



**Latvia University  
of Life Sciences  
and Technologies**

**21st International Scientific Conference  
STUDENTS ON THEIR WAY TO SCIENCE  
(undergraduate, graduate, post-graduate students)  
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## **STUDENTS ON THEIR WAY TO SCIENCE**

(undergraduate, graduate, post-graduate students)

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## **INFORMATION TECHNOLOGIES**

# INTERDISCIPLINARY DEVELOPMENT OF A CLOTHING RENTAL PLATFORM

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Statistical data show that every year around 92 million tonnes of clothing and textiles are thrown away worldwide. More than 80% of these textiles end up as waste, while less than 1% are recycled into new products [1]. To address this growing problem, the European Union is developing policies aimed at reducing textile waste and promoting circular economy principles, including the Waste Framework Directive [2]. The increasing amount of textile waste shows that new approaches to clothing consumption are needed. One possible solution is clothing rental platforms, which can extend the life cycle of garments and reduce the need for new clothing production.

The aim of this study was to develop a functional clothing rental platform as an interdisciplinary academic project that combined software engineering, web development, and database design. The project was carried out during the 2024/2025 academic year at Latvia University of Life Sciences and Technologies as part of several study courses. Agile methodology was applied to plan the project and prepare technical documentation. It was chosen because the requirements were not fully defined and were expected to evolve throughout development. Work was organised iteratively, with each cycle delivering a usable product increment, progressing from core functionality through its refinement to additional features. Tasks were prioritised and regularly adapted to changing requirements. The user interface was developed using HTML, CSS, and JavaScript, following recommended coding practices. In addition, a relational database structure was designed using PostgreSQL to store and manage platform data, such as users, clothing items, and rental transactions.

The results show that the development of the clothing rental platform has been successfully started and partially implemented. Technical documentation and a working user interface were created, allowing users to browse clothing items and submit rental requests. Although the database structure has already been designed, it has not yet been fully integrated with the user interface. This integration will be completed in future development stages. Once fully implemented, the platform could operate as a complete clothing rental system that helps reduce textile waste and encourages more sustainable clothing consumption.

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# **APPLICATION OF MACHINE LEARNING FOR FINANCIAL MARKET PREDICTION**

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Financial markets are characterised by high complexity, constant change, and unpredictability, which makes their forecasting one of the most difficult tasks in the modern economy. Their behaviour is influenced by many factors, which complicates the use of traditional statistical methods. In recent years, machine learning techniques have become increasingly important due to their ability to identify hidden patterns. This study aims to analyse several articles on the use of machine learning methods in financial market prediction and evaluate their effectiveness.

The first article by Koukaras, Tjortjis and Rousidis [1] considers classical machine learning approaches, including linear regression, support vector machines (SVM), k-nearest neighbours, and Random Forest, for stock price prediction. The results show that these models can achieve higher accuracy compared to traditional methods. However, their effectiveness largely depends on data quality and feature selection. They are also sensitive to noise, prone to overfitting, and often unable to capture complex temporal dependencies, which limits their performance in volatile market conditions.

The next article by Rao [2] focuses on deep learning methods, particularly Long Short-Term Memory (LSTM) networks. The model is applied to historical stock data and evaluated using RMSE. The findings indicate that LSTM can effectively model temporal dependencies in financial data. However, such models require large datasets and significant computational resources. In addition, they are difficult to interpret and may not consider external factors, such as economic events, which reduces their practical usefulness.

The last article by Sonkavde et.al. [3] highlights the importance of data selection and the use of alternative data sources. The study examines the integration of sentiment analysis from social media platforms, such as Twitter and StockTwits, with traditional financial indicators. The results show that including sentiment data can improve prediction accuracy, as public opinion often correlates with market movements. However, such data are often noisy and may contain misleading information. Moreover, sentiment analysis does not always correctly interpret financial texts, and its relationship with market behaviour is not always stable.

In conclusion, machine learning methods have significant potential for improving financial market prediction. Classical models provide reliable results but are limited in capturing complex patterns, while deep learning approaches offer better performance at the cost of higher complexity. The use of alternative data can further enhance prediction accuracy. However, challenges such as data quality, noise, and model interpretability remain important. Future research should focus on developing more robust and transparent models.

