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METSADE SERTIFITSEERIMISE ROLL KLIIMAMUUTUSTE LEEVENDAMISEL: FSC JA PEFC SERTIFITSEERITUD METSADE VÕRDLEV UURING

THE ROLE OF FOREST CERTIFICATION IN CLIMATE CHANGE MITIGATION: A COMPARATIVE STUDY OF FSC AND PEFC CERTIFIED FORESTS

Master's thesis
Planning and Analysis in Multifunctional Forestry

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Lõputöö uurib metsasertifitseerimise mõju süsiniku sidumisele Eestis, Lätis ja Leedus. See võrdleb kahte peamist sertifitseerimissüsteemi, Metsahoolekogu (FSC) ja Metsasertifitseerimise Kinnitusprogrammi (PEFC), hinnates nende tõhusust säästva metsamajandamise ja kliimamuutuste leevendamise edendamisel. Metsainventuuri andmete, heitkoguste statistika ja sidusrühmade küsitluste analüüsi põhjal leiab uuring, et FSC-sertifitseeritud metsad siduvad üldiselt rohkem süsinikku kui PEFC-sertifitseeritud või sertifitseerimata metsad. Lätil ja Leedul on suurem metsade sidumisvõime kui Eestil. Küsitluse vastused näitavad aga lahkarvamusi selle kohta, kas sertifitseerimine aitab kaasa jätkusuutlikkusele, mis rõhutab vajadust parandada avalikkuse teadlikkust ja läbipaistvust. Uuringus jõutakse järeldusele, et kuigi sertifitseerimine toetab süsiniku sidumist, sõltub selle edu metsapoliitika rakendamisest ja kohalikest ökoloogilistest tingimustest. Uuring soovitab viia sertifitseerimistavad paremini vastavusse riiklike kliimaeesmärkidega ja tõhustada süsiniku seire jõupingutusi kogu piirkonnas.			
Võtmesõnad: metsasertifitseerimine, süsiniku sidumine, säästev metsamajandamine			

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Abstract: This thesis explores the impact of forest certification on carbon sequestration in Estonia, Latvia, and Lithuania. It compares two major certification schemes, the Forest Stewardship Council (FSC) and the Programme for the Endorsement of Forest Certification (PEFC), assessing their effectiveness in promoting sustainable forest management and climate change mitigation. Analysis of forest inventory data, emission statistics, and stakeholder surveys, the study finds that FSC-certified forests generally sequester more carbon than PEFC-certified or non-certified forests. Latvia and Lithuania have stronger forest sink capacities compared to Estonia, although it has the highest FSC-certified forest area. However, survey responses reveal divided opinions on whether certification contributes to sustainability, highlighting the need for improved public awareness and transparency. The research concludes that while certification supports carbon sequestration, its success depends on forest policy implementation and local ecological conditions. The study recommends aligning certification practices more closely with national climate goals and enhancing carbon monitoring efforts across the region.

Keywords: forest certification, carbon sequestration, sustainable forest management

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INTRODUCTION

Forests play a critical role in mitigating climate change by acting as significant carbon sinks, sequestering atmospheric carbon dioxide, and reducing greenhouse gas concentrations (IPCC, 2019). Globally, sustainable forest management has emerged as an essential strategy for addressing climate change while balancing ecological, social, and economic needs. Forest certification schemes, such as the Forest Stewardship Council (FSC) and the Programme for the Endorsement of Forest Certification (PEFC), have become pivotal in promoting responsible forest management. These certification systems establish guidelines that ensure forests are managed sustainably, thereby contributing to conservation efforts and reducing emissions from deforestation and forest degradation (Rametsteiner & Simula, 2003).

In the Baltic region, encompassing Estonia, Latvia, and Lithuania, forests cover a substantial portion of the landscape and serve as a critical resource for both ecological balance and economic development (Stupak et al., 2011). The region's high forest cover, combined with its commitment to sustainability, positions it uniquely within the global forestry sector. However, the effectiveness of certification systems in delivering climate mitigation outcomes remains an area of ongoing debate and research.

Forest certification systems, particularly FSC and PEFC, are designed to enhance the environmental, social, and economic sustainability of forestry operations. While both certifications aim to achieve similar goals, their approaches, governance structures, and implementation processes differ (Overdevest & Rickenbach, 2006). This raises questions about their comparative effectiveness in mitigating climate change, especially in regions like the Baltic states, where forest resources are central to national economies and environmental policies.

Understanding the contributions of FSC and PEFC certifications to climate change mitigation is crucial not only for policymakers and forest managers but also for global efforts to meet climate targets such as those outlined in the Paris Agreement. By analyzing and comparing the impacts of these two major certification systems, this study will provide

valuable insights for stakeholders, including policymakers, forest managers, and environmental organizations who seek to optimize sustainable forest management practices to meet climate targets. The findings may inform improvements in certification standards, influence policy development, and assist consumers and industries in making informed choices that support climate mitigation.

In recent times, there has been an increasing global concern over climate change and the need for sustainable forest management practices that promote carbon sequestration and climate mitigation. Forest certification systems and organizations, such as the Forest Stewardship Council (FSC) and the Programme for the Endorsement of Forest Certification (PEFC), promote responsible forest management. However, there is limited empirical evidence on the comparative effectiveness of these certification standards and their role in climate change mitigation efforts.

Despite the increasing adoption of FSC and PEFC certifications globally, limited empirical evidence exists on their specific contributions to climate change mitigation. A comparative analysis of these certifications is particularly relevant in the Baltic region, where forests play a pivotal role in carbon sequestration. Key questions remain unanswered: How do FSC and PEFC certifications influence forest management practices that contribute to carbon storage and reduced emissions? What challenges and opportunities do these certifications present in the Baltic context? Addressing these gaps is essential to inform sustainable forestry policies and practices (Auld et al., 2008).

Research Hypothesis:

Null Hypothesis (H0): There is no significant difference in the effects of climate change mitigation, such as carbon sequestration rates and greenhouse gas reduction, between FSC-certified forests and PEFC-certified forests.

Alternate Hypothesis(H1): FSC-certified forests contribute more effectively to climate change mitigation through higher carbon sequestration rates and better climate resilience practices than PEFC-certified forests.

This study aims to evaluate the contributions of FSC and PEFC certifications to climate change mitigation in the Baltic region. The specific objectives are:

1. To analyze the role of FSC and PEFC certifications in promoting sustainable forestry practices that contribute to climate change mitigation.
2. To compare the effectiveness of FSC and PEFC certifications in enhancing carbon sequestration and reducing emissions.
3. To identify challenges and opportunities associated with implementing these certification systems in the Baltic.

The research seeks to answer the following key questions:

1. How do FSC and PEFC certifications influence climate change mitigation practices in the Baltic region?
2. What are the differences in effectiveness between FSC and PEFC certifications in promoting sustainable forestry?
3. What challenges and opportunities exist for implementing these certifications in the Baltic States?

1. LITERATURE REVIEW

1.1 Background of study

The role of forest certification in sustainable forest management has been widely studied, with particular attention given to its environmental, social, and economic benefits. As global attention turns to climate change mitigation, certification systems such as the Forest Stewardship Council (FSC) and the Programme for the Endorsement of Forest Certification (PEFC) have been recognized for their potential to promote sustainable practices that contribute to reducing carbon emissions and enhancing carbon sequestration (Rametsteiner & Simula, 2003; Cashore et al., 2004). This literature review critically examines existing research on forest certification, its contributions to climate change mitigation, and its application within the Baltic region, focusing on FSC and PEFC certifications.

1.2 Forest Area

More than half of the land area in Estonia, Latvia, and Lithuania is covered with forests. The main tree species in these forests are Pine, Spruce, and Birch. Although the main tree species are predominantly conifers, there are also some broadleaf trees like Oak, Aspen, Maple, and Ash. Approximately 7.2 million hectares of land are covered by forests in all three Baltic countries combined. These forests are not only serving as a home to many living creatures but also as a major source of fun, relaxation, and adventure. Forests in the Baltic states have great hiking trails that go through different types of forests with amazing landscapes and views.

In an era where biodiversity, conservation, and climate change are of great concern, forests in Estonia, Latvia, and Lithuania are contributing tremendously to sustainable forestry and the mitigation of climate change. Forests are one of Earth's largest carbon sinks, and over the years, forest owners, governments, and stakeholders in the forest industry have become more involved and actively working towards reducing carbon levels in the environment. This has resulted in the introduction of various sustainable forestry management practices. Forest management plays a vital role when it comes to carbon level reduction. The reason

is that forests have the potential to absorb significant amounts of carbon from the atmosphere (Björheden, 2020). The forest cover of all three countries can be seen in Figure 1 below. From the map, forest areas are represented by the green color, and these areas spread across the total land size of the Baltic states.

