One of Estonia's greatest values and resources is the forest. How Estonian forests are used in economic activities is a common topic today. The importance of forests and the economy in our lives has increased considerably over the last half century. The forest is no longer just a producer of wood, but an extremely important designer of the living environment, a place of rest, a place for picking berries, mushrooms, herbs, etc., a hunting ground, a source of aesthetic pleasure and inspiration for artists, etc. Wood is also needed more and more. Only biologically diverse forests can perform such diverse tasks (Lõhmus et al. 2000).

The aim of the master's thesis is to analyse Estonian practice in the case of projects involving large-scale forest clearing. The clearing approach is assessed in terms of the methodology, effectiveness and alternatives of Strategic Environmental Assessment (SEA) and Environmental Impact Assessment (EIA). The process is assessed using the Strategic Environmental Assessment (SEA) report of the approved Rail Baltic railway project, which was carried out at the level of detail of the Environmental Impact Assessment (EIA).

The work focuses on today's intensive deforestation. Climate change as a result of human activities is one of the most important environmental problems of the last few decades, which is increasingly affecting forestry (Metsade mõjust…2010). Estonian forest land makes up 51.4% of the land (Metsa statistika, 2020). The problem in Estonia is the small share of forests

in their natural state. At the same time, the frequency of stand structures (including old ecologically valuable trees and coarse dead wood) continues to decrease in forests and the forest habitat diversity is impoverished (Eesti metsanduse...2018). However, trees and forests are very important in absorbing carbon from the perspective of climate. During photosynthesis, trees store carbon, which is obtained from the CO_2 compound in the air, in their trunks, branches, leaves and roots for a long time. Deforestation will have a major impact on the climate, depending on what is done with the wood.

Throughout the thesis, the forest clearing process is evaluated on the example of the Rail Baltic project. In order to implement the project in Estonia, county plans have been established in Harju, Rapla and Pärnu counties, during the preparation of which a strategic environmental assessment (SEA) was performed at the level of accuracy of the Environmental Impact Assessment (EIA).

1 Theoretical overview

1.1 Development of ecological thinking and the concept of sustainability

In order to gain an overview of anthropogenic environmental change, it is necessary to monitor its changes over time and the contribution of industrial society in recent decades. Environmental changes became the focus of researchers' attention in the 70s of the 20th century. The thinking of the 1970s was perhaps most influenced by the Club of Rome, a global community organization uniting political, financial, cultural and scientific unions. (Estonian Association for the Club of Rome, 2020). One of the tasks of the organization was to draw the attention of the world community to global problems and, above all, to the harmonization of the relationship between man and nature. The Club of Rome drew public attention to the ecological crisis caused by the depletion of nature. In 1972, the Club of Rome predicted in its book *Limits to Growth* that exponential growth would eventually lead to economic and environmental collapse. On a planet of a limited size, the number of people, the area of cultivated land, the amount of mined mineral resources cannot grow indefinitely. Known reserves of many important mineral resources will, at the current rate of continuous growth of consumption, last for a few decades to a hundred years. Pollution increases in parallel with production and increasingly reduces the environmental viability of the environment (Rooma klubi, 2020).

The authors based their forecasts on the growing population, environmental pollution, industrial output, consumption of natural resources and food production. The book describes how the research group modeled human resource use and proposed a timetable for addressing ecological global issues in the 21st century to rise to the surface. Particular attention was paid to problems in agriculture, water consumption and energy. The book had a huge impact on the spread of the concepts of sustainable development and zero-growth economy (The Limits to Growth, 2020).

The activities of the Club of Rome, as well as other global social organizations, revealed a crisis of modernist ideology and paradigm. It was replaced by new ways of thinking, and ecological thinking was one of those new directions that involved more and more people. In addition to the paradigm crisis, an oil crisis came, and the manifestations of the latter were perceived in various areas of the environment.

While ecological thinking developed in the 1970s, the 21st century brought with it the need to revise existing positions. In the new century, sustainable development came first. New confrontations arose: sustainable development and the previous economic expansion. (Jätkusuutlikkus, 2020)

The notion that the world is changing and that the Western way of life has put the whole planet at risk for the future led to the concept of a sustainable society already in the early 1990s.

Our Common Future report in 1984, launched by the UN General Assembly and chaired by Norwegian Prime Minister Gro Harlem Brundtland and published in 1987, was the first to set out the concept of sustainable development that should meet the needs of today's generation without compromising the ability of future generations to meet their own needs.

The Brundtland Report formulated a definition of sustainability: "Sustainable development is meeting the needs of the current generation without doing so at the expense of meeting the needs of future generations" (Brundtlandi aruanne, 2020).

The concept of sustainability was also confirmed in Agenda 21. Agenda 21 was an action plan for governments, international development institutions, the United Nations and independent groups to prevent environmental degradation, adopted at the UN Conference on Environment and Development in 1992. The main content of Agenda 21 was to address environmental and development issues in a coherent way and to formulate strategies to achieve sustainable development in the world (Agenda 21, 2020).

1.2 Forest as an ecosystem

A forest is an ecosystem consisting of forestland, the flora and fauna growing on it (Metsaseadus, 2006). ‘Forest land’ means land that is entered in the cadastral register as a forest land parcel or 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 (samas, 2006). According to the basic research report of the Estonian Forestry Development Plan until 2030, there are few forests in their natural state in Estonia, however, there are many economical forests with a close-to-nature structure in historically consistent forest land and parks. In addition, the frequency of forest structures (including old ecologically valuable trees and coarse dead wood) continues to decline and forest habitat diversity is impoverished (Eesti

metsanduse arengukava, 2018). In order for a forest to function, it is necessary to manage the forest, i.e. to renew, grow, use and protect it (Metsaseadus, 2006). There are certain rules and options for forest management that follow good practices and help ensure the sustainability of forestry. It is permitted to carry out maintenance felling for the forest and to regulate the water and nutrition supply regime of the forest soil (samas, 2006).

Forests play a unique role in climate change. On one hand, they release greenhouse gases when trees are cut down or decay or when the soil underneath is disturbed, contributing to global warming. On the other hand, forests capture greenhouse gases through photosynthesis and they also help to cool the planet. This makes them crucial in the fight against climate change (Meie planet…2018).

Humans are cutting down the world's forests at an alarming rate: up to 80% of tropical deforestation is done to clear land for farms, but trees are also being cut down to make products such as timber and paper or to build roads and mines. As well as speeding up climate change, deforestation destroys the habitats of forest animals and changes rainfall patterns, causing droughts (samas, 2018).

1.3 Deforestation

According to § 28 (4) of the Forest Act, the following types of felling are permitted:

1) regeneration cutting, including clear cutting and shelterwood cutting;

2) improvement cutting, including cleaning in stands with the DBH of up to eight centimetres, thinning in stands with the average DBH of eight centimetres and larger, and sanitary cutting;

3) selective cutting;

4) track cutting, including the cutting of quarter or boundary lines or the cleaning of an existing ride or road shoulder, ditch bank or ditch shoulder from trees with the average DBH of more than eight centimetres;

5) deforestation;

6) formative cutting carried out at a protected natural object in order to attain the protection goal in accordance with the protection management plan, action plan for the protection and control of a species or for the purpose of preservation and improvement of the status of a protected individual natural object or key habitat (Metsaseadus, 2006).

1.3.1 Forest clearing approach in the forest Act (MS)

The present master's thesis focuses on forest clearing. Clearing is a type of felling that allows forest land to be used for purposes other than forest land. The Estonian Forest Act uses the term deforestation instead of clearing.

The Forest Act § 32 (1) (redaction as of 15/03/2019) claims that deforestation is a type of felling which is carried out in order to enable the use of land for purposes other than forest management (Metsaseadus, 2006).

According to § 32 (2) of the FA, deforestation is performed in the following cases:

1. for the purpose of compliance with the requirements established for the maintenance of a construction works having a protection zone and maintenance of the protection zone of the construction works on the basis of building design documentation or on the basis of an operational plan of the electrical installation if the preparation of a detailed plan is not mandatory;
2. on the basis of other valid design documentation, maintenance schedule or document arising from legislation which serves as the basis for the use of land for purposes other than forest management.

1.3.2 Regeneration cutting (clear-cutting and shelterwood cutting)

Regeneration cutting is carried out in order to enable reforestation or forest regeneration (Metsaseadus, 2006).

Clear-cutting differs from clearing in a sense that the purpose of the land does not change after clear-cutting. It is a type of regeneration felling. After clear-cutting, new forest will grow in the same place after a while, but the cleared areas will not bear forest in the future (Raadamine toimub…2019)

According to the FA § 29, in the event of clear cutting, all trees are cut from the cutting area within one year after the beginning of the cutting, with the exception of:

> 1) 20–70 pines, white birches, ashes, oaks, black alders, European white elms or Scots elms per hectare, dispersed or situated in small groups, which are left as seed trees, and viable undergrowth;
>
> 2) old crop trees, i.e. trees that are necessary to ensure the biological diversity, or the preserved standing parts of such trees, with the total volume of stem wood of at least five solid cubic metres per hectare or, in the case of a cutting area sized over five hectares, at least ten solid cubic metres per hectare.

As stated in § 30 (1) of the FA, shelterwood cutting is divided into shelterwood compartment cutting, group selective cutting and shelterwood strip cutting.

Shelterwood cutting may be carried out in a stand which belongs to the type of forest in which shelterwood cutting is permitted in accordance with the rules of forest management and where the average age of the upper layer weighed on the basis of the composition of the stand is equal to or exceeds the rotation age of the upper layer weighed on the basis of the composition of the stand or which has attained the average DBH (Metsaseadus, 2006).

In Estonia shelterwood cutting can be done as shelterwood compartment cutting, group selective cutting and shelterwood strip cutting (Lõhmus et al. 2000). In the event of shelterwood compartment cutting, dispersed trees are cut in the forest subject to reforestation in two or more cutting stages (Metsaseadus, 2006)

During shelterwood compartment cutting, the trees are felled scatteringly over the entire cutting area, but several times at longer intervals. Therefore, natural regeneration occurs in a thinned stand with better lighting conditions. Shelterwood compartment cutting does not always give the desired result, as light-demanding species (such as Scots pine) do not regenerate under the remaining stand and undergrowth. In Estonia, shelterwood compartment cutting is suitable for spruces, which, as a result of felling, however, become susceptible to storms. After thinning pines, the next generation of forests in even slightly fertile habitats tends to consist of spruce as a shade-tolerant species.

In the event of group selective cutting, the forest subject to reforestation will be cut by groups in several cutting stages (Metsaseadus, 2006). In the case of group selective cutting, the trees are cut in small groups and then waited for the natural regeneration of the areas. It mimics a process that occurs naturally when one or more large trees die. The groups renew unevenly: the edge of the group exposed to the sun usually renews faster. Regeneration by group selective cutting can be considered close to nature (Lõhmus et al. 2000).

In the event of shelterwood strip cutting, trees will be cut from the edges of the cutting area by way of clear cutting at a width that does not exceed the height of the stand. Single trees or groups will be cut at the width corresponding to the height of the stand next to a clearcut strip if there is undergrowth. A clearcut area may be expanded after the regeneration of the part of the forest that was clearcut at the previous cutting stage (Forest Act, 2006). The shelterwood strip cut area is well renewed, because a lot of seeds fall from the edge of the old forest, there are favourable microclimate and lighting conditions. On the rest of the cutting area, the stand can be thinned evenly or even group selective cut to encourage pre-regeneration (Lõhmus et al. 2000).