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# REQUIREMENTS ENGINEERING FOR A DIGITAL FOOD SAFETY SYSTEM: MAPPING HACCP PRINCIPLES TO THE HONEY VALUE CHAIN

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The "Trustable and Sustainable Open Platform for Smart Honey Value Chains" (TOP4HoneyChains) seeks to establish an innovative model for the honey agrifood sector affected by sustainability challenges such as climate change, food safety concerns (specifically honey fraud), and increasingly competitive market conditions. As leading honey producers, Argentina and Türkiye face obstacles in gaining recognition for their higher-value honey products in the global market. The project aims to create a smart honey value chain that emphasizes transparency, efficiency, and responsiveness across the honey food system, ensuring producers can meet market preferences and consumer demands. Currently, the global honey industry is migrating towards a digital transformation to satisfy rising demands for transparency and safety standards [1]. Traditional food safety management revolves around outdated Hazard Analysis and Critical Control Points (HACCP) systems that lack real-time intervention capabilities due to their reliance on manual processes. The research underpinning TOP4HoneyChains focuses on developing the Requirements Engineering (RE) foundation for a digital food safety platform, steering efforts away from manual compliance towards proactive, data-driven management for enhanced traceability [2]. Utilizing a Design Science Research approach [3] and a mixed methods design [4], the study lays out a Data Dictionary and a Digital Critical Control Point (CCP) Matrix that translates biochemical safety limits into actionable requirements validated through field tests involving expert beekeepers in Ordu province, Türkiye. The project translates HACCP principles into a digital infrastructure with significant outputs: identification of biochemical hazards, definition of Digital CCPs, established thresholds for moisture and HMF levels, integration of sensor-based monitoring, automated alerts for noncompliance, and compliance analytics in accordance with the Turkish Honey Codex. The established Data Dictionary provides the technical specifications essential for monitoring complex parameters, thus positioning this digital infrastructure as a transformative blueprint for the honey industry. Overall, the successful mapping of HACCP principles to digital requirements aims to overcome the limitations posed by traditional methods, ensuring economic resilience for small-scale beekeepers while facilitating their integration into the digital economy. Future directions for the project will focus on advanced quality monitoring practices and enhanced consumer transparency instruments, fostering a modernized honey production landscape that benefits all stakeholders involved.

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# **TOWARDS RESPONSIBLE AI THROUGH EXPLAINABILITY**

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The EU AI Act 2024/1689 now legally requires that high-risk AI systems be designed with transparency, which enables developers to interpret system output and use it properly [2]. Despite this, AI models are often evaluated by their accuracy, and the aspect of transparency in the model's reasoning remains left out, producing AI models that perform well in accuracy and numbers but cannot be fully trusted by the stakeholders, as they cannot audit or see these models' output with transparency. Arrieta et al. defined responsible AI as a framework for deploying AI with interpretability, explainability, fairness, and accountability at its core [1]. We argue that explainability is the process through which two additional properties are achieved for building responsible AI: transparency, which makes model reasoning traceable and interpretable to humans, and trust, which is the confidence that must be achieved before automated predictions can have an impact on high-stakes decisions [1]. To explain this practically, we present a case study in predictive modelling where four models are evaluated not just on their performance, but also on their interpretability profiles. SHAP (SHapley Additive exPlanations) assigns features used in the predictive modelling an importance value for a particular prediction [3], which can generate both local and global explanations of the model's behaviour. Another XAI method, in addition to SHAP, is LIME (Local Interpretable Model-agnostic Explanations) [3], which is used to explain the predictions of any AI model in an interpretable and faithful manner. This way of evaluating the model by applying explainable AI methods to understand accuracy and explainability reframes model selection as responsible AI, not just a selection based on technical accuracy. The output results show that XAI methods transform a black-box predictive model into models that are transparent and trustworthy, even in critical decision-making. We conclude that explainability in AI models should not be seen as optional, but rather as an essential component for designing responsible AI.