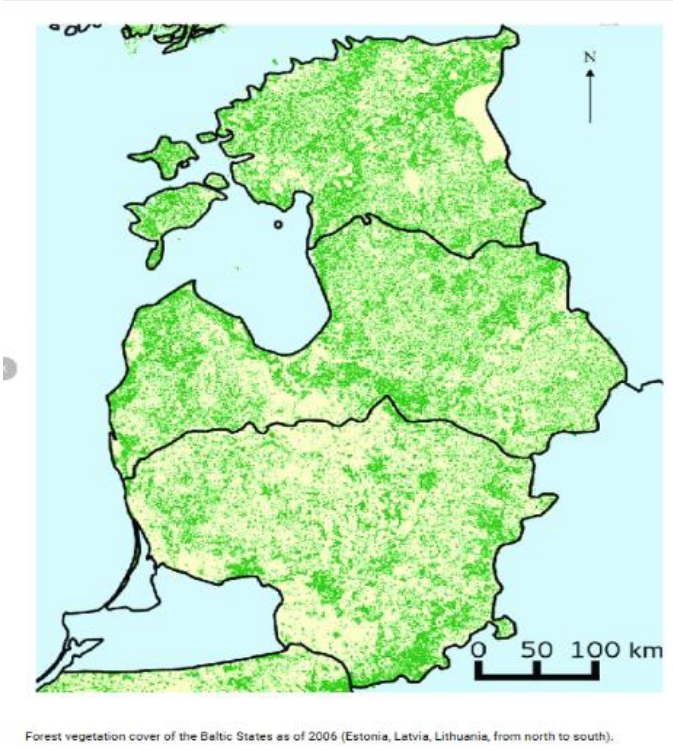

Figure 1. Forest Cover Map of Estonia, Latvia, and Lithuania. **(**Jogiste et al., 2018)

1.2.1 Forest Types in the Baltic States

Estonia's forests cover 51% of the total land area. The forests are a natural and economic treasure to the people of Estonia. Forest types are based on the classification of Estonian vegetation site types. There are five forest types: dry boreal forests, floodplain forests and shrublands, paludified forests, peatland forests, and drained peatland forests. Estonia has some Natura 2000 habitat types, including ten forest habitat types endangered in Europe (Loodusveeb, 2021).

The forests cover an area of 2.7 million hectares, representing 42% of the total land area of Latvia. Over the years, there has been a steady growth in forest area cover. Forests in Latvia are grouped into three divisions based on their function and significance from certain perspectives. These include ecological, economic, or some other particular function. There are protected forests, restricted management forests, and exploitable forests. These three classes of forests make up 12.6%, 38.5%, and 48.9% of the total forest area, respectively. Latvia's forests are either naturally or artificially regenerated (FAO, 2020). Forest types in Lithuania are classified based on forest site types, which are determined based on fertility and humidity. The types of forests are hemiboreal and nemoral coniferous forests, mesophytic deciduous forests, mire and swamp forests, floodplain forests, non-riverine Alder, Birch, and Aspen forests, and introduced tree species forests (Kulbokas, 2010).

1.3 Forest Management and Ownership

According to the Forest Act, "Forest management is the silvicultural use of forests, and forest protection." The Forest Act also outlines various regulations about the use and management of forests (Forest Act, 2006). In Estonia, the state owns 51% of the forest and is managed by the State Forest Management Centre (RMK). Private owners possess 49% of forest land. Natural persons own 27% and legal persons own 22%. Protected areas, limited-conservation areas, species protection sites, individual protected natural objects, and nature objects protected at the municipal government level comprise one-fifth of Estonia's forest land. Strict nature reserves and conservation zones of protected areas comprise one-tenth of Estonia's forest land. Apart from strict nature reserves and conservation zones, sites of protected category I species, important habitats of state forests and private forests covered by a contract, and planned strict nature reserves and conservation zones for planned protected areas are also under strict protection (Loodusveeb, 2024). The broad distribution of forest ownership by owner type and location by county can be described using land cadastre data, which has mostly been used to characterize the nature and changes of forest ownership. It is not feasible to determine the number of forest owners or the distribution of their land by size because the data of cadastral units and the land register are not connected.

Other land use regions, such as wetlands, have also been recorded in the cadastre as forest land in the case of territory under the State Forest Management Centre (RMK) (Forest Yearbook, 2020).

According to the statistical forest inventory, 18.4% (429,610 hectares) of Estonian forest area was strictly protected in 2023. Furthermore, protected forests, or forest land where limited forest management operations are permitted, accounted for 13.2% (308,454 ha) of all forest land. State territory contains the majority of the strictly protected forest land, which is 34.1% (365,047 ha) of forest land managed by RMK (Loodusveeb, 2024).

Forests are classified based on designated management goals, which are conservation of biodiversity, multiple use, production forest, and protection of soil and water. Strictly protected forests fall under the category of conservation of biodiversity, and they include forest areas on conservation sites, strict nature reserves, protected woodland key habitats, and category I protected animal and plant species (FRA, 2020). A place where the likelihood of narrowly adapted, endangered, vulnerable, or unusual species occurring is high is known as a key habitat. A rule issued by the minister in charge of the policy sector will define the key habitat classifications and the selection criteria. In a forest owned by a legal entity subject to public law, the landowner or their designated representative, as well as the state forest manager, coordinate the preservation of important habitats in compliance with the protocol set forth by the minister overseeing the policy sector. Depending on the primary habitat conservation goal, the regulation may limit or outright forbid economic activity in a vital area (Forest Act, 2006).

Latvia is one of the most wooded European Union (EU) member nations, with forests occupying over half of its land, about twice the global average. The standing volume has increased 3.8 times, to 680 million cubic meters, while the forested area has doubled during the past 80 years. Of the 41,039 hectares of forest regenerated in 2022, 44% were in state-owned forests and 56% were in private-sector woods. (Investment and Development Agency of Latvia, 2022). In order to ensure that forest management practices prevent the health of forest stands from deteriorating and that diseases and insect infestations are detected early, the Forest Service monitors the state of all Latvian forests. According to the

Forest Assessment Report (FRA), the state forest service's information on forest resources is used to categorize forest areas. National parks and strict nature reserves are included in these categories. Additionally, there are protected forest areas that contain several habitats listed in Natura 2000. In Latvia, the ownership of forests has evolved since 1990. Public ownership, private ownership (by individuals), private ownership (by private companies), and other ownership forms like free and joint land are the different ownership categories (FRA, 2020).

Lithuanian forests are mainly managed by the State Forest Enterprise and other private owners (Daiva et al., 2020). The state forest performs a variety of management tasks, such as evaluating the effectiveness of forest management techniques and inspecting forest inventory and cadaster data on-site. All public and private forest managers are invited to engage in internal forest management projects. This is to guarantee that both state-owned and private forest management adhere to a specific set of management techniques (State Forest Services of Latvia, 2023). At the beginning of 2022, approximately 1,115,100 hectares, or half of Lithuania's total forest acreage, were of state importance. The projected size of private forests was 935,000 hectares after the strata of all forests and private holdings intersected. The State Forest Enterprise oversaw 1,080,000 hectares of forest land, with an average of 41,500 hectares of forest area administered by each of its 26 regional subdivisions. The State Enterprise Centre of Registers reports that in 2021, there was a 6,000-hectare increase in the amount of forest under private property rights management (Forestry Ownership Statistics, 2022).

1.4 Forest Policy

Forest policies across the globe are increasingly geared toward climate change mitigation through sustainable forest management. While some countries prioritize recreational and aesthetic forest values, others emphasize economic development via timber and forest-based industries. Despite these differences, there is broad recognition of the growing diversity of forest-related interests and the pressures forests face from pollution, land-use change, and

climate impacts. A persistent misconception in Europe portrays forestry as a serene and unproblematic sector. In reality, forest ecosystems are under considerable stress, necessitating proactive governance. As Krott (2024) argues, forest policy is fundamentally a social bargaining process, involving scholars, policymakers, and stakeholders negotiating the use and preservation of forests. Forest certification, particularly through schemes such as FSC and PEFC, has increasingly become a vital extension of these policy frameworks, helping translate sustainability goals into practice through measurable and enforceable standards.

1.4.1 Forest Policy in Estonia

Forest policy is founded on the knowledge that Estonia's forestry industry has great potential to provide profitable material and social advantages; therefore, its use should be encouraged while protecting other values and benefits, such as those related to environmental protection (Ministry of Climate, 2025). Estonia’s forest policy acknowledges the sector’s potential to deliver both economic and ecological benefits. It promotes sustainable forest management practices that maintain forest vitality, productivity, and biodiversity (Loodusveeb, 2022). The Forest Act governs core forest activities, including reforestation, silviculture, and protection, ensuring legal compliance among forest owners (Forest Act, 2025). The Estonian Forest Policy of 1997 laid the groundwork for this sustainable approach, integrating internationally accepted principles that later aligned with forest certification systems, particularly FSC. Estonia has made progress in adopting certification, primarily under FSC, which complements national policy by enforcing environmental and social safeguards beyond legal minimums. Certification supports the state’s goals of balancing economic outputs with conservation and reinforces the policy’s emphasis on biodiversity protection and ecological integrity (Ministry of Climate, 2025).