The success of shelterwood felling depends on the species composition of the stand, the seed year and the soil. In the case of thick and secured decay, there is no natural renewal because the germination conditions of the seeds are poor and the roots of the young trees do not reach the minerals. The maximum area of a shelterwood cutting area is 10 hectares (Lõhmus et al. 2000).

1.3.3 Improvement felling (cleaning, thinning, sanitary felling)

Improvement cutting is carried out for the improvement of the daylight and nutrition conditions of trees and shaping of the composition of the forest (cleaning); as well as for the raising of the value of a forest, for the regulation of forest density and composition, and for enabling the use of the timber of dead trees which will fall out in the immediate future (thinning). It is also done for the improvement of the sanitary state of the forest and for enabling the use of the timber of dying or dead trees that are not a source of danger, if this does not endanger the biological diversity (sanitary cutting). (Metsaseadus, 2006).

In traditional forestry, the main goal of improvement felling is often to change the combination of species in a stand. In order to ensure the naturalness of stands, it is necessary to be guided

by the condition of the typical species and communities when performing maintenance felling (Lõhmus et al. 2000).

1.3.4 Selective cutting

Selective cutting is carried out for the purpose of management as a selection forest in a forest stand that has attained the established rotation age by cutting out single trees and minor groups. The diameter of minor groups may be up to 20 metres (Metsaseadus, 2006).

Selective felling is the forest management system with the longest history. Selective felling means selecting the necessary tree from the forest, cutting and using it. In the case of low population density, the impact of selective felling on the forest is not very large. However, as human population density grows, it causes the best trees to disappear from the forest and the value of the forest to decline. Today, selective felling is important for maintaining the natural balance. When selecting trees for felling from the forest, natural processes are taken into account. Trees are being cut that are likely to approach their biological maturity and that would soon die even without human interfering. While cutting individual "mature" trees, the stand as a whole is preserved (Lõhmus et al. 2000).

1.4 Strategic Environmental Assessment (SEA) and Environmental Impact Assessment (EIA)

The concept of sustainable development as the cornerstone of SEA became known worldwide in 1987, when the United Nations published the report "Our Common Future" (also known as the Brundtland Report). A short sentence stating that sustainable development is one in which today's generations meet their own needs in a way that does not impair the ability of future generations to meet their own needs, has given food for thought for later decades. The UN Conference on Environment and Development in 1992 adopted *Agenda 21,* which emphasized the need to act locally, but to think globally. In the early years, the prevailing interpretation of sustainable development was the understanding that economic, social and environmental aspects must be considered equally in decision-making (Peterson et al. 2017).

Informing and involving the public plays an important role in environmental impact assessment. The Aarhus Convention, adopted in 1998, provides the legal framework for this, stipulating that, in so far as the environment is a matter of general interest, joined countries

must guarantee the right of citizens to information, participation and, where necessary, legal proceedings. Environmental impact assessment, including strategic environmental assessment, is one of the most important tools for predicting and preventing adverse effects of human activities on the natural environment and thus on human health and well-being, cultural heritage or property. Environmental impact assessment, both at the strategic and project level, plays an important role in preventing and raising awareness of adverse effects, taking into account the cumulative nature of effects and achieving environmentally friendly solutions. Therefore, environmental impact assessment, including SEA, has become the main tool for implementing the concept of sustainable development. Viide

1.4.1 Strategic Environmental Assessment (SEA) and methodology

Strategic environmental assessment is a policy-making tool. One of the key activities of policy-making is strategic planning, which results in a forward-looking develoment document that describes the goals and activities to achieve them. During the preparation of the development document, the possible positive and unfavourable effects on the economy, people and the natural environment are analysed. SEA is used to assess the impacts of the development document on the natural environment and the impacts on human health and well-being, cultural heritage and property through the changing state of the natural environment (Peterson et al. 2017).

The purpose of the Strategic Environmental Assessment (SEA) is to take environmental considerations into account when preparing and establishing strategic documents. (1) According to § 32 of the Environmental Impact Assessment and Environmental Management System Act (EIAEMSA), SEA is an assessment carried out with the public and relevant agencies to identify significant environmental impacts, identify alternative options and find mitigation measures; which is considered when compiling a strategic planning document and is accompanied by a required report (Keskkonnamõju hindamise…2005).

§ 31^1 of the Environmental Impact Assessment and Environmental Management System Act (EIAEMSA) puts forward three objectives of strategic environmental assessment (Keskkonnamõju hindamise…2005).

1) to contribute to the integration of environmental considerations into the preparation and adoption of strategic planning documents;
2) to contribute to the integration of environmental considerations into the preparation and adoption of strategic planning documents;
3) to provide for a high level of protection of the environment;
4) to promote sustainable development.

According to the valid Environmental Impact Assessment and Environmental Management System Act, strategic environmental assessment must be initiated where a strategic planning document:

1) is prepared for agriculture, forestry, fisheries, energy, industry, transport, waste management, water management, telecommunications or tourism and on the basis thereof an activity specified in subsection 1 of § 6 of this Act is proposed or the proposed activity is likely to have a significant environmental impact, on the basis of the provisions of subsections 2–4 of § 6 of this Act;
2) is a national plan, a special plan of the state or local authority, a county plan or a comprehensive plan;
3) is a detailed plan on the basis of which an activity specified in subsection 1 of § 6 of this Act is proposed;
4) serves as the basis for an activity which, according to objective information, may alone or in conjunction with other activities potentially significantly adversely affect the protection purpose of a Natura 2000 site and which is not directly related to or necessary for the protection procedure of the site (Keskkonnamõju hindamise…2005).

1.4.2 Environmental Impact Assessment (EIA) and methods

Environmental Impact Assessment and Environmental Management System Act states the purpose of environmental impact assessment as follows:

(1) The purpose of environmental impact assessment is to give to the issuer of the development consent information on the significant environmental impact of the proposed activity and its reasonable alternatives and regarding the choice of the most suitable solution for the proposed activity, which makes it possible to prevent or minimise adverse impact on the environment and to promote sustainable development.

(2) Upon assessment of environmental impact, the following is identified, described and assessed: the direct and indirect significant environmental impact of the proposed activity on the environmental elements such as earth, soil, water, ambient air, climate, landscape and natural diversity, on human health, welfare and property, on cultural heritage, protected natural objects and their mutual links; the significant environmental impact arising from a possible major accident or catastrophe.

The current Environmental Impact Assessment and Environmental Management System Act § 3 states mandatory environmental impact assessment when:

1) applying for development consent or for the amendment of development consent whereby the proposed activity which is the reason for applying for the development consent or for the amendment of the development consent potentially results in significant environmental impact;
2) where an activity is proposed whereby, according to objective information, it cannot be precluded that the activity alone or in conjunction with other activities may potentially significantly and adversely affect the protection purpose of a Natura 2000 site, and which is not directly related to or necessary for the protection procedure of the site.

2 Forestry in Estonia

Forests are seen as playing a very important role in mitigating climate change. Young and actively growing forests bind carbon from the air and increasing the area of forest land is seen as one solution to combating climate change. If forest is cleared, we will also lose a powerful carbon bank in this area, and the future carbon binding capacity of this area will be significantly lower or even non-existent (Sims et al. 2019).

Various aspects of forest protection are regulated mainly in the Forest Act and the Nature Conservation Act. The main objectives of the Forest Act are to ensure the protection and sustainable management of the forest as an ecosystem, which means having various restrictions and requirements established for forest management and regulating the protection of key habitats. Thus, the Forest Act must ensure both the diversity of forest biota and opportunities for the economic management and protection of forests. However, forest nature protection in Estonia is primarily based on the Nature Conservation Act, according to which the most important principle of nature protection is to restrict the use of areas important for nature conservation (Sims et al. 2019).

The following terms are used to divide the forest by type of management: strictly protected forest, protection forests, commercial forest and protected forest in total. Forest categories do not exist at the legislative level, but it is still necessary to provide the relevant data for different assessments. A commercial forest is a forest where forest management is permitted in accordance with the general requirements of the Forest Act. Protection forests are considered to be forests where management activities are restricted but not prohibited, the severity of the restriction can vary greatly. Strictly protected forest is forest land where all economic activities are prohibited. By combining strictly protected forests and protection forests, we get protected forests in total (Sims et al. 2019).

Strictly protected forests (samas, 2019):

- special management zone of permanent habitat;
- special management zone of the planned permanent habitat;
- planned natural special management zone;
- maintained planned special management zone;
- habitats of protected animals of category I;

- plant growth sites of category I;
- contracted key habitats on private land;
- key habitats in the state forest;
- nature reserves;
- natural special management zone;
- maintained special management zone

Protection forests (Sims et al. 2018):

- storage areas;
- limited management zones;
- permanent habitat limited zones;
- shore limited zones;
- local object limited zones;
- protected area limited zones;
- single object limited zones;
- Natura 2000 natural areas;
- Natura 2000 bird areas.

One of the important ways to preserve forest biota is the protection of key habitats. A key forest habitat is a habitat for species that are sensitive to changes in ancient living conditions inherent in the forest (Lõhmus et al. 2000). Key habitats, according to the Forest Act, are areas which need protection outside a protected natural object and where the probability of the occurrence of narrowly adapted, endangered, vulnerable or rare species is great (Sims. et al. 2019). The value of a key habitat as a habitat is confirmed by the very rare species found there. In practice, key habitats are found on the basis of indirect characteristics, which are the presence of relatively undemanding species and biological and landscape key features that indicate the quality of a particular habitat (biotope elements) (Lõhmus et al. 2000). The Environmental Board make inventories of key habitats, forward the collected information to the Environment Agency, make proposals for the conclusion of contracts for the protection of key habitats and evaluate the fulfilment of such contracts. Key habitats in the state forest are protected by a directive of the Minister of the Environment (Vääriselupaik, 2020).

The characteristics of the key habitat are (Vääriselupaikade kaitse, 2019):

- an ancient or rare forest community grows in the area (low human impact, naturally developed forest etc.);
- there are biological (minor groups, trees of different ages, plenty of fallen trees, old or hollow trees etc.) and landscape indicators (different areas affected by water, precipice, burns etc.) that indicate specific living conditions;
- there are characteristics that indicate special living species (species, which require special conditions for growth, which is often not present in managed forests).

2.1 General felling and forest clearing statistics in Estonia

Approximately half (51.4%) of the Estonian mainland is covered with forest. There are a total of 2,332,600 hectares of forest land. Forested land covers 2,142,000 hectares of it and non-forested covers 190,600 hectares, Figure 1 (Eesti metsavaru…2020).