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## **FORESTRY**

# **DRIVERS OF FOREST LAND, MANAGEMENT AND POLICY CHANGES IN LATVIA**

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The research focuses on the drivers of forest land, management, and policy changes in Latvia over the past century and highlights the importance of sustainable forest governance in modern environmental and economic development. Forests play a crucial role in environmental sustainability, economic growth, and social development, therefore understanding the historical and political drivers of forest management is essential for future planning. The aim of the research is to analyse the main political, economic, social, technological, environmental, and legal factors that have influenced forest land use and forest policy development in Latvia and to evaluate their impact on sustainable forestry. Theoretical sources show that forest lands significantly contribute to environmental quality, biodiversity, climate regulation, and economic value in many countries. Forest ecosystems provide essential services such as air and water purification, soil protection, and carbon storage, which makes them important for sustainable development and climate change mitigation. These ideas demonstrate that forests are not only natural resources but also a strategic component of national development, which requires careful management and policy regulation. The study also explains that forest land use and management in Latvia have been strongly influenced by political and economic changes during different historical periods, including the Russian Empire, independence period, Soviet occupation, and European Union membership. Political systems and economic interests determined how forests have been used, whether for industrial logging, agriculture, or environmental protection. This analysis shows that political and economic drivers have been the most significant factors affecting forest management, while environmental and legal factors have become more important in recent decades due to climate change and EU policies. Another important aspect of the research is the use of PESTEL analysis (political, economic, social, technological, environmental and legal factors) to evaluate the influence of different drivers on forest policy and land use changes. This method helps to compare historical periods and identify the dominant factors influencing forestry development. The results indicate that sustainable forest management has improved after Latvia joined the European Union, as stricter environmental regulations and modern technologies were introduced. In conclusion, the research shows that forest management in Latvia has evolved under the influence of political, economic, and environmental factors, and sustainable forestry is becoming increasingly important for future development. The study highlights the need for balanced forest policies that consider environmental protection, economic growth, and social needs to ensure long-term sustainability.

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# **RAPID DETECTION OF WINDTHROWS IN FOREST CRISIS MANAGEMENT**

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Windthrows are one of the most significant types of forest ecosystem disturbances in Latvia and Northern Europe, causing significant economic losses, increasing forestry risks and creating secondary threats, such as the mass proliferation of bark beetles. Effective forest crisis management after storms directly depends on timely, spatially complete and reliable information on the extent and location of damage. Traditional field survey methods are often time-consuming and limited in availability, whereas remote sensing enables rapid situational awareness of large areas, which is often more critical than immediate quantitative accuracy during the first response phase. The aim of this study is to analyze and evaluate the possibilities of operational windthrow detection in forest crisis management using open remote sensing data, paying special attention to Sentinel-1 synthetic aperture radar (SAR) data.

The theoretical part reviews scientific studies on windthrow detection with SAR data, emphasizing their advantages in crisis conditions. Senf and Seidl [1] confirm that storms are one of the dominant types of forest disturbances in Europe and that satellite-based mapping allows to be analyzed their spatial nature on a continental scale. Vaglio Laurin et al. [2] explain that the decrease in interferometric coherence in Sentinel-1 data is an effective indicator of changes in forest stand structure after storms, allowing the detection of damage areas regardless of cloud cover. In practice, coherence-based indicators are particularly helpful when optical imagery is unavailable. Park et al. [3] analyzes the backscatter intensity change method, emphasizing its suitability for operational windthrow detection with minimal pre-processing, which is especially important in the first days after a crisis event.

The study also analyzes the trade-off between data acquisition speed and mapping accuracy. In operational crisis management, the main task is not to immediately determine the exact extent of damage, but rather to identify priority areas, assess risks and plan resources. Operationally, these early maps are most useful for prioritising field checks, access and salvage planning. For further planning and monitoring of the elimination of consequences, operational SAR results can be integrated with optical satellite data and aerial photographs, providing a more detailed analysis.

It is concluded that open Sentinel-1 data provide a solid basis for operational windthrow detection in forest crisis management, especially in harsh meteorological conditions. Their use allows to improve the speed of decision-making, reduce economic risks and plan the elimination of consequences more effectively. To be effective in daily operations, such products should be delivered through an automated GIS-based workflow with clear confidence levels. The results of the study emphasize the need to integrate operational remote sensing data flows into forestry institutional systems.

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# OCCURRENCE OF HIMALAYAN BALSAM (*IMPATIENS GLANDULIFERA ROYLE*) IN BLACK ALDER FORESTS IN LIEPĀJA