1.4.2 Forest Policy in Latvia

Latvia ensures sustainable forestry, meaning its forests retain their value and are not diminishing. Balancing economic, environmental, and social interests is key. Economic benefits rely on consistent timber production and processing into higher-value products, requiring human involvement. Latvia prioritizes cultivating high-quality logs, which takes 70-100 years in many forests. Its forestry practices are more conservative compared to countries like Sweden, Finland, or Germany due to stricter regulations (Ministry of Agriculture, 2022). Latvia's forest policy is grounded in a commitment to long-term sustainability, aiming to ensure that forest resources are not depleted and continue to provide economic, environmental, and social value. Latvia emphasizes high-quality timber production through conservative, regulation-intensive forest practices (Ministry of Agriculture, 2022). Its forest policy has deep historical roots and evolved significantly after independence, culminating in a modern regulatory framework that aligns with both EU policy and global standards. The growth of the forest sector is closely tied to advancements in land use policies, climate change mitigation efforts, environmental protection, energy policies, and other related areas (Slamikele, 2022). Forest policy in Latvia began with the introduction of forest management regulations. The earliest known forest-related document dates back to the 16th century. In the First Republic of Latvia, two key laws on forest protection were enacted: one in 1923 and another in 1937. After Latvia regained independence, a modern regulatory framework for managing forests was established. One of the first major strategic documents in this new era was Latvia's Forest Policy, which represented a shared vision for the development of the national forest sector (Slamikele, 2022, as cited in LR Ministru Kabinets, 1998).

Certification has become a central mechanism for implementing and verifying sustainable practices. Latvia has seen broad adoption of certification, which enhances transparency, supports market access, and complements the country's policy focus on biodiversity and climate resilience. Certification provides an external validation layer, ensuring that Latvia's policy commitments translate into tangible on-the-ground outcomes.

1.4.3 Forest Policy in Lithuania

Lithuania's forest policy is rooted in sustainable forest management principles. It is influenced by international agreements such as the Strasbourg (1990), Helsinki (1993), and Lisbon (1998) Ministerial Conferences on the Protection of Forests in Europe. The Forest Law, first issued in 1994 and updated in 1996 and 1999, establishes the rights and responsibilities of forest managers, owners, and users, ensuring a balance between private and public interests. It is the core legal instrument that makes up the forest policy and strategy. The forest policy in Lithuania focuses on key aspects such as afforestation initiatives, biodiversity protection, economic regulation, European Union (EU) integration, and research and education. These key aspects ensure that forest policies align with international standards and the EU forestry regulations (UNECE, 2000).

The forest policy of Lithuania has undergone significant transformation since the country regained independence in 1990, shifting from centrally planned management to a market-oriented, sustainability-focused framework aligned with European Union (EU) environmental and forestry standards (Palšauskas et al., 2015; FAO, 2020). National policies aim to balance ecological, economic, and social functions, as reflected in the *National Forestry Sector Development Program 2012–2020*, which emphasizes biodiversity conservation, climate change mitigation, carbon sequestration, and rural development (Ministry of Environment, 2012). As an EU member, Lithuania integrates European directives such as Natura 2000 and complies with international forest-related agreements, including the Forest Europe process and the Paris Agreement (Forest Europe, 2020).

Forest certification has become an important policy instrument, with significant forest areas certified under FSC and PEFC schemes, contributing to improved sustainability practices, enhanced market access, and climate policy integration (Špulmanas, 2016). Despite progress, Lithuania faces several challenges: balancing timber production with biodiversity conservation, improving private forest management amid highly fragmented ownership, and addressing illegal logging and governance concerns (Palšauskas et al., 2015). Lithuania’s forest policy represents a dynamic interplay of national priorities, EU alignment, and global sustainability commitments, making it a relevant case study for understanding post-Soviet

forest governance transitions and their role in climate change mitigation. Certification helps mitigate some of these issues by introducing uniform sustainability standards, especially in areas where state oversight is limited. It also plays a vital role in strengthening forest governance and enhancing the credibility of national policy on the international stage.

Table 1: Comparison of Forest Policies and Certification Alignment

Forest Europe (2020); FSC (2023); Loodusveeb (2022); Palšauskas et al., (2015); PEFC (2023); Ladzinis et al., (2005); Špulmanas, (2016); UNECE (2000)

Aspect	Estonia	Latvia	Lithuania
Legal Framework	Forest Act	Forest Law and Cabinet Regulations	Forest Law 1994
Main Certification Scheme	FSC-dominant	Balanced FSC and PEFC	Balanced FSC & PEFC
Biodiversity Emphasis	Strong	Moderate–Strong	Strong
Market Orientation	Moderate	High (export and timber quality focus)	High (EU market-oriented)
EU Policy Integration	Medium	High	High
Private Forest Challenges	Less prominent	Some issues with private forest oversight	High fragmentation and governance issues
Historical Policy Development	Post-1997 sustainable forestry reforms	Deep-rooted governance with post-independence reforms	Transition from Soviet to EU-aligned model
Certification in Policy Texts	Indirectly supported via sustainability mandates	Encouraged, especially for market access	Explicitly supported in national policy

Table 1 shows that forest policy sets the foundation for sustainable forest management in all three countries. Certification acts as a complementary mechanism that enforces, enhances, and verifies these principles in practice. Lithuania is the most explicit in linking certification to national climate and development policy. On the other hand, Latvia has a deeper historical foundation in forest governance and a more economically driven forestry model. Estonia emphasizes ecological integrity and conservation with FSC standards aligning well with its national values. FSC and PEFC certification schemes are increasingly integrated into

national forest strategies, providing essential tools for climate change mitigation, biodiversity conservation, and market competitiveness. The interaction between policy and certification reflects a hybrid governance approach, where voluntary standards and state regulation work together to shape sustainable forestry in the region.

1.5 Overview of Forest Certification

Forest certification, which is an optional market-based tool, is carried out through two distinct but connected procedures: chain of custody certification and sustainable forest management certification. Certified sustainable forest management ensures forests are maintained to meet strict environmental, social, and financial standards. From sustainable origins to the finished product, forest-based products are tracked via chain of custody certification to ensure unsustainable sources are not included. To demonstrate sustainable forest management, forest certification is essential. It allows forest managers and owners to show that their current forest management techniques are sustainable and that their forests can meet the demands of present and future generations. Additionally, it facilitates sustainability by giving businesses and customers the chance to select products supplied responsibly, rewarding conscientious forest owners, and providing an incentive for uncertified forest owners to become certified. By fostering consumer trust and hence increasing demand for forest goods, forest certification raises the value of forests. One of the best methods to maintain forests standing is to increase the value and demand for their products, which keeps them from being cut down for other uses like agriculture (PEFC, 2025).

1.5.1 Historical Development of Forest Certification

The idea of preserving and conserving the world's forests gave rise to the first forest certification program. Concerns about sustainable forests came up during the United Nations Conference on Environment and Development (UNCED) in Brazil in 1992. The term "sustainable development" was defined as a shared aim of human growth and progress.

The ‘Forest Principle’ document had the opening statement: "Forests are essential to economic development and the maintenance of all forms of life.” Forest certification emerged as a procedure and a means of uniting people to define sustainable forest management because governments could not agree on its specifics at the UN level (PEFC, 2025).

The emergence of forest certification systems in the 1990s responded to global concerns about deforestation, forest degradation, and unsustainable logging practices. The FSC, established in 1993, and PEFC, founded in 1999, represent two of the most prominent certification schemes (Auld et al., 2008). The PEFC was established to address the unique needs of small and family forest owners who had been unable to obtain certification through other certification systems. Since 1991, PEFC has grown to become the preferred certification system for small forest owners (PEFC, 2005). FSC and PEFC aim to ensure that forests are managed responsibly, balancing ecological, social, and economic needs. While FSC emphasizes a globally unified approach, PEFC provides a framework for mutual recognition of national certification systems, allowing regional flexibility (Overdevest & Rickenbach, 2006).

1.5.2 Key Features and Mechanisms of FSC and PEFC

FSC and PEFC certifications require rigorous standards addressing sustainable forest management, biodiversity conservation, and community engagement. Both systems employ third-party audits to verify compliance, but differences exist in their governance structures and certification processes. Research highlights that FSC tends to have stricter environmental criteria, while PEFC focuses on incorporating regional and national contexts (Rametsteiner & Simula, 2003).

The FSC and PEFC are the two dominant international forest certification schemes, each promoting sustainable forest management through distinct but overlapping mechanisms. The FSC is known for its rigorous environmental and social standards, built around 10 principles addressing issues such as biodiversity conservation, indigenous rights, environmental impact, and stakeholder engagement (FSC, 2015). FSC certification operates

primarily through independent third-party audits and chain-of-custody (CoC) systems that track certified material throughout the supply chain (Cashore et al., 2006).

In contrast, the PEFC functions as an umbrella organization endorsing national certification systems that meet its sustainability benchmark, making it particularly popular in Europe, where national schemes are strong (PEFC, 2018). PEFC emphasizes flexibility and national-level customization, often aligning with regional forest management practices and legal requirements (Auld et al., 2008). While both schemes use third-party auditing and CoC mechanisms, the FSC is often perceived as stricter in terms of environmental and social criteria, whereas PEFC is seen as more accessible for smallholders and family forests due to its group certification options (Rametsteiner & Simula, 2003; Karmann & Smith, 2009). Both systems aim to provide market-based incentives for responsible forestry, enhance transparency, and contribute to global climate mitigation goals by promoting practices that maintain forest carbon stocks and ecosystem services (Petersen & Sandhövel, 2001).