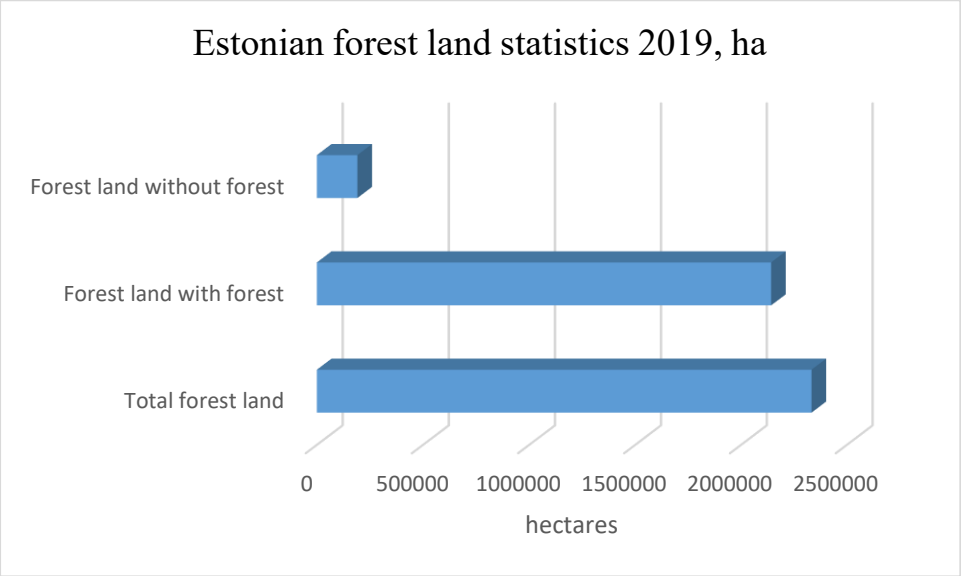

Figure 1. Estonian forest land statistics 2019 (ha)

The state forest inventory, i.e. statistical forest inventory (SFI), is carried out by the Environmental Agency under the administration of the Ministry of the Environment. It is a selective survey that provides information on the nature and changes of Estonian forest resources and other forest-related indicators. The characteristics of forest land and trees growing on it are measured and evaluated on small sites based on systematic random selection (Metsastatistika, 2020).

National statistics on deforestation are collected based on two main sources of information (Valgepea et al. 2019):

1. measurement data of statistical forest inventory (SFI) sample sites;
2. felling documents (performed RMK felling data and forest notifications).

Statistical or National Forest Inventory as a method of objective and economic inventory of larger forest areas is based on the selection methods of mathematical statistics, ie probabilistic sampling. The results of the inventory are obtained by generalizing the measurement data collected from small plots placed with a randomised selection system (Statistiline metsa… 2018).

In Estonian forests, 39% of stands are over 60 years old (Estonian Forest Reserve, 2020). The age distribution of forested land or stands is shown in Figure 2 (Eesti metsavaru…2020). Also forest land distribution by tree species is shown in Figure 3 (Eesti metsavaru…2020).

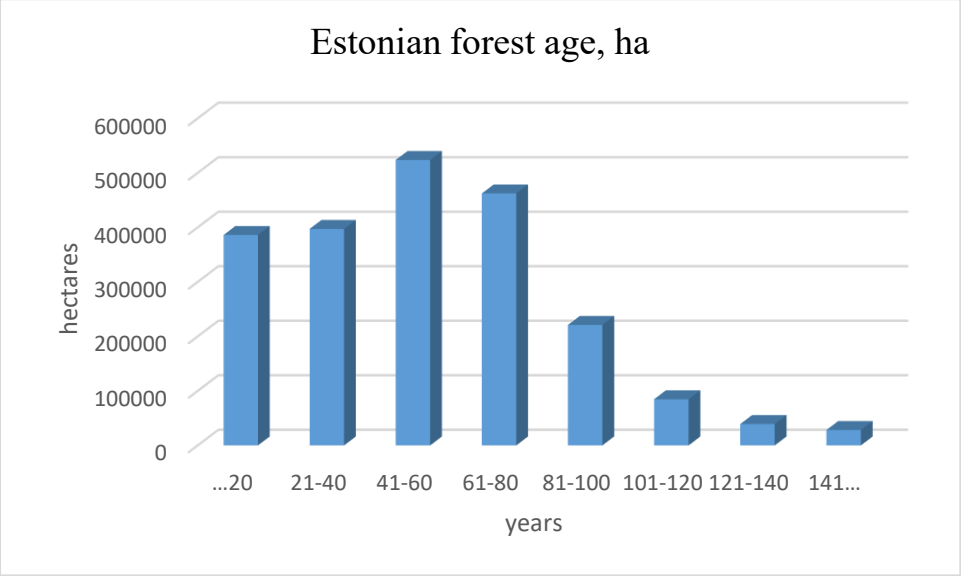

Figure 2. Estonian forest age (ha)

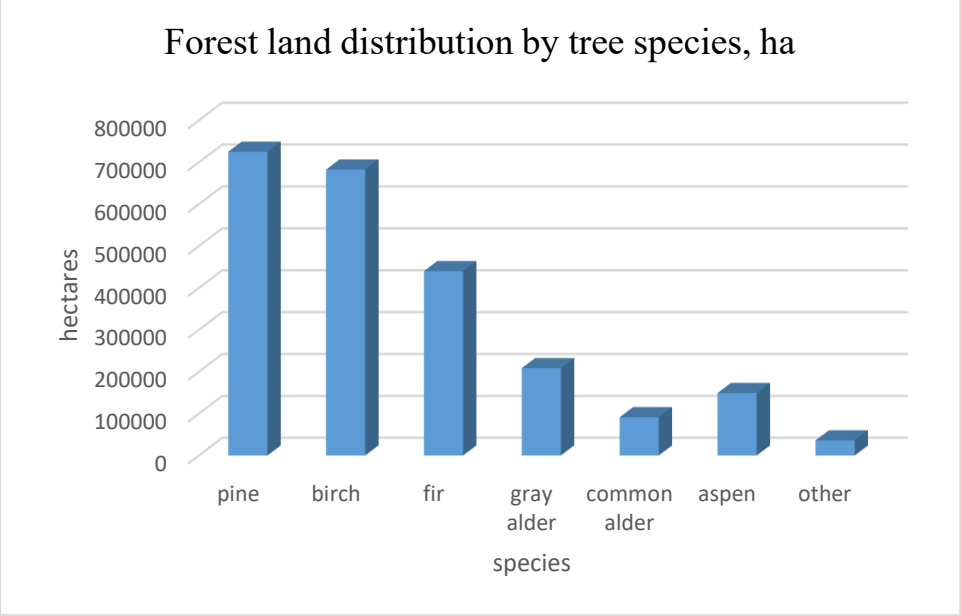

Figure 3. Forest land distribution by tree species (ha)

According to the felling documents, the total felling volume of Estonian forests in 2018 was 15.6 million m^3 (13.9 million m^3 in 2017, respectively). Of this total, the volume of felling carried out on RMK land was 4.3 million m^3 and the planned volume of felling in private forests was 11.3 million m^3, of which the planned felling volume of self-employed forest owners was 38% in 2018 (36% in 2017) and the planned felling volume of legal entities was 62%. The volume of fellings planned for other lands was 81,194 m^3. Based on felling documents, clear cutting (81% in both 2017 and 2018) and thinning (10% and 11%, respectively) accounted for the largest share of the total felling volume, Figure 4 (Eesti metsavaru…2020). It should be taken into account that the Environmental Agency's expert assessment of felling revealed that in 2017 56% of the planned clear-cutting volume of individual forest owners was felled (54% of the planned clear-cutting area); According to the Forest Register, 2,284 ha of forest damage were registered in 2018, which is more than twice less than in 2017 (5,137 ha) and almost five times less than in 2016 (11,274 ha). Storm damage was registered in 2018 on 475 hectares (Õunap et al. 2019).

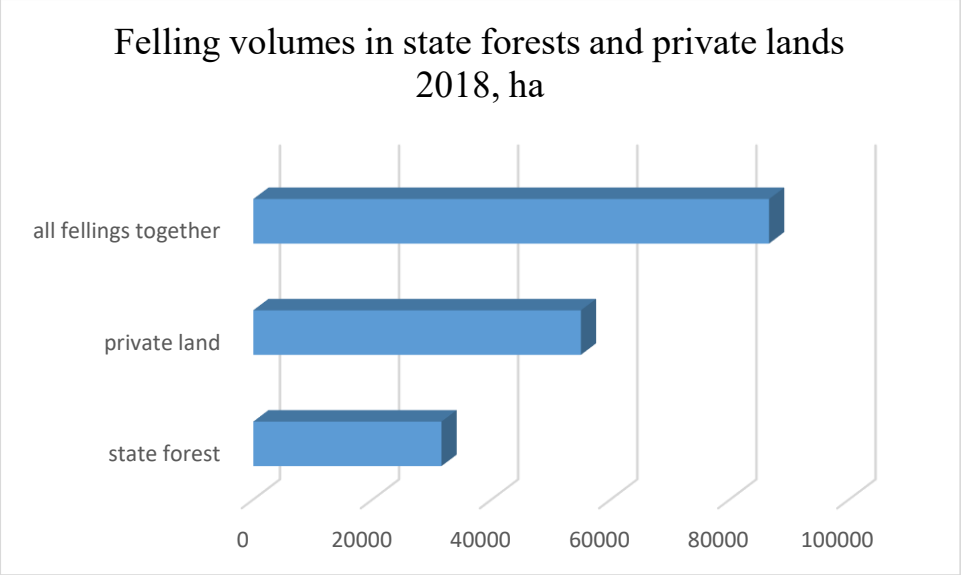

Figure 4. Felling volumes in state forests and private lands 2018 (ha)

Deforestation statistics (ha) are obtained by summing the total areas of all planned felling plans in forest areas where deforestation has taken place during the year and at least the first felling acceptance certificate has been drawn up. The felling volume (m^3) was calculated together with the amount of illiquid timber. Liquid wood is consumer and heating wood with real market and consumption value, Figure 5 and 6 (RMK raiemahu…2020). The volume (m pu) of liquid timber from deforestation is obtained as the sum of the quantities felled during the year, on the basis of felling documents. The amount consists of the quantities felled for which a work acceptance document has been prepared (RMK raiemahu…2020)

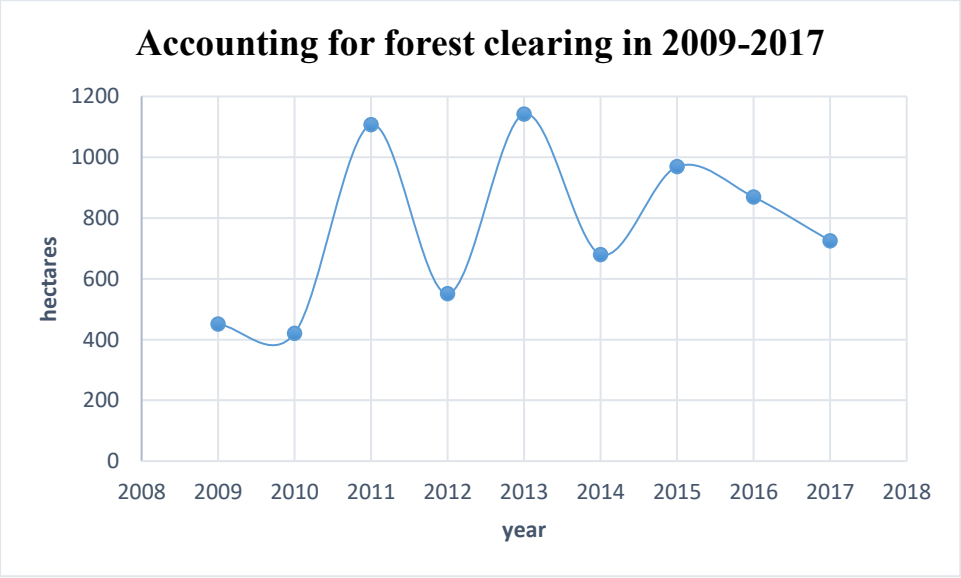

Figure 5. Deforestation calculation in 2009-2017

According to Figure 5 “Accounting for forest clearing in 2009-2017”, clearing is on a downward trend.