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In ecology, it is accepted that higher biological diversity increases an ecosystem's resistance to external disturbances, including invasive species. Black alder (*Alnus glutinosa* (L.) Gaertn.) forests are very biodiverse, which can be attributed to higher soil moisture levels and their characteristic association with watercourses, riparian zones, and lower terrain [3]. However, ecosystems such as black alder forests remain vulnerable to invasion by species whose ecological requirements match the invaded habitat conditions. An example in this case is the Himalayan Balsam (*Impatiens glandulifera* Royle) [2]. Urban forests are affected both by direct and indirect anthropogenic disturbance, such as recreational pressure, fragmentation, and increased seed dispersal caused by human interaction with invasive species [1]. This makes it important to examine what affects *I. glandulifera* occurrence in urban black alder forests. The aim of this study was to assess the occurrence of *I. glandulifera* in black alder forests of Liepāja. The field data was collected during the 2025 growing season in 36 sample plots, 20 × 20 m established in 12 black alder stands in the Dienvidrietumi and Karosta microdistricts of Liepāja. Anthropogenic pressure was estimated from recreational intensity shown in the Strava heatmap. Vegetation was assessed using the Braun-Blanquet approach. Soil samples from A and B horizons were collected from 10 probing points per plot and analysed for field and absolute moisture, pH (H<sub>2</sub>O and KCl), total nitrogen, organic carbon, and organic matter using Wakley-Black method. In plots where *I. glandulifera* cover exceeded 25%, control soil samples were collected in non-invaded areas that closely match the plot conditions.

*I. glandulifera* was recorded in all 18 Dienvidrietumi plots, where average projective cover in invaded plots reached 50% and maximum cover reached 95%. In Karosta, the species was recorded in only one stand and with low projective cover. Native species richness was higher in uninvaded Karosta stands. Invaded plots had significantly higher soil moisture in both A and B horizons than uninvaded plots. Soil pH differed slightly between invaded and control samples, while organic carbon, organic matter and nitrogen content were higher in invaded A horizon samples. The projective cover of *I. glandulifera* was positively related to anthropogenic pressure. In conclusion, the results indicate that *I. glandulifera* occurrence in urban black alder forests of Liepāja is associated with higher anthropogenic pressure and higher soil moisture. The absence of the species in Karosta, despite equal forest type and structure, supports the role of human disturbance as a reason for invasion in urban ecosystems.

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# CORNUS MAS CULTIVATION POSSIBILITIES IN LATVIA

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Cornus mas (Cornelian cherry) is a tree that grows in the east and south regions of Europe and in West Asia, in moderate climate. Cornus mas is famous for being a rich source for vitamin C and polyphenols, having significant amount of flavonoids, anthocyanins and iridoids which are very beneficial for health. Cornus mas fruits are also used in foods [5]. The aim of this research is to find out if it is possible to cultivate Cornus mas in Latvia.

Cornus mas is relatively disease resistant and tolerates a variety of conditions, needing very little maintenance which makes it perfect for lazy gardeners [1]. The ideal growing conditions for Cornus mas are sunny to partial shade, it also loves warmth, but can cope with colder areas. It can grow in sandy or loamy or even humus rich soils as long as they are not too dry, the preferred soil pH being 7.4 [4]. It is entirely possible for Cornus mas to grow in Latvia as Latvia contains 12% of drained soils in forests and it is possible to make almost any soil into a drained soil as well. Its resistance to diseases can make its cultivation even more successful [1, 3].

As mentioned before, Cornus mas is very beneficial for health. It is used in traditional medicine to treat diarrhoea, inflammatory bowel disease, cholera, fever, malaria, kidney stones, urinary tract infections, and heat stroke and includes copper, zinc, manganese. It is also important to mention, that 1 gram of fresh Cornus mas fruit contains the needed intake of potassium, recommended by The World Health Organisation [2, 5]. The wood of Cornus mas is very dense which makes it perfect for creating items that require durability. As Cornus mas has a variety of health benefits, craft and food wise, this can make people think about its cultivation in Latvia. In conclusion, it is possible for Cornus mas to be cultivated in Latvia, because it can live in a variety of conditions, is relatively disease resistant and lives in drained soils. Not only should the growing requirements be kept in mind, but also its benefits for health, as it can help with many health problems, can be used in foods like jams and jellies, and its wood can be used to make walking canes and many more things.

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# DOES AGROFORESTRY HAVE POTENTIAL IN LATVIA?

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Agroforestry is a land management approach that supports ecology, provides multiple-source income, and is generally more profitable than forestry but less profitable than agriculture. Most of the time, it is defined as land-use systems and technologies where woody perennials are deliberately used on the same land management unit as agricultural crops and/or animals, in some form of spatial arrangement or temporal sequence. In agroforestry systems, there are both ecological and economic interactions between the components.