1.6 Forests and Climate Change Mitigation

1.6.1 Forests as Carbon Sinks

Forests play a vital role in the global carbon cycle by sequestering atmospheric carbon dioxide and storing it in biomass and soil (IPCC, 2019). Sustainable forest management practices are essential to maintaining and enhancing this carbon storage capacity. Studies emphasize that deforestation and forest degradation contribute significantly to global carbon emissions, underscoring the importance of conservation and restoration initiatives (Houghton & Nassikas, 2017). In Lithuania, Latvia, and Estonia, forests cover roughly 50% of the land area and act as net carbon sinks, sequestering more CO_2 annually than is emitted by the forestry and land-use sectors combined (FAO, 2020; European Environment Agency, 2021). Studies show that Baltic forests absorb between 3 to 7 million tonnes of CO_2 per year, depending on annual growth, harvesting levels, and land management practices (Liski et al., 2006). The Baltic region's temperate and boreal forest ecosystems are particularly

effective at long-term carbon storage due to their large biomass pools and relatively slow decomposition rates (Karjalainen et al., 2003).

Forest management practices, including thinning, afforestation, extended rotation periods, and the maintenance of deadwood, directly influence the carbon sink capacity of these forests (Lazdiņš et al., 2019). For example, Lazdiņš et al. (2019) reported that sustainably managed Latvian forests, including certified areas, maintain higher average carbon stocks compared to intensively logged stands. However, the climate mitigation potential of forests in the Baltic states faces pressures from increasing timber demand, land-use changes, and climate-related disturbances such as drought, storms, and pests (Karjalainen et al., 2003; European Environment Agency, 2021). Strengthening the role of forests as carbon sinks requires integrating sustainable forest management with national and EU climate goals, alongside robust monitoring and reporting systems.

Forests in the Baltic States serve as significant carbon sinks, with Lithuania's forests sequestering an estimated 5.5–6 million tonnes of CO_2 annually, Latvia's forests sequestering about 7 million tonnes, and Estonia's forests approximately 4.5–5 million tonnes (FAO, 2020; Lazdiņš et al., 2019). On average, forest carbon stocks range from 110 to 140 tonnes of carbon per hectare, depending on forest type and management practices (Karjalainen et al., 2003). These contributions play a central role in each country's climate mitigation strategies under the Land Use, Land Use Change and Forestry (LULUCF) sector.

1.6.2 The Role of Certification in Climate Mitigation

Forest certification promotes sustainable practices that mitigate climate change by reducing deforestation rates, ensuring responsible logging, and encouraging reforestation. Certified forests often have higher carbon sequestration potential due to improved management practices (Van der Ven & Cashore, 2018). However, the effectiveness of certification in achieving measurable climate benefits remains a subject of debate (Gullison, 2003). Certification plays a crucial role in climate change mitigation by promoting practices that enhance carbon sequestration and reduce deforestation. Certified forests in Europe help

maintain carbon stocks and reduce greenhouse gas emissions. These contributions align with global climate goals, making certification a valuable tool for environmental policy (Houghton & Nassikas, 2017).

1.6.3 Contributions of FSC and PEFC Certifications to Climate Change Mitigation

Several studies compare the contributions of FSC and PEFC certifications to climate mitigation goals. FSC-certified forests are often associated with stricter conservation measures, reduced carbon emissions, and enhanced biodiversity (Durst et al., 2006). PEFC-certified forests, while promoting sustainability, are sometimes critiqued for less stringent environmental standards. Research indicates that both certifications contribute positively to climate mitigation but vary in their approaches and outcomes (Auld et al., 2008). Latvia's forests play a vital role in carbon sequestration, helping to mitigate climate change. Forests absorb and store carbon dioxide in tree biomass, soil, and deadwood, acting as significant carbon sinks. Sustainable forestry practices, such as extending harvesting cycles and avoiding clear-cutting, enhance this capacity. For example, certain tree species like black alder and birch are particularly effective at storing carbon, especially on drained soils.

1.6.4 Challenges and Criticisms

Despite their benefits, FSC and PEFC certifications face challenges such as high implementation costs, limited accessibility for smallholders, and insufficient enforcement in some regions (Overdevest & Rickenbach, 2006). Critics argue that certification alone cannot address broader systemic issues such as illegal logging and weak governance. In the Baltic context, challenges include balancing economic interests with sustainability goals and ensuring robust monitoring and compliance mechanisms (Jänicke, 2012).

1.7 Forest Certification in the Baltic States

The Baltic States (Estonia, Latvia, and Lithuania) have embraced forest certification as a key strategy for sustainable management. FSC and PEFC certifications are widely adopted,

reflecting the region's commitment to balancing economic development with environmental conservation. Studies highlight the significant role of certified forests in maintaining the region's high forest cover and contributing to EU climate goals (Stupak et al., 2011).

Verifying the origin of timber and sustainable forest management techniques is gradually becoming crucial on a global scale. For many timber products, a customer can only be found if the timber used to create them has a certificate of sustainable forest management. In Estonia, certification of forests and forest management has become popular over the years. The certificate the forest manager receives serves as proof that they manage their forests following sustainable forest management principles. Globally, various systems certify sustainable forest management. In Estonia, FSC and PEFC are the main ones, ensuring forests are managed in a balanced way across ecological, social, and economic aspects. The state forests are certified by both systems. Private forests have less certification, but it is growing. By the end of 2018, private forests had around 240,000 hectares certified by PEFC and 125,000 hectares by FSC. By 2020, these areas increased to 260,000 hectares for PEFC and 160,000 hectares for FSC. This means about one-third of Estonia's private forest lands are certified for sustainable management (Loodusveeb, 2022).

Forest certification has become a key instrument for promoting sustainable forest management (SFM) across the Baltic States (Lithuania, Latvia, and Estonia) following their transition from centrally planned to market economies after the early 1990s. Both the FSC and the PEFC schemes are active in the region, with FSC having a relatively stronger presence in Estonia and Lithuania, while PEFC holds a larger share in Latvia (UNECE/FAO, 2019; Rametsteiner & Simula, 2003). Certification provides assurance that forests are managed according to environmental, social, and economic sustainability standards, supporting access to environmentally conscious markets, particularly in Western Europe (Solberg et al., 2010).

By 2020, approximately 50–70% of forest areas in the Baltic countries were certified under either FSC or PEFC, reflecting both growing international demand and national policy support for sustainable forestry (UNECE/FAO, 2019). Certification has played a vital role in improving forest management practices, enhancing biodiversity protection, and

contributing to climate change mitigation strategies by maintaining carbon sinks and promoting responsible harvesting (Domaskaitė et al., 2013). Despite these advances, the Baltic States face challenges such as ensuring small private forest owners' participation in certification, harmonizing national standards with international criteria, and balancing production-oriented forest use with biodiversity conservation goals (Solberg et al., 2010; Rametsteiner & Simula, 2003). In summary, the Baltic region represents a significant case study in how forest certification can support the post-socialist transition to sustainable forest governance while integrating into global climate and biodiversity policy frameworks.

1.7.1 Case Studies from the Baltics

Several case studies from the Baltic States demonstrate how forest certification contributes to climate change mitigation by promoting sustainable forest management (SFM), maintaining forest carbon stocks, and enhancing ecosystem resilience. For example, FSC-certified forests in Estonia have demonstrated higher carbon sequestration rates than uncertified forests (Valgepea et al., 2020). PEFC-certified forests in Latvia have successfully integrated sustainability into commercial forestry operations (Pētersone et al., 2019). These examples underscore the potential of certification systems to drive positive environmental outcomes while addressing regional challenges.

In Lithuania, Domaskaitė et al. (2013) found that FSC-certified forests showed improved harvesting practices, reduced clear-cutting intensity, and better soil and water protection measures, which collectively enhance long-term carbon sequestration potential. Similarly, in Estonia, Paluots and Nysten-Haarala (2019) analyzed the impact of FSC certification and found that certified forest operations incorporated stricter environmental safeguards, such as longer rotation periods and the preservation of high conservation value forests, thus reducing net carbon emissions compared to non-certified areas. In Latvia, Lazdiņš et al. (2019) conducted field-based studies showing that FSC and PEFC-certified forests contributed to better regeneration practices and increased deadwood retention, which improves forest carbon dynamics over time.

These Baltic case studies align with broader international findings that forest certification can serve as a complementary tool to national climate policies under the LULUCF (Land Use, Land-Use Change, and Forestry) framework by ensuring that commercial forestry operations maintain or enhance carbon sink functions (Yli-Viikari et al., 2012). However, the climate benefits of certification are not automatic; they depend on rigorous implementation, monitoring, and the alignment of certification standards with national climate strategies. Moreover, challenges such as smallholder inclusion, cost barriers, and limited climate-specific indicators within certification schemes continue to limit the full potential of certification as a climate mitigation instrument in the Baltic context (Paluots & Nysten-Haarala, 2019; Domaskaitė et al., 2013).