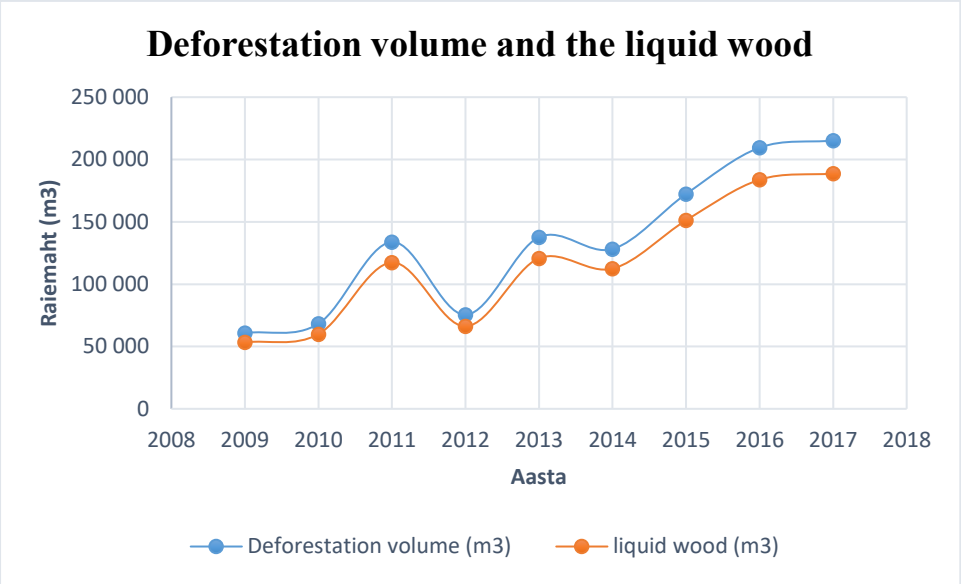

Figure 6. Deforestation volume and the liquid wood (ha)

The logging report is prepared based on the logging acceptance documents entered in RMK's forestry information system (FIS) and the growing forest sales documents. On the basis of the acceptance documents for felling works, the volume of marketable wood felled (m^3) and the accompanying felling area (ha) are calculated in the report. Marketable wood is consumer and heating wood with real market and consumption value. Based on the sales documents of the growing forest, the report includes the felling volume (m^3) as a growing forest and the accompanying felling area (ha) (RMK raiemahu…2020).

3 Forestry and biodiversity strategies, action plans and laws

3.1 UN Agenda until 2030

On 25 September 2015, global Sustainable Development Goals (SDGs) and Agenda 2030 were adopted at the UN Summit. The main goal of the declaration Transforming our world: the 2030 Agenda for Sustainable Development, which was adopted by the heads of state and government, is to eradicate poverty and to guarantee dignity and good quality of life for all, taking into consideration the resources of our planet. Agenda 2030 spells out 17 Sustainable Development Goals across 169 targets and the guidelines for completing them. The goals cover topics such as human well-being, economic growth, employment, innovation, social protection, environmental protection, energy, climate change, international cooperation, etc. Agenda 2030 for sustainable development is universal. This means it applies for all member states (both developed countries as well as developing countries), and governments as well as other stakeholders (companies, universities, NGOs) must contribute to the implementation of the agenda (Ülevaade ÜRO… 2016).

The implementation of Sustainable Development Goals is monitored through an agreed set of sustainable development indicators. The set of indicators is renewed on a regular basis and covers all relevant sustainable development related topics. The current set of indicators was agreed upon in cooperation with the Sustainable Development Commission, inter-ministerial sustainable development working group and the statistical Office and Government Office (Ülevaade ÜRO…2016).

Goal 15 is to protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, halt and reverse land degradation, and stop biodiversity loss. To protect species and habitat types, the Natura 2000 network of protected areas was established by the Habitats Directive and Birds Directive (Ülevaade ÜRO…2016).

3.2 The Estonian Forestryt Development Plan until 2020

The Estonian Forestry Development Plan until 2020 unites measures for the preservation of the diversity of the living and natural environment of forests and for the diverse and efficient

use of forests, including the goal of increasing the growth and carbon sequestration capacity of forests through timely reforestation (Metsanduse arengukava…2019).

The need to prepare a forestry development plan arises from the Forest Act and the Sustainable Development Act. As stated in § 7 of the Forest Act, a forestry development plan is prepared for the management of forestry every ten years. The development plan sets out the objectives for the development of forestry and describes the measures and resources needed to achieve them (Metsanduse arengukava…2019).

The aim of the development plan is to reach a social agreement to guide the sustainable management of forests, taking into account all social, economic, environmental and cultural aspects. Sustainable forest management means using forests in a way and to an extent that ensures the diversity, productivity, regeneration, viability and potential of their biota and allows them to continue to perform ecological, economic and social functions at local, national and global levels without compromising other ecosystems (samas, 2019).

Objectives of the development plan (samas, 2019):

1) To ensure the preservation of forests as a living and natural environment;

2) To create preconditions for improving the competitiveness and adaptability and development opportunities of enterprises in the forest sector, including the preservation and creation of jobs;

3) Increase investment in forestry and research and development;

4) To strengthen the identity and reputation of the forest sector;

5) Diversify recreational and leisure opportunities in forests;

6) Improve the management of private forests

Estonian forests are managed according to the principles of sustainable forest management agreed within the Forest Europe process. According to the main function, managed forests make up 75%, protected forests 15% and strictly protected forests 10% of the total forest area. The general precondition for forest management is the existence of current forest inventory data in the forest register in Estonia (Ülevaade ÜRO…2016).

3.3 Sustainable Estonia 21

Estonia has considerable experience in advancing sustainable development. The Sustainable Development Act was adopted by Parliament already in 1995. In 2005, the Parliament adopted the Estonian Sustainable Development Strategy „Sustainable Estonia 21“ 2, which states 4 main goals for sustainable development in Estonia: 1) Viability of Estonian cultural space; 2) Growth of welfare; 3) Coherent society; 4) Ecological balance. The Estonian national sustainable development strategy is implemented by governments’ sectoral and thematic strategies and action plans. The national sustainable development strategy is one of the main horizontal strategies that has to be taken into account when designing governments’ strategic development plans (Ülevaade ÜRO…2016).

Sustainable development is the harmonious development of the social, environmental and economic spheres. In other words, a country is sustainable if people's living standards improve, the country has a safe and clean living environment, and natural resources are used wisely to increase the competitiveness of the economy (Säästev areng, 2019).

Maintaining ecological balance in Estonia is a vital condition for sustainability. At the same time, it is also Estonia's contribution to global development, following the principle that at all levels of the living environment there must be a balance in both biological cycles and energy flows (Eesti säästva arengu…2005).

The overall aim is to integrate the considerations of self-regeneration capacity of nature into the use of nature. The main function of environmental protection is not to protect resources and the natural environment but to achieve their harmonious and balanced management in the interests of the Estonian society and local communities. The aim is to reach a situation where human does not regard the environment as a pool of objects requiring protection but as an integral whole which human itself is part of. The aim is combined conception of nature as a value and as a central development resource of the society in the context of overall development of Estonia (Eesti säästva arengu…2005).

In planning the protection and use of the environment, Estonia should not necessarily pursue the conceptions of developed countries, which are environment- and pollution-centred and directed to consumption habits, but we should proceed also from the local tradition and specificity. For instance, the native landscapes of Estonia as cultural heritage could be regarded

as an added value which can partly compensate for the higher living standard in several countries and thereby reduce “brain drain”. The landscape of Estonia could become a key element of the ecosystem, becoming treated as a living environment encompassing inter alia also global resources such as weather (climate), air and water. At the local level, landscape means a place of living along with its biological diversity, recreational resources, but also views and other aesthetic parameters, whose preservation and development is important for the achievement of all development goals (Eesti säästva arengu…2005).

3.4 Estonia Environmental Strategy 2030

The Environmental Strategy 2030 is a strategy for developing the sphere of the environment which builds upon the principles of the National Strategy on Sustainable Development “Sustainable Estonia 21” and serves as the basis for the preparation and revision of all sector-specific development plans within the sphere of the environment. The sphere of the environment comprises various sectors that differ from each other materially in terms of contents, scope and specific features. Therefore, in order to plan the consistent development of these sectors, development plans need to be prepared for the sectors even if an environmental strategy as a general framework document exists (Eesti Keskkonnastrateegia…2018).

3.5 Estonian climate goals and agreements

Paris agreement

At the COP21 Paris Climate Conference in December 2015, 195 countries adopted a global, legally binding agreement to stop global warming. The main objectives of the agreement are climate change mitigation and emission reduction. The way to achieve this is to keep the global average temperature rise well below 2 ° C compared to pre-industrial times (Pariisi kokkulepe, 2017)

The governments agreed:

1) the long-term goal of keeping global average temperature rises well below 2 ° C (even 1.5 ° C) compared to pre-industrial times;

2) the need to halt global emissions growth as soon as possible, recognizing that it will take longer for developing countries;

3) the need to reduce emissions sharply after peaked emissions, based on the best available scientific information.

During and after the Paris Conference, countries presented long-term national climate action plans to reduce emissions. However, these action plans are not sufficient to keep temperature rise below 2 ° C, but the Paris Agreement provides a framework for action to achieve the objectives of the agreement (Pariisi kokkulepe, 2017).

4 The impact on forest clearing based on the Rail Baltic project

4.1 Purpose of the Rail Baltic project

The aim of the Rail Baltic project is to reconnect the Baltic States with the European railway network. To date, the Baltic railway system with a standard track gauge of 1520 mm is incompatible with the continental Europe railway track gauge of 1435 mm. On April 29, 2004, the European Commission adopted Decision No. 884/2004 that Estonian, Latvian and Lithuanian rail transport must be fully integrated into the wider European rail transport system. Rail Baltic is one of the projects of the highest priority of the European Union's Trans-European Transport Network (TEN-T). The construction of the Rail Baltic railway will lead to better transportation of people and goods, reduction of air pollution due to the reduction of road transport and a significant improvement in traffic safety. ("SEA Report of Rail Baltic County Plans", 10.08.2017). In Estonia, Rail Baltic will also include building passenger terminals in Ülemiste and Pärnu, as well as integrated freight terminals based on new technologies (Projektist, 2020).