The previous research on the impact of the agroforestry system of hybrid aspen and perennial grasses or legume on soil and water quality that was carried out in 2011 in Skrīveri, Latvia, showed that tree growth and development of root systems decrease the soil bulk density in the upper soil layers. Reduction of soil organic carbon stock was detected which is very unusual considering that agroforestry systems have a large carbon sequestration potential. However, it can be explained by the mineralization of peat applied 20 years ago on the experiment field. Potential nutrient leaching into groundwater should be reduced, but because of the methods of the research, it is hard to tell if this effect was present or not. In general, higher nutrient values were detected at the beginning of the experiment after the fertilizer application [2].

During the research in 2022, the total area of agricultural land with low-quality soil for agriculture where agroforestry could provide a solution for more effective land management was estimated to be 351.5 kha, which is 5.44% of all the Latvian territory. Although the number is not big (compared to 55.8% of forest land and ~ 30% of agricultural land), this type of management could offer a better solution both economically and ecologically than leaving the land as it is [1].

Another research conducted in 2022 in the Baltic Sea region showed that, by properly setting up and managing short-rotation tree plantations, it is possible to create economically efficient agroforestry systems for biomass production. The most suitable tree species as biomass producers on short-rotation plantations are *Salix* spp., *Populus* spp. and *Alnus* spp., which, as local ones, are well available on the market and easy to establish [3].

Although different forms of agroforestry are present in Latvian landscapes, agroforestry itself is not defined by national legislation, which inevitably leads to a lack of motivation among landowners and farmers due to the lack of supporting policies at both national and European levels. However, Latvia, in terms of available suitable land and available tree species, has potential for agroforestry development and public recognition. The previously conducted research supports this point and proves that such practices are possible; however, in the authors' opinion, more research should be done for more definitive results and diversity of examples on Latvian land.

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# EFFECTS OF HYDROLOGICAL REGIME MISCLASSIFICATION ON FOREST MANAGEMENT MODELLING

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In modern forest management planning, accurate assessment of the hydrological regime is essential, as it directly influences forest site classification and the modeling of forestry operations. The topicality of this research is related to increasing uncertainty in environmental data and its impact on decision-making in forestry. The aim of this study is to evaluate how inaccuracies in hydrological regime assessment affect forest management modelling and to identify the main sources of uncertainty.

Hydrological processes in forested areas are strongly dependent on land use, soil properties, and vegetation characteristics. According to Fragoso et al. [1], runoff estimation in forested watersheds is highly sensitive to the quality of cartographic data, and none of the available sources provide sufficient information for precise parameter determination. This indicates that hydrological inputs used in forest management models may contain systematic errors. The study emphasizes that the selection of inappropriate data sources leads to overestimation or underestimation of runoff values, which directly affects planning decisions. These findings are supported by the research on the interaction between forest cover and hydrological response. Sidău et al. [2] explained that even small variations in forest area could significantly influence peak discharge values. This highlights the importance of accurately defining forest characteristics in hydrological modelling. Misclassification of hydrological regimes may result in incorrect assumptions about soil moisture conditions, which in turn affects forest growth modelling, harvesting planning, and infrastructure development.

In addition, the availability and quality of hydrological data remain a major limitation in large-scale modelling. Revilla-Romero et al. [3] pointed out that the lack of continuous and up-to-date streamflow data was one of the main constraints in hydrological forecasting systems. To address this issue, remote sensing and data assimilation techniques are increasingly used. However, these methods also introduce uncertainty related to spatial resolution and signal interpretation, especially in forested areas where canopy cover affects data accuracy.

Forest typology plays a key role in integrating hydrological conditions into forest management planning. According to Liepa et al. [4], forest management decisions are based on comprehensive understanding of site conditions, including soil, moisture, and vegetation interactions. Therefore, inaccurate hydrological classification may lead to inappropriate selection of tree species, ineffective silviculture practices, and reduced sustainability of forest ecosystems.

In conclusion, inaccurate assessment of the hydrological regime introduces significant uncertainty into forest management modeling. The results indicate that improving data quality, integrating remote sensing technologies, and refining classification methods are essential steps towards more reliable forest planning. Accurate representation of hydrological conditions is important for sustainable forest management and effective decision-making.

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# **REMOTE SENSING RELIABILITY IN DETECTING IPS TYPOGRAPHUS DAMAGE: THE INFLUENCE OF STAND PROPERTIES IN HETEROGENEOUS MANAGED FORESTS**

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Forest ecosystems across Europe are increasingly threatened by climate-driven disturbances, prompting growing interest in effective monitoring and assessment methods.

Disturbances from wind, bark beetles and wildfires have increased in Europe's forests throughout the twentieth century. Climatic changes was identified as a key driver behind this increase, yet how the expected continuation of climate change will affect Europe's forest disturbance regime remains unresolved [2].