1.7.2 Economic and Environmental Impacts of Certification

Over the years, there has been a rising demand for forest certification and certified forest products in Europe. This is a result of the global climate challenges and the efforts to combat the effects of climate change. Improved market access has been linked to forest certification, especially in areas where consumer tastes are influenced by sustainability concerns. In markets that place a high value on environmental responsibility, certified timber products frequently fetch higher prices. In addition to providing financial gains to stakeholders, certification programs like the Forest Stewardship Council (FSC) and the Programme for the Endorsement of Forest Certification (PEFC) seek to advance sustainable forest management (Cortceriro et al., 2024).

1.7.3 Enhanced Market Access and Premium Pricing

Improved market access has been linked to forest certification, especially in areas where consumer tastes are influenced by sustainability concerns. In markets that place a high value on environmental responsibility, certified timber products frequently fetch higher prices. The study focuses on European case studies where forest managers have benefited financially from FSC and PEFC certifications, which have made it easier to enter environmentally conscious markets (Rametsteiner & Simula, 2003).

1.7.4 Cost Implications and Challenges

While certification can enhance market opportunities, it also imposes costs on forest managers, including compliance with rigorous standards, audit fees, and operational adjustments. There is a financial burden on small-scale forest owners, emphasizing the need for support mechanisms to ensure equitable participation in certification schemes. In Europe, subsidies and cooperative models have been instrumental in mitigating these challenges (Overdevest & Rickenbach, 2006).

1.7.5 Employment and Rural Development

By generating jobs and promoting investment in sustainable forestry practices, certification programs support rural development. In Europe, certified forests have been associated with the development of jobs, especially in areas where forestry is a major economic sector, according to the article. Furthermore, forest workers' skill and capacity training is encouraged via certification (Auld et al., 2008).

1.8 Research Gaps and Theoretical Framework

While existing literature provides valuable insights, gaps remain in understanding the specific contributions of FSC and PEFC certifications to climate mitigation in the Baltic context. Comparative studies focusing on measurable outcomes, such as carbon sequestration and emissions reduction, are particularly scarce (Stupak et al., 2011). This study adopts a framework that integrates principles of sustainable forest management and climate change mitigation. By examining the effectiveness of FSC and PEFC certifications in promoting these principles, the research aims to provide a comprehensive understanding of their roles in addressing climate challenges in the Baltic (Cashore et al., 2004).

1.9 Conclusion

The existing body of literature highlights the importance of forest certification in promoting sustainable practices and contributing to climate mitigation goals. FSC and PEFC certifications, despite their differences, offer valuable tools for enhancing forest management and addressing climate change. However, further research is needed to evaluate their comparative effectiveness, particularly in regions like the Baltics where forests are central to environmental and economic priorities. This review provides a foundation for the study's exploration of these themes and identifies key areas for future inquiry.

2. RESEARCH METHODOLOGY

2.1 Research Design

This study adopts a comparative case study approach to examine the role of forest certification in climate change mitigation in the Baltic region. The research focuses on forests certified by the Forest Stewardship Council (FSC) and the Programme for the Endorsement of Forest Certification (PEFC). A mixed-methods approach was employed, integrating both qualitative and quantitative data to provide a comprehensive understanding of the impact of certification on carbon sequestration, biodiversity conservation, and sustainable forest management.

2.2 Study Area

The research was conducted across Estonia, Latvia, and Lithuania, collectively known as the Baltic states. These countries have significant forest coverage and actively participate in FSC and PEFC certification schemes. The selection of this region is based on its ecological significance, policy frameworks, and the increasing role of certified forestry in climate mitigation efforts. Also, the Baltic region has significant forest cover and plays a vital role in the European timber market.

2.3 Data Collection Methods

This research employs a desk study approach, and data from secondary sources were used. Primary data was collected through a survey (Appendix 1). Structured surveys were distributed among certified forest owners and managers to assess their experiences, challenges, and benefits associated with FSC and PEFC certifications. The survey contained questions about forest area, type of management practices, climate change mitigation practices, environmental impact, and perceptions of forest certification. Thirty (30) survey

forms were sent via email to forest owners and managers of both FSC and PEFC-certified forests in Estonia. Thirteen (13) responses were successfully received, and the results were used in this research's analysis and discussion sections. This study also examined official FSC and PEFC documentation, national forest policies, and climate action strategies in the Baltic States to assess their role in forest certification and climate change mitigation. A review of academic articles, case studies, and other relevant documents was conducted to provide a comprehensive analysis of certified forestry practices. The use of secondary data ensures access to reliable sources that describe the impact of certification on climate change mitigation in the region. This approach also facilitates a comparative evaluation of FSC and PEFC certification systems, allowing for a detailed assessment of their environmental, social, and economic criteria.

Additionally, certification body reports and academic studies were examined to strengthen the research findings. To enhance the quality of this thesis, artificial intelligence tools ChatGPT-4o mini and Copilot AI were utilized for text revision. ChatGPT-4o mini was specifically used for proofreading, improving grammar, language consistency, and overall structure. However, the final adjustments to the AI-generated content were made by the author, ensuring precision and contextual relevance. Despite the incorporation of AI tools, the research integrity and adherence to academic standards remain fully upheld.

2.4 Data Analysis

Descriptive and inferential statistical techniques were employed to analyze and visualize survey responses and carbon sequestration data. Excel was used to create graphical presentations of the data from the survey and existing literature. A comparative analysis was made between FSC and PEFC standards and their role in carbon sequestration. Stakeholders' interests, roles, and interactions, such as government, forest owners, local communities, NGOs, certification agencies, and international bodies, for FSC and PEFC, were analyzed to understand the opportunities and challenges encountered by both certification systems. This combination of content, comparative, and stakeholder analysis

facilitates the accomplishment of a comprehensive assessment on the effectiveness and effects of the FSC and PEFC standards in the Baltic states.

2.5 Reliability and Limitations

Consent was obtained from all survey respondents. Data confidentiality and anonymity were maintained throughout the study. Reliable and authoritative data sources were used, including official FSC and PEFC documents, government publications, and peer-reviewed academic literature. Potential limitations of the study include access to certain proprietary certification data, variations in national forestry policies, and possible biases in self-reported information. These were mitigated through diverse data sources. This methodology ensures a robust comparative analysis of FSC and PEFC-certified forests in mitigating climate change within the Baltic region.

3. RESULTS AND DISCUSSION

3.1 Introduction

This chapter presents the findings related to forest certification in the Baltic States (Estonia, Latvia, Lithuania), focusing on key actors involved, a comparative analysis of FSC and PEFC forest management standards, and the impacts of these certification schemes on the environment in terms of carbon sequestration and climate change mitigation. Survey responses from FSC and PEFC-certified forest managers were also analyzed.

3.2 Overview of Forest Certification

Forest certification is a voluntary, market-based mechanism that promotes sustainable forest management (SFM). It serves as a means of ensuring that forests are managed to balance environmental conservation, economic profitability, and social responsibility. Certification verifies that forest products, such as timber and non-timber goods, are sourced from responsibly managed forests, providing a transparent chain of custody from forest to consumer (Bass, 2020). Established in 1993, FSC is known for its rigorous standards focusing on environmental conservation, respect for indigenous rights, and labor protections. It emphasizes maintaining biodiversity and preventing practices like illegal logging. Launched in 1999, PEFC is the world's largest forest certification system, supporting national certification schemes. It emphasizes flexibility and regional adaptability, making it particularly accessible for smallholders.

Both the FSC and PEFC operate on principles of certification with a focus on environmental sustainability, social responsibility, and economic viability. Conservation of biodiversity, soil, and water resources is a crucial aspect of the standards being implemented by the FSC and PEFC. To get a forest management certificate, forest owners or managers undergo an independent audit to assess compliance with the standards of the chosen scheme. After a

successful assessment, the forest manager receives a certificate (Meidinger et al., 2003). Chain of custody verification and labeling are different activities that may occur afterward. Since this process is driven by market demand, forest businesses typically want to label products from certified forests. This labeling requires a chain of custody audit, which is a way to independently track and verify the movement of forest products from the forest through processing, all the way to the final sale. This type of certification tracks certified materials through the supply chain to ensure their origin is from sustainable sources (Bass, 2003). Certification has helped align forestry practices with international agreements such as the Paris Agreement and the UN's Sustainable Development Goals (SDGs). It has also reduced deforestation, improved forest governance, and empowered local communities.

3.3 Comparison of FSC and PEFC

The FSC was founded in 1994 as a voluntary certification for sustainable forestry, encouraging the management of the world's forests in a way that is socially, ecologically, and commercially advantageous. Over 150 million hectares of forest managed under FSC criteria are part of the largest certified supply chain network currently in existence, which facilitates links between markets and sustainable forestry (FSC, 2025). Established in 1999, the PEFC is a leading global alliance of national forest certification systems. As an international non-profit, non-governmental organization, PEFC is committed to promoting sustainable forest management through independent third-party certification (PEFC, 2025). Table 2 provides a comparative analysis between FSC and PEFC standards in terms of environmental impact and other criteria. It is obvious that both FSC and PEFC are committed to climate change mitigation. Although both certification bodies have a common goal, their approaches or standards vary to some extent.