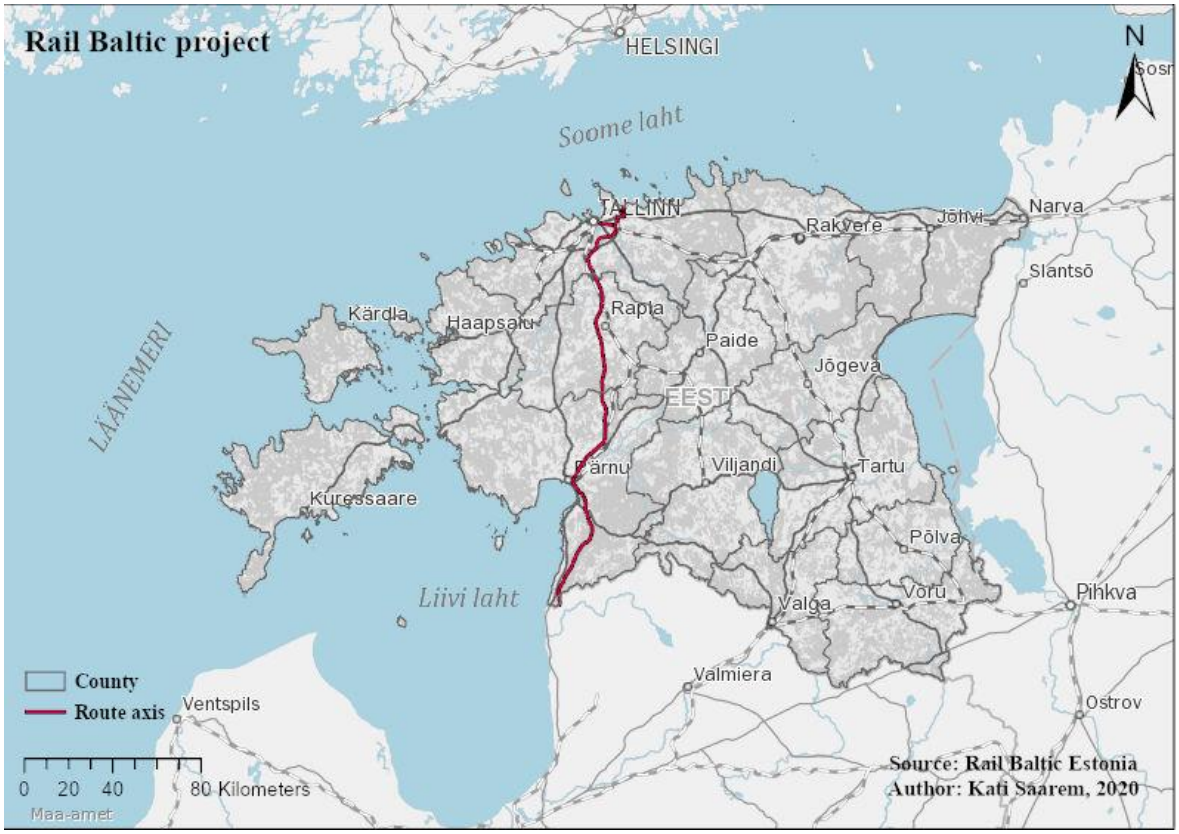

Figure 7. Rail Baltic route (data: Rail Baltic Estonia)

The following aspects were mainly taken into account when developing the route options:

1) location in relation to residential areas (buffer at least 500 metres);
2) location in relation to Natura sites, protected areas and habitats of protected species;
3) location in relation to cemeteries, heritage protection areas and objects; the technical suitability of the route;
4) cost and socio-economic expenses.

Based on the assessed criteria, the route options were proposed with the smallest negative impact of all assessed impacts (Korduma kippuvad…2020).

The pre-selection of route options was based on the principle that Natura sites should not normally be crossed by rail, which ensures the protection and minimum disturbance of priority species and habitat types. For all route variants, a nature value survey was conducted under the guidance of researchers from the University of Tartu, which provides information on the current situation and potential conflict areas. The main aspects studied were protected species, protected areas, large mammals, medium-sized mammals and bats. The study also mapped animal pathways and proposed mitigation measures (ecoducts and solutions for smaller animals) (samas, 2020).

Mitigation measures:

- Ecoducts, tunnels and culverts will be built along the corridors and animal routes of the main networks, together with the structures leading to them.
- Medium-sized animals (smaller than badgers) should be allowed to pass under the fence throughout the railway. An exception could be human settlement areas where domestic animals also move.
- Fences of at least 2.5 meters high should, in particular, restrict the movement of solipeds and large carnivores, as they pose a real threat to rail traffic.
- During and after the construction of the railway, efforts will be made to preserve ecologically valuable feeding places and habitat.
- To ensure the protection of bodies of water and wetlands, geotextiles are used in the storage of construction materials to prevent potential contamination by suspended solids. In the vicinity of natural wetlands, special attention is paid to maintaining an important water regime for flora and habitats.

- Passages are built after every 25-50 meters for amphibians, reptiles and small mammals (rodents) that cannot climb rails. These are simple gutter-like openings. Depending on the needs of the natural environment, noise barriers will be built, for example in the vicinity of black grouse areas.
- In forests, construction activities are avoided during the main breeding season of animals and birds from April to June.

Following the construction of the railway, nature observations will be continued to detect unforeseen effects. Additional measures will be taken if necessary (Korduma kippuvad…2020).

4.2 Rail Baltic project and environmental impacts

In April 2013, the county planning process was initiated together with the SEA (Strategic Environmental Assessment) process for defining route options in Pärnu, Rapla and Harju counties (Rail Baltic maakonnaplaneeringute…2017).

The purpose of the SEA (Strategic Environmental Assessment) was to forecast and assess the environmental impact of the Rail Baltic project, describe and assess alternatives, identify positive impacts and plan measures to prevent and mitigate possible negative impacts to ensure the integration of environmental considerations into the county plan (CP) of the strategic planning document. During the course of the work, all significant environmental aspects related to railway design and the consequences of their possible impact were examined. The impact assessment was initiated as a strategic environmental impact assessment for the county plans of the route options (Rail Baltic maakonnaplaneeringute…2017).

Among the tasks of the project was the preparation of a preliminary design of the railway course on the alternative preferred route, the impact of the construction and subsequent use of which was also assessed in the level of precision of this stage. From the point of view of the environmental impact assessment methodology, this first meant the selection of the most preferred route option using strategic environmental impact assessment methods, followed by a detailed analysis of the environmental impact of the implementation of the selected and preferred option, together with the development of the necessary environmental mitigation measures (e.g. noise barriers, ensuring the mobility of people,

ecoducts, etc.). In addition, the SEA aimed to analyse the environmental sustainability of the region, taking into account the widely recognized experience in environmental impact assessment and environmental legislation (samas, 2017).

4.3 Rail Baltic project and Strategic Environmental Assessment (SEA) in the level of detail of the Environmental Impact Assessment (EIA) and areas of impact

Strategic environmental assessment is a process that enables the implementation of the principles of sustainable development as well as the objectives of environmental policy. Strategic environmental assessment bears key importance in taking into account environmental policy obligations arising from both international agreements and European Union law in Estonian development documents, to ensure that the principles of sustainable development are guaranteed at all levels of decision-making (Rail Baltic maakonnaplaneeringute…2017). During the SEA of the Rail Baltic project, the impacts were assessed in the context of the SEA on the basis of the following criteria.

1. Impact on the climate;

2. Natura 2000 areas;

3. Mortality;

4. Disturbances;

5. Habitat loss;

6. Habitat fragmentation (including barrier effects);

7. Impact on groundwater quality;

8. Impact on surface water quality and movement;

9. Effects on soil and terrain;

10. Noise;

11. Ambient air quality;

12. Vibration;

13. Electromagnetic effects;

14. Waste generation and treatment facilities;

15. Economical use of materials;

16. Danger of accidents;

17. Living conditions;

18. Local identity;

19. Population development;

20. Community resilience;

21. Mobility, barriers;

22. Possibilities for the implementation of local train traffic to the extent of free railway capacity;

23. Buildings in the immediate vicinity;

24. Value of real estate - residential land;

25. Value of real estate for other land purposes;

26. Settlement structure;

27. Agricultural use of land;

28. Wholeness of agricultural land;

29. Forestry use;

30. Natural resources;

31. Infrastructure;

32. Impact on the local economic environment;

33. Cultural monuments;

34. Unmapped archaeological heritage;

35. Valuable landscape and environment;

36. Visual aspects;

37. Cultural heritage of critical or otherwise significant nature;

38. Other types of cultural heritage (Rail Baltic maakonnaplaneeringute…2017).

4.4 Rail Baltic mõju kliimale metsamaa raadamise seisukohast

According to § 6 – 31^1 of the EIAEMSA (entry into force 01.01.2020), clearing of forest land with an area of more than 100 hectares is an activity with a significant environmental impact (Keskonnamõju hindamise….2005).

When constructing the Rail Baltic railway line, it is necessary to clear an estimated 560 ha of forest land (taking into account the need for clearing of up to 50 m of the railway corridor). The maturity of forests has not been assessed separately in the case of stands remaining on the railway line, but as an Estonian average, the share of forests over 60 years of age is 37.8% of the total area of stands. Based on the Estonian average estimate of younger stands, the total area of stands younger than 60 years is approximately 350 hectares (Rail Baltic maakonnaplaneeringute…2017).

According to the Ministry of the Environment, the current rules and methodology claims that the emissions from clearing 560 ha of forest are approximately 282 Gg CO2 or 0.28 million tonnes of CO_2 (Environmental Agency, 2017). Considering the forest clearing areas of previous years (approx. 200 - 600 ha per year), due to Rail Baltic, 560 ha can be clearner for several years, which may hinder the fulfillment of Estonia's commitments under climate agreements, especially if forest clearing takes place after 2020. During the construction period of Rail Baltic, Estonia must take into account additional emissions resulting from fulfilling the obligations of the land use and forestry sector. As a mitigation measure, the timber harvested during the construction of Rail Baltic must be valued in Estonia to the maximum extent possible (Rail Baltic maakonnaplaneeringute…2017).

Forests sequester carbon dioxide and convert it into organic matter. They also emit carbon dioxide (and other anthropogenic greenhouse gases or GHGs) through the decomposition of organic matter and the respiration of forest biota (Mets ja kliima… 2020).

Forests absorb carbon from the atmosphere through photosynthesis to synthesize organic compounds. This carbon is stored in trees (tree trunks, roots, branches and leaves). Forests also store carbon in forest soils and undergrowth. Carbon is released during the decomposition of fallen leaves and branches and through the roots. The world's managed forests store an estimated 296 Gt (approximately 74 tonnes per hectare) of carbon in biomass both above and underground, which is almost half of all carbon stored in forests. About 44% of forest carbon is stored in living biomass, 5% in dead wood, 6% in fallen leaves and 45% in soil. In 2011, the world's forests stored a total of about 861 GB of carbon (Mets ja kliima… 2020).

5 Methodology

This study analyses the extent of the impact of the proposed railway route on the Rail Baltic to protected species and the green network. The analysis used railway planning literature, research articles, legislative acts, development plans, EELIS database, registers, project reports found on the Rail Baltic website, surveys and SEA, the Land Board's map application, ArcGIS software, etc.

To determine the extent of the impact of the Rail Baltic route on forest clearing (protected species and the green network), an analysis was performed with the ESRI software program ArcGIS 10.7.1. The data layers used in the ArcGIS program (Rail Baltic route, protected species and green network areas) come from Rail Baltic Estonia Ltd and the Environmental Register. The data layers have been digitised by the work author using the Land Board's Gray Map (2020) as a base. The study area is divided into two areas of influence: the direct area of influence, that is the railway protection zone, and the indirect area of influence, that is the railway displacement space, Figure 8 (data: Rail Baltic Estonia).

Figure 8. Areas of influence of Rail Baltic

Route corridor - a railway route corridor determined by county plans is the land and railway protection zone required for the construction of a railway together with the "displacement space" of the route. In a dispersed settlement, the width of the corridor is 350 metres. The 350-metre corridor includes a displacement space, while the actual land requirement of the railway is 66 metres**.** In Tallinn, Pärnu and larger populated areas, where the route corridor runs along the existing railway line (a well-established built environment), the width of the corridor is 150 metres. Inside the corridor, the proposed railway line with a protection zone, generally 66 metres wide and approximately 35 metres from the line, is fenced (Trassikoridor…2020).

Railway land - land under railway and railway infrastructure buildings, structures and land necessary for servicing (lines, slopes, maintenance roads, noise barriers, etc.). The extent of the railway area with the protection zone is generally 66 metres, the railway distance may be wider in case of special railway solutions (at stations, signalling points, in case of additional tracks). (Trassikoridor…2020).

Displacement space – (In a dispersed settlement areas 142 metres and in larger settlements 42 metres respectively) is necessary to allow for the necessary adjustments during project. It is not possible to consider all the details necessary for the project when compiling county plans, due to the approach typical of regional planning and the high degree of generalisation of the maps to be compiled. (Trassikoridor…2020).

Railway protection zone – to ensure the use of the railway for its intended purposes, smooth railway traffic and alleviation of the damaging effects caused by the railway. The width of the protection zone is calculated from the axis of the track (on multi-track railways and stations from the axis of the outermost track) and is 30 metres (as specified in the draft Railway Act). According to the current legislation, the width of the protection zone in cities and settlements is 30 metres and outside cities and settlements 50 metres. In the railway protection zone (outside the fenced area), the construction of buildings and structures, storage and installation of equipment and materials that endanger visibility in the protection zone may occur only with the prior written consent of the Technical Requlatory Authority and the relevant railway infrastructure manager or other railway owner or keeper. (Trassikoridor…2020).

5.1.1 Indicators for assessing the impact of forest clearing

In this master's thesis, two indicators have been selected to assess forest clearing on the Rail Baltic route.

1) Protected areas on the Rail Baltic route;

2) Support- and Core Areas of green network.

5.1.2 Protected areas on the Rail Baltic route

The assessment of protected areas on the Rail Baltic route is based on direct and indirect impact.

1) direct area of impact or railway protection zone — land area 66 m wide where a railway will be built and where plantation, animal habitats and other objects will actually be destroyed or can be damaged (Rail Baltic maakonnaplaneeringute…2017).

2) indirect area of impact or railway displacement space — 142 m area, within which it is possible to change the location of the railway during the design, if necessary (Rail Baltic maakonnaplaneeringute…2017).

Protected areas are territories, where human activities are restricted or prohibited entirely. Protected areas are established in order to preserve Estonia's natural resources. The protected areas and objects in Estonia are (Kaitstavad alad, 2020):

National parks;

- Nature conservation areas;
- Landscape conservation areas;
- Limited-conservation area;
- Species' protection sites;
- Parks and forest stands;
- Individual protected natural objects:

- Areas with old or non-renewed protection regime;
- natural objects protected at the local government level.

In the analysis of protected areas, the layers of the impact zones of the Rail Baltic route were used in the work together with the layer of nature conservation and Natura 2000 areas in the form of Esri shapefile (SHP). The layer of nature conservation and Natura 2000 areas comes from the Environmental Agency's spatial data service - KRATT. The service is only available to contractual partners for downloading map layers of the Environmental Register and the Estonian Nature Information System (EELIS). To find the common part of the impact zone with nature conservation and Natura 2000 areas, the ArcGIS Pro tool "intersect" was used for data processing, Figure 9 (data: ESRI). This tool was used to select all conservation areas, nature areas and Natura 2000 areas that reach the direct railway impact zone (66 m) and undirect impact zone (350 m).

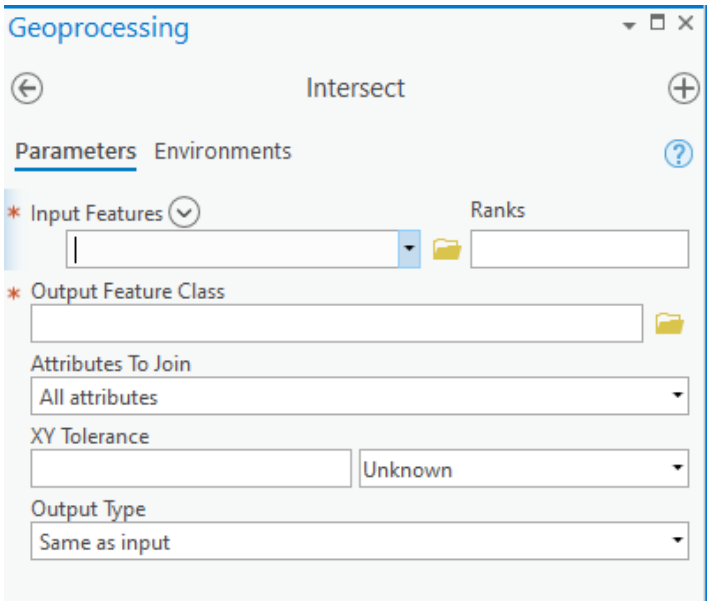

Figure 9. Intersect tool

In the next step, the results obtained with the Intersect tool were used and the region of each protected area was calculated and added together later. To do this, ArcGIS Pro tool “Add Geometry Attributes“ was used, Figure 10 (data: ESRI). To use the tool, the appropriate layer for data processing in the "Input Feature" window had to be selected, then the geometric feature, which, in the case of this analysis, was “Area”. The next step was to choose the Area Unit and the Coordinate System.

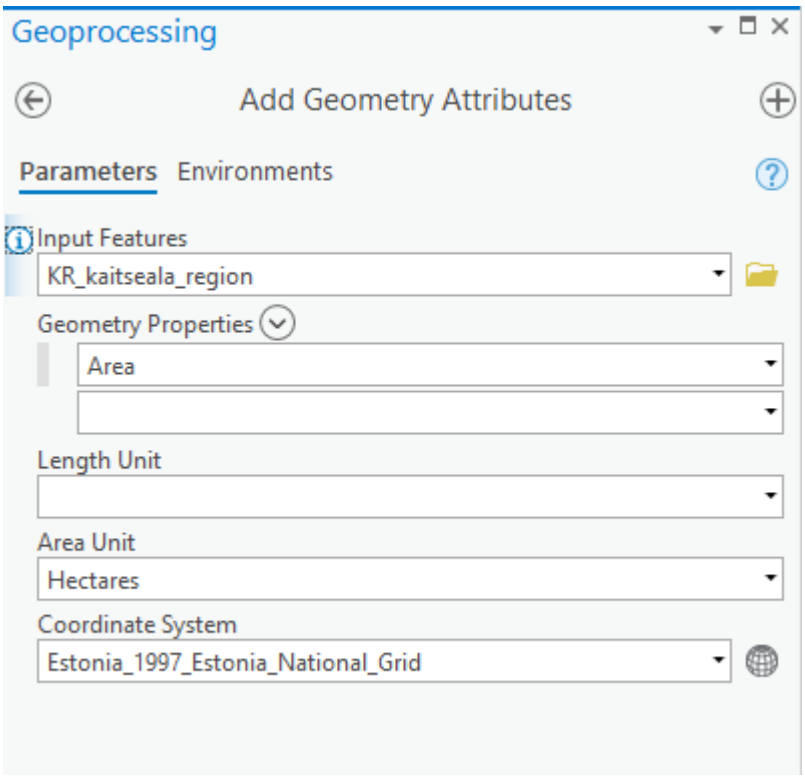

Figure 10. Add Geometry Attributes tool

In order to analyse the woody plants within the protected areas, vector data on the woody vegetation were downloaded from the Geoportal of the Land Board. For this purpose, the entire data "land use type" of Estonia was selected in a separate shape format. After downloading the data, the common part of the areas of the protected areas and the areas under the woody vegetation was found again with the tool "Intersect". As a result, it was possible to calculate how much of the forest overlaps the protected areas, Figure 11 and 12 (data: Rail Baltic Estonia).

Figure 11. Nature protection and Natura 2000 areas on Rail Baltic route

Figure 12. Nature protection and Natura 2000 areas on Rail Baltic route

5.1.3 Results

As a result of data processing in ArcGis Pro, five nature conservation and Natura 2000 areas remained under the direct influence of the route. The information is presented in the table 1 (data: Rail Baltic Estonia).

Table 1. Nature conservation and Natura 2000 areas on the Rail Baltic route with the area of woody flora

Name of the conservation area	**Name of the Natura area**	**Protected area within the impact area (ha)**	**Area of woody flora (ha)**	**Type**
Lemmejõe limited-conservation area (KLO2000247)	Lemmejõe nature area (RAH0000029)	1.1	0.26	forest
Luitemaa nature conservation area (KLO1000282)	Luitemaa area hosting birds (RAH0000105), Luitemaa nature area (RAH0000615)	0.09	0.09	forest
Pärnu landscape conservation area (KLO1000603)	Pärnu nature area (RAH0000325)	5.38	5.12	forest

Männiku natterjack toad and sand lizard species' protection site (KLO3000592)	-	10.3	0.37	forest
Rääma eagle owl species' protection site (KLO3001798), Urge lesser spotted eagle species' protection site (KLO3001311)	-	13.7	0.02	forest
Total		**30.57 ha**	**5.86 ha**	

Nine nature conservation and Natura 2000 areas remained in the indirect impact area of the route. The information is presented in the table 1 (data: Rail Baltic Estonia).

Table 2. Nature conservation and Natura 2000 areas on the Rail Baltic route with the area of woody flora

Name of the conservation area	**Name of the Natura area**	**Protected area within the impact area (ha)**	**Area of woody flora (ha)**	**Type**

Lemmejõe limited-conservation area (KLO2000247)	Lemmejõe nature area (RAH0000029)	6.24	2.67	forest
Laiksaare nature conservation area (KLO1000237)	Laiksaare nature area (RAH0000310)	14.3	3.2	forest
Luitemaa nature conservation area (KLO1000282)	Luitemaa area hosting birds (RAH0000105),Luitemaa nature area (RAH0000615)	5.4	4.9	forest
Rabivere landscape conservation area (KLO1000246)	Rabivere nature area (RAH0000560)	0.4	0.4	forest
Taarikõnnu nature conservation area (KLO1000058)	Taarikõnnu nature area (RAH0000557), Taarikõnnu-Kaisma area hosting birds (RAH0000085)	0.96	0.96	forest
Loo Fringed pink and Moor-king Lousewort species' protection sites (KLO3001652)	-	0.57	0	

Pärnu landscape conservation area (KLO1000603)	Pärnu nature area (RAH0000325)	152.8	27	forest
Männiku natterjack toad and sand lizard species' protection site (KLO3000592)	-	50	1.21	forest
Rääma eagle owl species' protection site (KLO3001798), Urge lesser spotted eagle species' protection site (KLO3001311)	-	71.2	0.36	forest
Total		**301.87**	**40.7**	

The forest stand type characterizes the stand height, shape and condition. The forest is a growing area for woody plants with a canopy cover of at least 30%, including felling and reforestation (ETAK…2019).

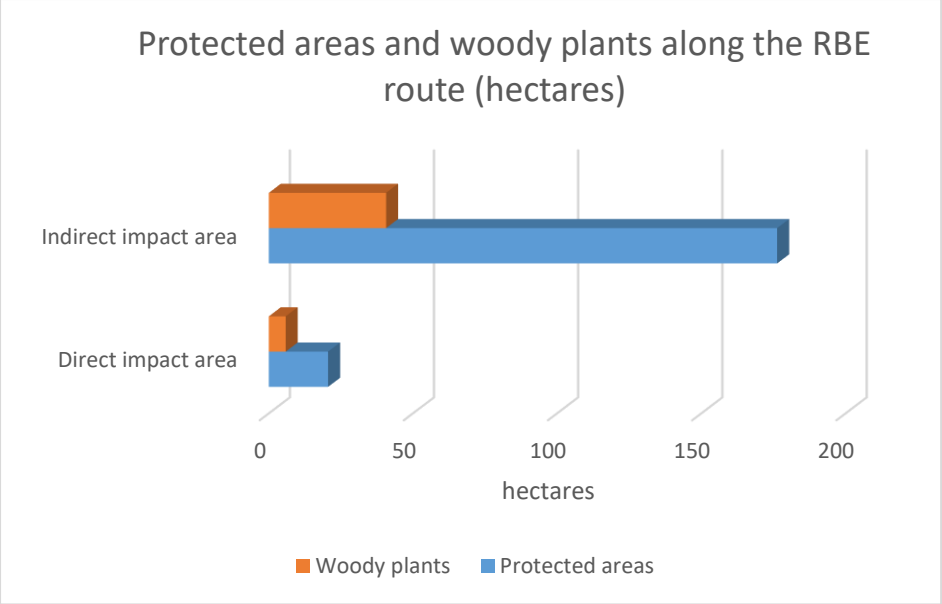

Figure 13. Conservation area and woody flora remain on the RBE route (ha).