Table 2: Comparison of key features of FSC and PEFC.

Sources: Cashore et al. (2006); Rametsteiner & Simula (2003); Karmann & Smith (2009); Auld et al. (2008); FSC (2015); PEFC (2018).

Criteria	FSC	PEFC
Purpose and Scope	Focuses on global, high-standard certification for sustainable forest management, emphasizing environmental, social, and economic criteria	Emphasizes recognition of national forest certification systems, tailored to specific regional contexts
Environmental Criteria	Known for its stringent environmental standards, including restrictions on deforestation and clear-cutting.	Promotes ecological sustainability but is often considered more flexible in its implementation
Social Considerations	Emphasizes protecting indigenous rights, improving labor conditions, and involving local communities	Supports social sustainability but focuses more on overarching guidelines than specific cultural or local considerations
Certification Process	Requires thorough, independent audits with transparency and stakeholder involvement	Enables self-assessment under national certification schemes, allowing for adaptability.
Market Influence	Often preferred for premium markets and products due to its reputation for high standards	Has broader adoption globally, with more certified hectares, due to its inclusivity of regional systems
Impact on Climate Change	Supports sustainable forest management practices that enhance carbon sequestration and reduce emissions	Supports sustainable forest management practices that enhance carbon sequestration and reduce emissions

3.4 Certified Forest Area

As of 2024, approximately 60% of Latvia's forests, 45% of Lithuania's forests, and 50% of Estonia's forests are certified under FSC or PEFC schemes (PEFC Latvia, 2023; FSC Estonia, 2023). The certified area has expanded steadily since 2010, driven by rising market demand, EU sustainability goals, and national policy alignment (Auld et al., 2019). For example, Latvia's FSC-certified area grew from 600,000 ha in 2010 to over 1 million ha in 2023 (Lazdiņš et al., 2019), while PEFC-certified forest areas in Estonia increased tremendously, reaching over 1.8 million hectares (PEFC, 2014).

Out of the thirteen (13) survey responses, ten (10) respondents have PEFC certification, and three (3) respondents have both FSC and PEFC certification. PEFC certification is more popular in Estonia as compared to the FSC certification, as shown in Figure 2. The survey results also showed that most respondents have been managing their certified forests for over ten years. This result correlates with statistics from both certification bodies, which is also the case in Latvia. However, the trend changes in Lithuania as most of the forests have FSC certification, which can be seen in Figure 3.

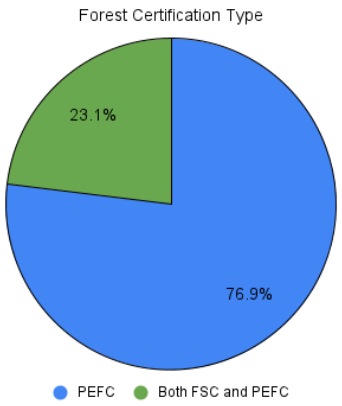

Figure 2: Summary of certification type based on the research survey.

Currently, Lithuania does not have an endorsed national PEFC forest certification system, and this explains why there is no data in Figure 3 for PEFC-certified forest area in Lithuania. While the country has been working to develop a PEFC certification framework, it is still undergoing the assessment process for endorsement. The Center of Sustainable Forest Management (CSFM), Lithuania's PEFC national member, submitted the national system for evaluation in May 2024, and a public consultation was held between June and August 2024 to gather feedback (PEFC, 2024). Although Lithuania does not have officially PEFC-certified forests, efforts are underway to establish a recognized certification system. Estonia has the largest area of PEFC-certified forests among the three states.

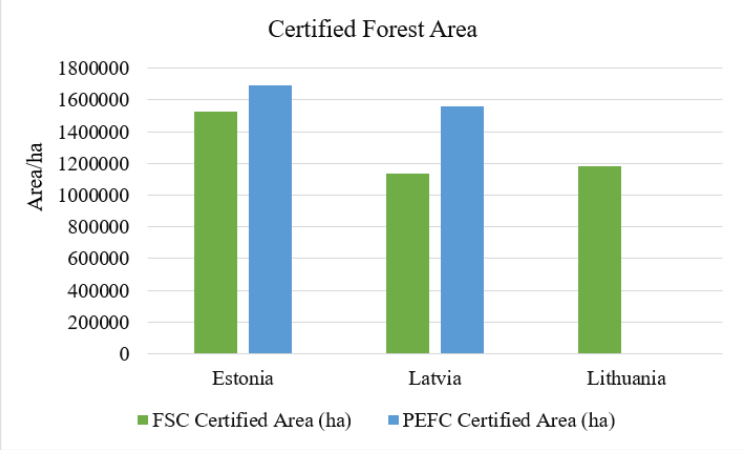

Figure 3: FSC and PEFC certified forest areas in Estonia, Latvia, and Lithuania **(**PEFC Global Statistics, 2024; FSC Facts & Figures, 2019)

3.5 Carbon Stock and Sequestration

FSC-certified forests tend to have higher carbon stocks per hectare due to stricter environmental safeguards, such as longer rotation periods and deadwood retention, which enhance long-term carbon storage (PEFC, 2024). PEFC-certified forests, while promoting sustainability, often allow more intensive harvesting, which can result in lower overall carbon sequestration compared to FSC-certified forests (PEFC, 2023). Forest certification plays a crucial role in promoting sustainable forest management while influencing carbon sequestration rates across different certification schemes. A comparison of FSC and PEFC forests in Estonia, Latvia, and Lithuania reveals variations in their contributions to climate change mitigation. FSC-certified forests generally demonstrate higher carbon sequestration rates due to their stricter environmental safeguards, which underscore longer rotation periods, selective logging, and deadwood retention. These measures contribute to enhanced carbon storage potential, particularly in forests with high biodiversity value (Valgepea et al., 2020). In contrast, PEFC-certified forests, while promoting sustainable practices, adopt more flexible guidelines, allowing shorter rotation cycles and higher harvesting intensities, which may result in lower overall carbon sequestration (Pētersone et al., 2019).

Recent case studies from the Baltic States highlight how forest certification under schemes like FSC and PEFC contributes to climate change mitigation through improved forest management, reduced degradation, and enhanced carbon sequestration. In Latvia, Lazdiņš et al. (2019) found that FSC-certified forests showed higher carbon retention per hectare compared to non-certified areas, due to lower harvesting intensity and better protection of high conservation value forests. Similarly, a Lithuanian case study by Auld et al. (2008) reported that FSC-certified stands exhibited improved soil carbon dynamics and reduced erosion risks, supporting long-term carbon storage. In Estonia, PEFC-certified forest owners have increasingly adopted climate-smart practices, such as selective harvesting and mixed-species planting, which enhance both carbon stocks and ecosystem resilience (PEFC, 2022). Results from the survey showed that only three (3) respondents undertook carbon monitoring or reporting as part of their certification requirements. Of the three respondents, one person had both FSC and PEFC certification. Forests in the Baltic States act as significant carbon sinks, contributing to the mitigation of national greenhouse gas (GHG) emissions. The carbon sequestration potential, however, varies considerably among the three countries.

Table 3: Carbon sequestration data of the three Baltic states. (FISE, 2020)

Country	Total Emission ($MtCO_2e$)	Forest Sink ($MtCO_2e$)	Carbon Stock in Living Trees (MtC)
Estonia	11.3	0.6	67.3
Latvia	10.5	4.7	84.6
Lithuania	20.0	7.6	82.1

As shown in Table 3, Latvia and Lithuania have stronger forest sinks in absolute terms compared to Estonia, which reflects differences in forest cover, forest management practices, and carbon accounting frameworks. Latvia's forest sink accounts for approximately 45% of its annual emissions, while Lithuania's forests offset about 38%. In contrast, Estonia's forests offset only about 5%, highlighting a lower relative contribution

of forests to national climate mitigation. The carbon stock in living trees is a critical long-term component of forest carbon accounting. Latvia holds the highest carbon stock in living biomass with a total of 84.6 million tonnes of Carbon (MtC), followed closely by Lithuania, 82.1 MtC and Estonia, 67.3 MtC. These carbon stocks are influenced by total forest area, species composition, and management intensity (FISE, 2024).