Forest maturity has not been assessed separately for forest stands remaining on the railway line, but as an Estonian average, the share of forests over 60 years of age is 37.8% of the total area of forest stands. Based on the Estonian average assessment of younger forest stands, the total area of forest stands younger than 60 years is total of 350 ha (Rail Baltic maakonnaplaneeringute…2017).

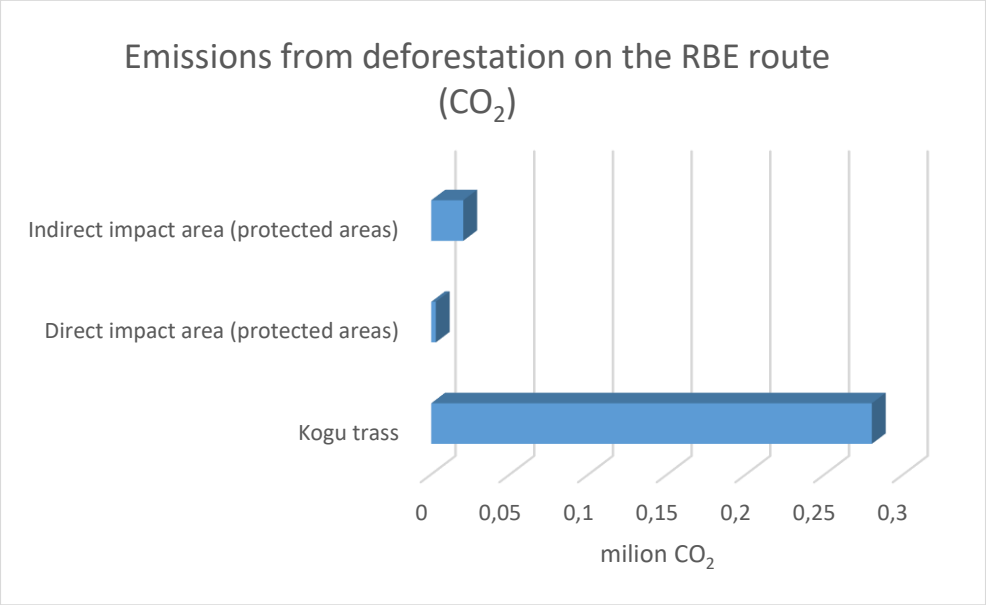

Figure 14. Emissions from clearing on the RBE route (CO2).

The calculation of emissions from forest clearing was based on the strategic Environmental Impact Assessment report on the Rail Baltic route. According to the report, clearing of 560 ha generates about 0.28 million CO_2 emissions (Rail Baltic maakonnaplaneeringute…2017). According to the calculations, it was found that the clearing of woody vegetation due to the protected areas (in the direct impact area of the route) leaves about 0.00293 million CO_2 unbound. Clearing the woody vegetation due to the protected areas (in the indirect impact area of the route) leaves about 0.02035 million CO_2 unbound.

5.1.4 Support and core areas of green network in Rail Baltic route

Green network' means a system which is comprised of natural and semi-natural biotic communities and which ensures the preservation of various types of ecosystems and landscapes and balances the impact of human settlement and economic activities and which consists of core areas and of green corridors that connect core areas (Planeerimisseadus, 2015).The green network preserves the values and functions of natural ecosystems and offers benefits for both the natural environment and people (Rohevõrgustiku väärtuste hinnang, 2018).

The green network is needed for natural self-regulation and for the functioning of such vital processes as groundwater and surface water generation, air purification, natural cycles of chemical elements, etc. The network also aims to mitigate and adapt to the effects of climate change (e.g. floods). The network mitigates or prevents anthropogenic impacts, supporting the preservation of biodiversity and a stable state of the environment. The green network ensures the free migration of animals and the preservation of their habitats, as well as the spread of flora and species. In addition to the above, the green network close to densely populated areas also plays a role as a provider of recreational opportunities and forest resources (berries, mushrooms) as well as a source of aesthetic value (landscape diversifier, nature proximity). On the one hand, green areas must offer residents the opportunity to move around in nature, and must provide a diverse and valuable living environment for animal and plant species on the other (Rohevõrgustiku väärtuste hinnang, 2018).

In all infrastructures, including the green network, three components can be distinguished (Sepp et al. 2002):

1. areas of support (the most important and efficient elements supporting the basic systems);

2. corridors, strip structures or so-called interconnection elements (nodes and step boards of strip structures that ensure coherence and territorial integrity);

3. Neutral area or zero areas (areas within which support areas and strip structures can be expanded and modified).

The assessment of the areas of the green network on the Rail Baltic Estonian route was based on the direct and indirect area of influence of the railway.

1) the direct impact area, i.e. the railway protection zone, is a 66 m wide thematic area where a railway is built and where plant communities, animal habitats and other objects are actually destroyed or can be damaged (Rail Baltic maakonnaplaneeringute…2017).

2) indirect area of influence, i.e. the displacement space of the railway - 350 m area, within which it is possible to change the location of the railway during the design if necessary (Rail Baltic maakonnaplaneeringute…2017)

In order to compile the analysis of the green network on the Rail Baltic Estonian route, source data were collected from Rae municipality, the Environmental Agency and Skepast & Puhkim Ltd. The spatial areas of the green network are visible in Figure 15 (data: Rail Baltic Estonia).

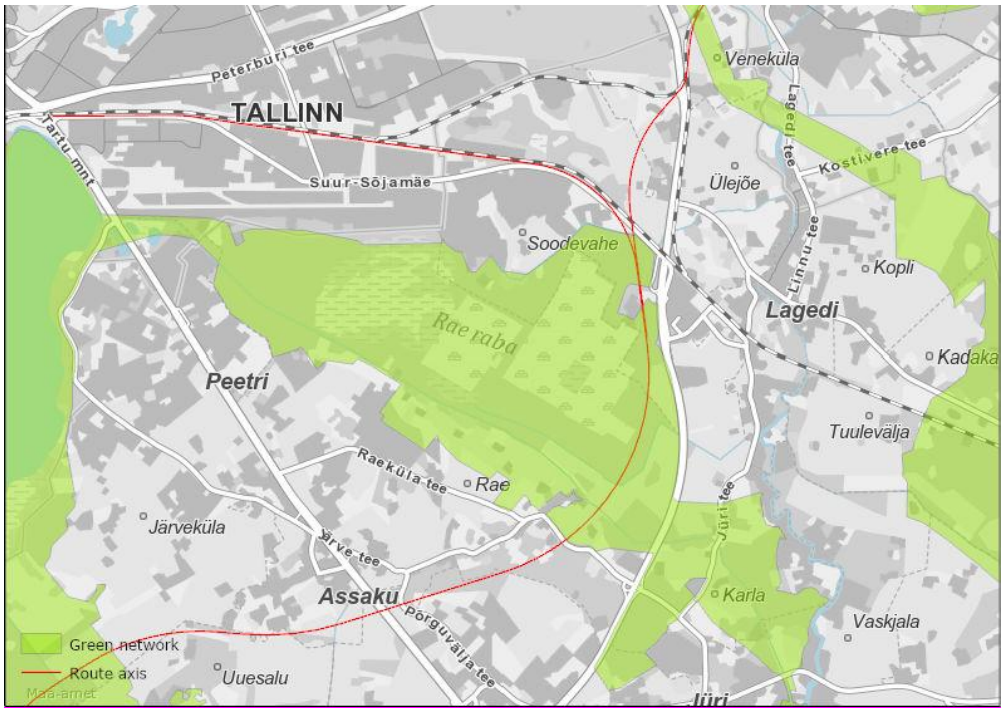

Figure 15. Data analysis of the green network areas

To find the overlap of direct and indirect impact areas with the green network areas, ArcGIS Pro tool "Intersect" was used to process the data, Figure 16 (data: ESRI), The tool was used to select all areas of the green network that extend into the direct (66 m) and indirect (350 m) impact areas of the railway route.

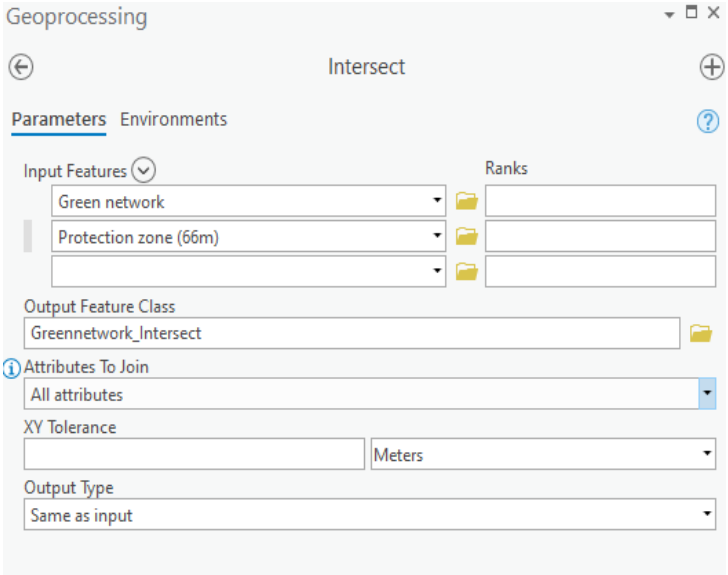

Figure 16. Intersect Tool

In the next stage, the results obtained with the Intersect tool were used and the area of each green network was calculated and then added together. For this, ArcGIS Pro tool “Add Geometry Attributes” was used, Figure 17 (data: ESRI). To use the tool, the appropriate layer for data processing in the "Input Feature" window had to be selected, and then the geometric feature that was "Area" for this analysis. The next step was "Area Unit" and "Coordinate System".

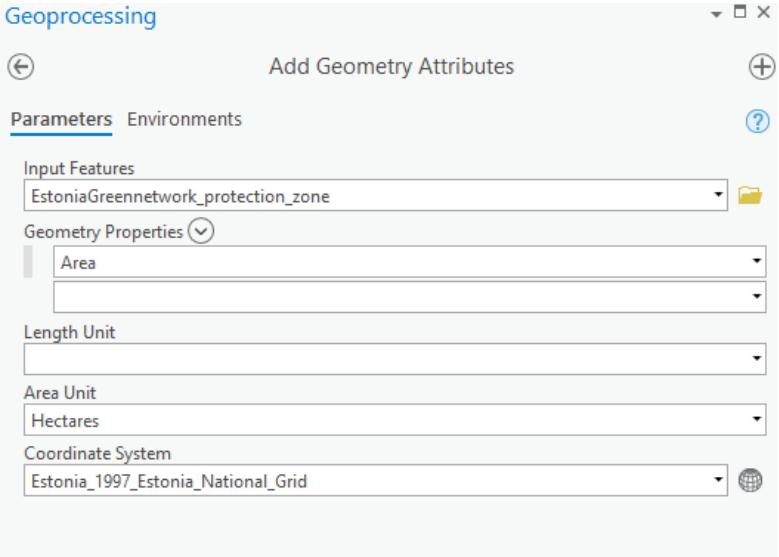

Figure 17. Add Geometry Attributes Tool

In order to analyse the woody plants within the green network, vector data on the woody vegetation were downloaded from the Geoportal of the Land Board. For this purpose, the entire data "land use type" of Estonia was selected in a separate shape format. After downloading the data, the common part of the areas of the green network and the areas under the woody vegetation was found again with the tool "Intersect". As a result, it was possible to calculate how much of the forest overlaps the green network.