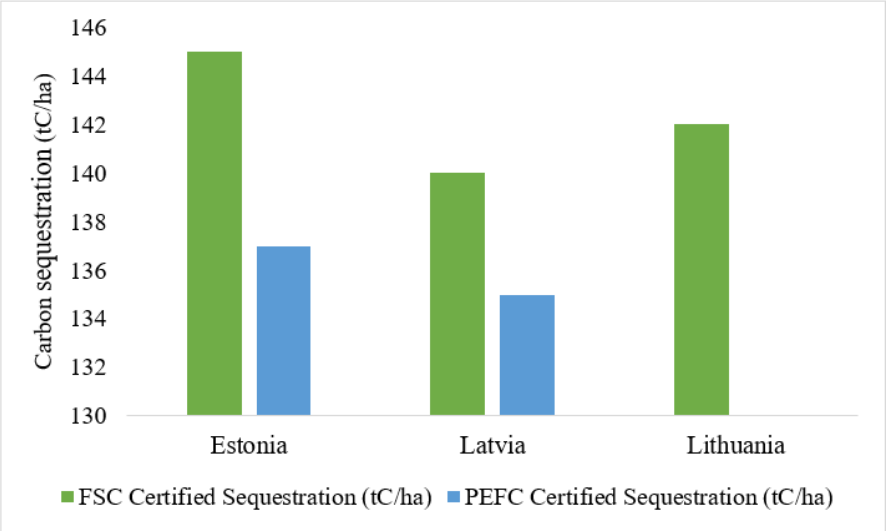

Figure 4: Average Carbon Sequestration in FSC and PEFC Certified Forests in the Baltic States. Source: (Kuusinen et al., 2022; FSC International, 2021)

Research shows that Baltic forests absorb between 3 and 7 million tonnes of CO_2 annually, depending on forest type, certification, and management approach (Lazdiņš et al., 2019). FSC-certified forests in Estonia and Lithuania tend to store 110 to 140 tonnes of carbon per hectare, whereas PEFC-certified forests in Latvia average slightly lower at 95 to 125 tonnes per hectare (Karjalainen et al., 2003). Figure 4 shows a graphical representation of carbon sequestration data in FSC and PEFC-certified forests. In all three countries, FSC-certified forests sequester a higher amount of carbon as compared to PEFC forests. Estonia recorded the highest amount of carbon sequestration in both FSC and PEFC forests. This disparity highlights the trade-offs between conservation priorities and economic forestry practices. While FSC certification places stronger restrictions on clear-cutting, soil disturbance, and species diversity conservation, PEFC certification offers national-level flexibility, accommodating commercial forestry interests alongside sustainability objectives.

Despite their differences, both certification schemes contribute significantly to climate mitigation and the promotion of sustainable forest management. FSC's environmental rigor ensures long-term carbon storage benefits, while PEFC's adaptability supports broader certification accessibility, particularly for smaller forest owners (Rametsteiner & Simula, 2003). This comparison reinforces the need for integrating certified forestry practices with national climate policies to maximize the carbon sequestration potential of the Baltic region's forests (UNECE/FAO, 2019). While certification alone is not a silver bullet, these cases demonstrate its role as part of an integrated climate strategy, complementing national LULUCF targets and EU climate commitments.

3.6 Management Practices and Environmental Impact

Forest certification leads to qualitative improvements in forest management, particularly regarding biodiversity protection, soil conservation, and reduced impact logging (Auld et al., 2008). FSC certification emphasizes maintaining high conservation value forests (HCVFs), riparian buffer zones, and deadwood retention, all contributing to long-term carbon storage (Karmann & Smith, 2009). PEFC standards prioritize alignment with national regulations and promote climate-smart practices such as adaptive thinning and afforestation of degraded lands (PEFC, 2024).

The marked difference in forest sink capacity between the Baltic countries can be partially attributed to forest management regimes. Latvia and Lithuania have more extensive afforestation and reforestation programs, better age-class distribution, and longer rotation period practices that are often embedded in certification standards. In certified forests, especially FSC-certified ones, there is an emphasis on maintaining ecological integrity and avoiding large-scale clear-cuts, which supports long-term carbon accumulation. For example, FSC guidelines in Latvia prioritize mixed-species stands and deadwood retention, which enhance carbon stock stability over time (FSC, 2021). During the survey, respondents were asked about the type of forest they manage and the management practices they employ. The results from Figure 5 below show that most respondents manage commercial forests. A

significant number of respondents also employ mixed management practices and manage conservation and recreational forests.

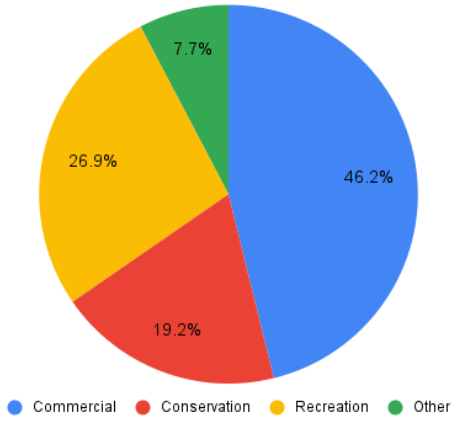

Figure 5: Summary of types of forest managed by respondents. (Survey data, 2025)

From Figure 6, Carbon sequestration recorded the lowest response, the reduction of emissions through sustainable logging had 10 responses, and reforestation had 11 responses. Respondents had the option to choose more than one practice for this question. Three (3) respondents carry out carbon sequestration practices on their forests. These results correspond with responses about carbon monitoring or reporting as part of certification requirements. Only three (3) respondents took part in carbon monitoring activities, and this could be because of the type of forests being managed. The highest responses were recorded in reforestation and afforestation management practices. Traditional forestry, clear-cutting, knowledge from the Environmental Protection Agency, and the Estonian University of Life Sciences were some other management practices employed by some respondents.

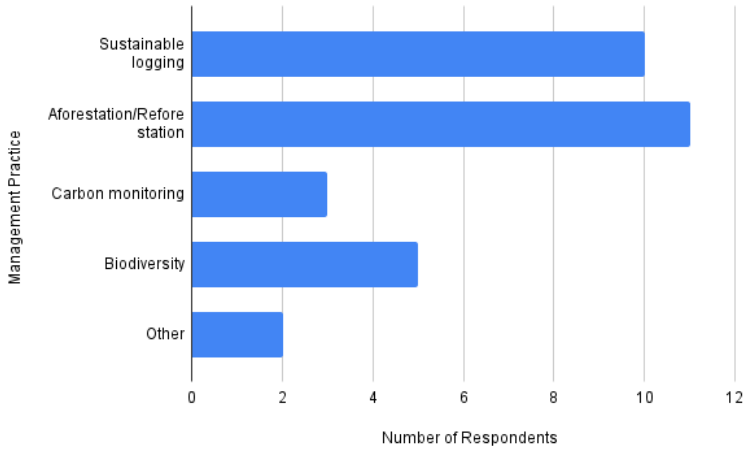

Figure 6: Summary of the forest management practices employed by respondents. (Survey data, 2025)

Given their relatively high forest cover, the Baltic States have a strategic advantage in meeting EU climate targets, particularly under the LULUCF Regulation. However, maximizing forest carbon sinks requires not only expanding forest area but also improving forest management practices. Certification schemes like FSC and PEFC offer a framework for sustainable forest management that aligns with climate mitigation goals. Their adoption should be scaled up and integrated with national forestry strategies to strengthen carbon sinks. Lithuania and Latvia, with higher certification uptake, demonstrate the co-benefits of this approach.

3.7 Stakeholder Perspectives and Governance Issues

Stakeholder perspectives, drawn from secondary reports and case studies, highlight mixed motivations for certification. While many Baltic Forest owners adopt certification to access international markets, non-governmental organizations emphasize their role in environmental stewardship and climate mitigation (Auld et al., 2008). Governance challenges include the cost and complexity of certification for smallholders, as well as the need for stronger integration of certification schemes with national climate and biodiversity policies (Lazdiņš et al., 2019). Despite these barriers, certification is broadly recognized as a complementary tool for achieving sustainability goals in the Baltic forestry sector. From

the research survey conducted, 38.5% of respondents have less than 10% of their income linked to certification. 53.8% of the respondents stated none of their income was linked to certification. This could mean that forest managers may not be making any substantial income from certification due to different certification types. It could also be that participants in the survey did not have Chain of Custody certification. In response to the question *"Do you think certification has helped in maintaining a sustainable forest?"*, participants were evenly split between the answers "Yes" and "No" while some participants selected "I don't know" as seen in Figure 7 below. This lack of consensus suggests that the effectiveness of certification in promoting sustainability is not universally recognized among stakeholders.

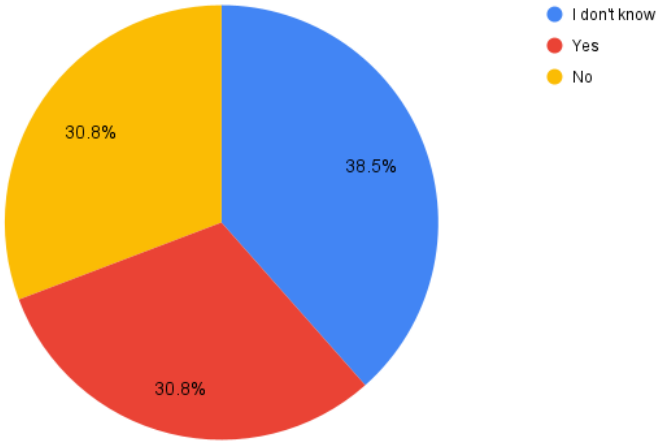

Figure 7: Summary of participants' perception of certification. (Survey data, 2025)

These results were not very different from responses about which certification type was more effective in promoting sustainable forestry practices for climate change mitigation. The equal split between affirmative and negative responses could stem from varied experiences with certification schemes, differences in forest ownership types, or limited visibility of on-the-ground changes following certification. Meanwhile, the presence of "I don't know" responses indicates gaps in awareness or information dissemination, suggesting that certification systems may not be fully transparent or well-communicated to all actors involved in forest management. Therefore, there is a need for more stakeholder

engagement and education about certification objectives and impacts. Also, there should be improved transparency in how certification outcomes are monitored and reported.