5.1.5 Work results

In the analysis, the assessment and calculation of emissions on the Rail Baltic Estonian route as a result of forest clearing was based on a strategic environmental impact assessment on the Rail Baltic route. According to the report, the clearing of 560 ha generates about 0.28 million tonnes of CO_2 emissions (Rail Baltic maakonnaplaneeringute…2017). As a result of the calculations, it was found that the total amount of woody vegetation in the areas of the green network in the direct impact area of the route (66 m) is approximately 594.4 ha. The woody vegetation in the indirect impact area of the route forms the largest part, i.e. 3152.5 ha. Woody vegetation (in the direct impact area of the route) is approximately 740.3 ha. The results are shown in Table 3 and Figure 18 (data: Rail Baltic Estonia).

Table 3. Areas of the green network on the Rail Baltic Estonian route with the area of woody vegetation

Green network (direct impact area 66 m)	740,3 ha
Woody vegetation (direct impact area 66 m)	594,4 ha
Green network (indirect impact area 350 m)	3 917,5 ha
Woody vegetation (indirect impact area 350 m)	3 152,5 ha

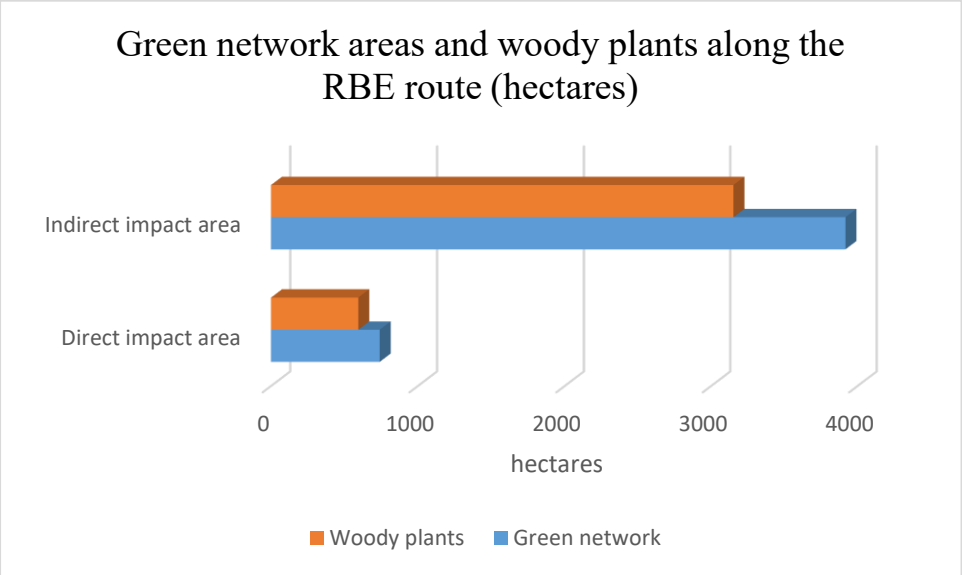

Figure 18. Green network areas woody plants along the RBE route (ha)

Next, the amount of unbound CO_2 due to forest clearing was calculated, assuming that the clearing of 560 ha of forest leaves unbound emissions in the amount of approximately 0.28 million tonnes of CO_2. As a result of the calculations, it was found that 0.2972 million tonnes of CO_2 would be discharged in the direct area of the route due to forest clearing under the green network. Using the same calculation, it was concluded that 1.5762 million tonnes of CO_2 would

be discharged in the indirect impact area of the route due to deforestation under the green network, Figure 19 (data: Rail Baltic Estonia).

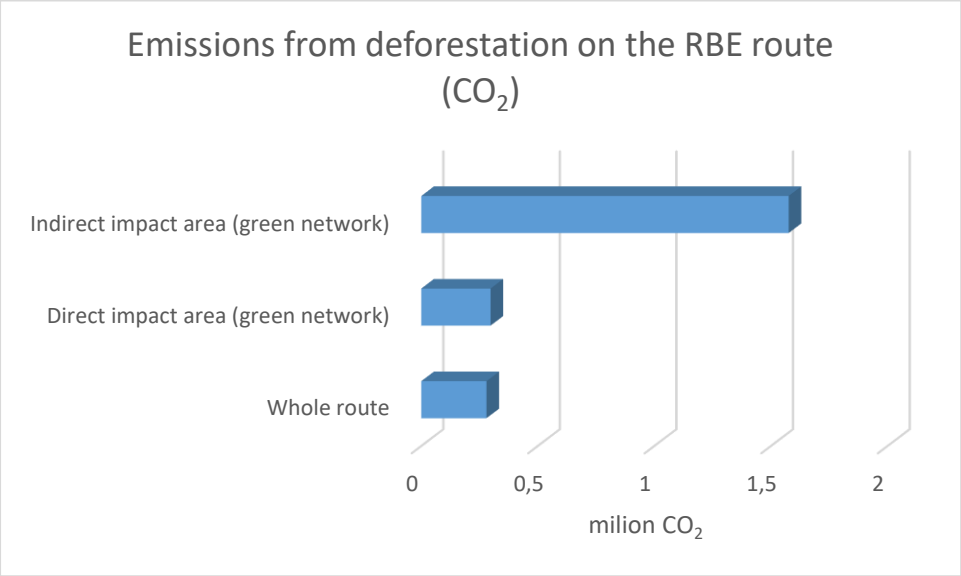

Figure 19. Emissions from deforestation on the RBE route (CO_2)

5.2 Rail Baltic project and possible clearing mitigation measures

Carbon storage in forests can be maintained and increased by reducing forest clearing, afforestation and changing forest management practices at the stand level (Metsad ja kliima muutused, 2020).

In the different phases of the Rail Baltic project, no mitigating measures to reduce forest clearing damage are separately provided for on the Estonian route. The Strategic Environmental Assessment report mentions the maximization of the amount of timber harvested during the construction of the Rail Baltic Estonia route in Estonia as one of the mitigation measures, but no stricter measures are proposed in the report. Habitat loss due to forest clearing and other land use changes is not compensated.

One further possibility is to implement forest clearing taxation or a forest clearing tax in the case of such large-scale projects. Such a solution would make it possible to contribute to the production of forest benefits elsewhere. Taxation could be linked to the amount of CO_2 not sequestered by the forest area in question over a certain period of time set by law. Such a calculation model would require the development of a corresponding tax guide and, in the case

of various projects, a mandatory forest inventory in order to determine the condition and age class structure of the forest. An analysis based on the age class structure of the forest would provide a more relevant overview and input for assessing CO2 values. Another possible solution would be to tax the cost of forest clearing. Such a solution would also require a strong control mechanism with very clear guidelines for new forest management.

It is difficult to create a unitary system for assessing forests when designing additional clearing taxation. It is very difficult to determine the absolute value of forests alone. Value can be formed by making thorough assessments (Lõhmus et al. 2000).

In general, forest value can be divided into utilitarian and non-utilitarian. The former has a price based on direct consumption value (wood, mushrooms, berries). The price of other values is indirectly derived from their consumption value. Attempts have been made to assess them financially using various methods, based on either the loss of income, the amount needed to prevent or restore damage, the cost of the object as real estate, the population's willingness to pay for the benefit, etc. (Lõhmus et al. 2000).

The value of the forest and its assessment is related to the use and protection of the forest. There have been talks of a sentimental goal if one wants to achieve harmony between man and nature. The ethical justification is important – that all living beings have an equal right to live and that man has a responsibility to be a “shepherd” to all living things. According to the recreational justification, nature is a provider of aesthetic pleasure and an invigorating experience that allows a person to recover from everyday routine. The educational goal is based on the view that nature is a source of educational experience that allows a person to feel their environment, and to reminder us of our place in the Universe. The scientific justification sees nature as an inexhaustible source of research, and the aim of research is to ensure the existence of humanity. The consumption argument considers nature conservation as one of the possible uses to keep natural ecosystems as producers of the resources that are essential for human life (Lõhmus et al. 2000). The broader goal of forest protection is to preserve the forest as our traditional living environment, at the same time ensuring its productivity. Excessive proportion of intensively managed commercial forests in general or concentration in a certain area can lead to deterioration of the health and productivity of the entire forest environment (Lõhmus et al. 2000).

Abstract

Rail Baltic on kavandatav moodne, keskkonnasõbralik ja kiire raudtee, mis ühendab Eestit tihedamalt Kesk- ja Lääne-Euroopa naaberriikidega. Kavandatav raudteetrass kulgeb Eestis läbi Harju, Rapla ja Pärnu maakonna.

Käesoleva magistritöö eesmärgiks oli analüüsida kavandatava Rail Baltic raudtee trassi mõju keskkonnale raadamise seisukohast. Töös hinnati raadamise mõju kaitsealadele ja rohevõrgustiku aladele ning arvutati välja ligikaudne CO_2 hulk, mis jääb raadamise tõttu puude poolt sidumata. Põhjalikemate CO_2 uuringute koostamiseks oleks edaspidises protsessis vaja läbi viia metsa inventeerimised, et hinnata puistute vanuselist koosseisu töös uuritud aladel.

Uurimise tulemusena leiti Rail Baltic trassi otsesest mõjualast 5 looduskaitseala ja Natura 2000 ala. Raudteetrassi kaudsest mõjualast leiti 9 erinevat looduskaitse ala ja Natura 2000 ala. Metsade raadamisest tekkiva emissiooni arvutamisel võeti aluseks Kesskonnamõju strateegilise hindamise aruanne Rail Baltic trassil. Vastavalt arvutustele leiti, et kaitsealade tõttu raadatav puittaimestik (trassi otseses mõjualas) jätab sidumata ca 0,00293 miljonit CO2-te. Kaitsealade tõttu raadatav puittaimestik (trassi kaudses mõjualas) jätab sidumata ca 0,02035 miljonit CO2-te.

Rohevõrgustiku alasid leiti Rail Baltic trassi otsesest mõjualast 740,3 hektari ulatuses. Kaudses mõjualas 3 917,5 hektari ulatuses. Arvutuste tulemusel leiti, et trassi otseses mõjualas jääb rohevõrgustiku alla jääva metsa raadamise tõttu sidumata 0,2972 miljonit CO_2-te sidumata. Sama arvutuskäiku kasutades jõuti järelduseni, et trassi kaudses mõjualas jääb rohevõrgustiku alla jääva metsa raadamise tõttu sidumata 1,5762 miljonit CO_2-te. Arvutuste tulemused on ligikaudsed ja annavad esmase ülevaate raadatavate metsade süsinikuringest.

Magistritöö uurimise tulemusi saab rakendada edaspidi keskkonnamõju hindamisega seotud tegevuste korral Rail Baltic Estonia OÜ-s. Antud töö võiks huvi pakkuda samuti keskkonnamõju hindamisega ja planeeringute koostamisega tegelevatele asutustele.

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