3.8 Barriers and Challenges

Despite the recognized environmental and climate benefits of forest certification in the Baltic region, several barriers limit its broader implementation and effectiveness. A key challenge is the high cost of certification audits and compliance, which disproportionately affects small and medium-sized forest owners who often lack the financial and technical resources to meet certification requirements (Auld et al., 2008; Lazdiņš et al., 2019). Certification uptake in Estonia is hindered not only by economic factors but also by institutional fragmentation and limited cooperation among forest owners. According to Põllumäe, Lilleleht, and Korjus (2016), institutional barriers significantly reduce the efficiency of cooperative certification models, particularly for small-scale forest owners. There are also concerns about the limited market premiums for certified timber, with some studies noting that price incentives are often insufficient to fully cover certification costs (UNECE/FAO, 2019). Furthermore, stakeholders report gaps in national policy integration, where certification standards sometimes overlap or conflict with national forest regulations, leading to redundancy or regulatory confusion (Lazdiņš et al., 2019).

Finally, there is a lack of awareness and capacity-building programs, especially for engaging smallholders and local communities, which reduces the potential for certification to scale up as a mainstream climate mitigation tool (Auld et al., 2008). Addressing these barriers is critical to enhancing the role of certification in achieving the Baltic states' forest-based climate and sustainability goals. While certified forests demonstrate slightly higher sequestration capacities, differences were not always statistically significant, particularly between FSC and PEFC forests in certain regions. This suggests that certification alone does not guarantee enhanced carbon storage, but must be complemented by ecologically sound management practices and enforcement mechanisms.

4. CONCLUSION

This thesis has highlighted the essential role that forests in Estonia, Latvia, and Lithuania play in mitigating climate change through carbon sequestration. Using national-level data and comparative analysis, it was found that certified forests, especially those under the FSC, tend to exhibit higher aboveground carbon stocks than forests certified under the PEFC or those without certification. Latvia and Lithuania, in particular, demonstrate substantial forest sink capacities, offsetting up to 45% and 38% of their total annual emissions, respectively, in contrast to Estonia's 5% offset. The study also revealed that the alternate hypothesis of this research is true, as results and data from existing literature show that FSC-certified forests have higher carbon sequestration rates.

These findings support previous literature indicating that FSC-certified forests often adopt stricter ecological practices, such as longer rotation cycles, greater species diversity, and retention of deadwood, which enhance their carbon sequestration potential. While the differences between FSC and PEFC-certified forests are sometimes modest, the broader implication is that forest certification, when implemented with integrity, can serve as an effective mechanism for climate mitigation in the Land Use, Land-Use Change and Forestry (LULUCF) sector.

However, certification alone does not guarantee superior carbon performance. Its effectiveness is contingent upon national forest governance frameworks, enforcement capacity, and landscape-specific ecological conditions. Moreover, current reporting mechanisms still underrepresent carbon pools such as soil organic carbon and deadwood, which are significant in northern temperate and boreal forest ecosystems. Soil carbon, which can comprise a significant portion of total forest carbon stocks, was not included in this analysis due to limited data availability. Future research should integrate soil carbon pools and life cycle assessments of harvested wood products to provide a more holistic understanding of forest carbon dynamics.

To maximize the climate benefits of forest management in the Baltic States, this study recommends greater integration of certification standards into national climate and forestry

strategies, particularly under the EU's LULUCF regulation. By advancing evidence-based forest governance, the Baltic States can enhance the resilience and carbon performance of their forests, contributing meaningfully to EU and global climate goals.

Based on the findings of this study, several policy and research recommendations can be made to enhance the role of forests in climate change mitigation in the Baltic States. First, national governments should expand the adoption of forest certification schemes, particularly those with rigorous environmental standards such as FSC, by offering financial incentives, technical assistance, and market-based support to forest owners and managers. Second, certification bodies and national forestry agencies should collaborate to harmonize monitoring and reporting systems for carbon sequestration, especially to include underrepresented carbon pools such as soil carbon, deadwood, and litter. Third, to better integrate certified forestry into national climate strategies, certification standards should be aligned with EU LULUCF targets, ensuring consistency in carbon accounting and verification procedures. In Estonia, where forest sinks are relatively low, greater attention should be paid to sustainable harvesting practices in peatland and wetland areas, which are highly sensitive carbon reservoirs. Furthermore, transboundary collaboration between the Baltic States could facilitate knowledge exchange and the development of regional certification frameworks tailored to the unique ecological and socio-economic conditions of the region. Finally, future research should adopt spatially explicit and longitudinal approaches to assess the long-term carbon performance of certified versus non-certified forests, while evaluating the cost-effectiveness and biodiversity co-benefits of certification.

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APPENDICES

Appendix 1. Survey Questions

Metsasertifitseerimise mõjude hindamine kliimamuutuse leevendamisel Selle küsimustiku eesmärgiks on uurida metsasertifitseerimise rolli kliimamuutuse leevendamise kontekstis. Kuna ülemaailmne mure kliimamuutuse süvenemisest suureneb, siis nähakse metsade majandamise viisides ja metsasertifitseerimise süsteemides uusi võimalusi, et tugevdada vastutustundlikku metsade majandamist, suurendada süsiniku sidumist ja tagada paremini elurikkuse kaitset. Uurimuse tulemused aitavad aru saada seostest metsasertifitseerimise ja kliimamuutuse leevendamise vahel, pakkudes uut informatsiooni teadlastele, praktikutele ja poliitikakujundajatele, et toetada jätkusuutlikku ja säilenõtket metsandust muutuva kliima tingimustes. Teie osalemine küsimustiku täitmisel on oluline, et arendada sellealast uurimistööd. Teie vastused on anonüümsed ja neid kasutatakse vaid teadustöö eesmärgil. Täname teid uurimuses osalemise eest

1. Mis eesmärgil kasutate oma metsaomandit? (Võib valida mitu vastust)
    a. Tulu saamiseks
    b. Looduse kaitsmiseks
    c. Puhkamiseks
    d. Muu eesmärk, palun täpsustage: …….
2. Milline metsasertifitseerimise sertifikaat teie metsadel on?
    a. FSC
    b. PEFC
    c. Mõlemad
    d. Ei ole sertifikaati
3. Kui kaua olete oma metsa majandanud?
    a. Alla 5 aasta
    b. 5-10 aastat
    c. Üle 10 aasta
4. Mis laadi tegevusi te oma metsade majandamisel teete? (Võib valida mitu vastust)
    a. Süsiniku sidumise ja talletamisega seotud tegevused
    b. Mittemetsamaa metsastamine ja metsamaa taasmetsastamine

c. Loodushoiuga seotud tegevused
d. Säästlike raieviiside kasutamine
e. Muud tegevused, palun täpsustage: …….

5. Milline on teie metsa kogutagavara?
    a. Alla 500 tihumeetri
    b. 500-2000 tihumeetrit
    c. 2000-5000 tihumeetrit
    d. Üle 5000 tihumeetri
6. Kas jälgite metsasertifitseerimise tõttu oma metsas süsiniku sidumist ja talletamist ja/või olete teinud vastavaid aruandeid?
    a. Jah
    b. Ei

Sektsioon 3: Majanduslik ja keskkonnaalane mõju

7. Kui suur osa teie metsast saadavast sissetulekust on otseselt seotud metsasertifitseerimisega (näiteks toetused, hinnalisa)?
    a. Alla 10%
    b. 10-30%
    c. Üle 30%
    d. Üldse mitte
8. Kas sertifitseerimine aitab kaasa teie metsade jätkusuutlikule majandamisele?
    a. Jah
    b. Ei
    c. Ei oska vastata
9. Milliseid probleeme seoses metsasertifitseerimisega peate oluliseks oma metsa majandamisel? (Võib valida mitu vastust)
    a. Metsasertifitseerimise kulud
    b. Standardi nõuetele vastamine
    c. Piiratud eelised puiduturul
    d. Muud probleemid, palun täpsustage ……
    e. Ei ole olulisi probleeme

Sektsioon 4: Suhtumine metsasertifitseerimisse

10. Millist sertifitseerimise süsteemi (FSC või PEFC) peate efektiivsemaks kliimamuutuse leevendamise aspektist?
    a. FSC
    b. PEFC
    c. Mõlemad võrdselt
    d. Ei oska vastata
11. Kas nõustute, et metsasertifitseerimine on vastavuses Euroopa Liidu kliimapoliitikaga?
    a. Jah, kindlasti nõustun
    b. Jah, pigem nõustun
    c. Ei nõustu
    d. Ei oska vastata
12. Kas nõustute, et metsasertifitseerimine on mõjutanud teie metsade majandamist kliimamuutuse leevendamise suunas?
    a. Jah, kindlasti nõustun
    b. Jah, pigem nõustun
    c. Ei nõustu
    d. Ei oska vastata

Aitäh vastamise eest!

Appendix 2.

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