Bark beetles cause severe damage to European forests leading to impacts on many sectors, from the environmental to the economics sectors. Timely mapping of different stages of attacks is very important. Remote sensing has been widely used to map bark beetle damage using both airborne and satellite data. Newly available satellite multispectral data with a daily revisit time and high spatial resolution has the potential to monitor an attack in all phases [1].

For this purpose, remote sensing based on satellite images is considered one of the most efficient methods, particularly in homogenous and wide forested landscapes. However, under highly heterogeneous seminatural managed forest landscapes in lowland Central and Northern Europe, as illustrated by the eastern Baltic region and Latvia in particular, the efficiency of such an approach can lack the desired accuracy [3].

Therefore, while satellite-based remote sensing offers strong potential for monitoring bark beetle infestations, its application in heterogeneous forest landscapes such as those in Latvia requires further refinement to achieve reliable accuracy.

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# GROWTH DYNAMICS OF SWEET CHERRY (*PRUNUS AVIUM* L.) CLONES IN LATVIA

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Sweet cherry (*Prunus avium* L.) is a valuable broadleaved tree species of increasing importance in European forestry due to its high-quality timber, ecological significance, and economic potential [1, 2]. It is considered one of the most promising noble hardwoods for high-value timber production, particularly in plantation forestry and mixed stand systems [1, 3]. In recent decades, the relevance of sweet cherry has increased in northern Europe, including the Baltic region, where changing climatic conditions and growing interest in alternative broadleaved species have improved its perspectives for cultivation [1]. However, successful cultivation depends on a combination of factors, including genetic background, site conditions, plantation design and silvicultural management [1, 3, 4]. In particular, clone selection and stand density are considered among the most important determinants of growth performance, stem quality and future timber value [1, 2].

The aim of this study was to evaluate the growth performance and stem quality of selected sweet cherry clones under climatic conditions in Latvia. The research was conducted in experimental plantation stands established on former agricultural land in Latvia since 1997. A comparative assessment included five clone plantations: three local-origin plantations in Priekule, Talsi, Kuldīga and two clone plantations originally from Sweden (No.9 and No.10) but now growing in Bauska and Dobele. Tree height and diameter were measured, and stem quality defects were assessed to evaluate tree development and characterize growth dynamics. The results revealed significant differences among clones in growth dynamics and stem quality. In general, Swedish-origin clones showed higher productivity and better stem quality form compared to the local genotypes, especially under favourable site conditions. At the same time, variation among plantation sites confirmed the strong influence of environmental factors on stand performance.

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# **APPLICATION OF REMOTE SENSING DATA TO IMPROVE THE CALCULATION OF FOREST HARVESTING SITE DIFFICULTY INDEX**

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In recent years, the level of complexity in forest harvesting planning has significantly increased, therefore, the possibilities offered by remote sensing data and technologies are increasingly being used, especially nowadays when the development of these technologies has progressed rapidly. These data provide the opportunity to spatially evaluate and analyse potential harvesting areas while simultaneously improving the quality of forest harvesting planning. Environmental benefits must also be emphasized, as such an approach allows more efficient use of forest harvesting machinery, reducing the risk of soil damage and the overall impact on the forest ecosystem. The harvesting difficulty index is a combination of several data sources and factors that characterize how complex the harvesting of a particular stand is. The main objective of this study was to improve the existing calculation of the harvesting difficulty index by integrating remote sensing data.

Recent studies emphasize the new opportunities provided by remote sensing data and their modern analysis methods. By combining remote sensing data analysis methods with machine learning solutions, it is possible to obtain automated analysis models that allow planning analyses to be carried out within a shorter period of time. Such an approach provides the opportunity to analyse changes in forest stand structure and to identify these changes more efficiently, as well as to make data-driven decisions when carrying out forest management activities within a territory [1].

Scientific literature also highlights the necessity of spatial data in the forest harvesting planning process. Spatial data allow the determination of the mobility of forest harvesting machinery within a specific territory. The terrain, soil hydrological conditions and soil bearing capacity are only some of the factors that influence the mobility of forest harvesting machinery. The use of these data reduces the risk of soil damage and the direct costs of harvesting operations. By using spatial analysis methods, it is possible to identify and advance the locations where harvesting operations will be more complex under existing conditions [2].

Within the framework of the study, regeneration fellings carried out in the period from 2018 to 2024 in the territories of the company “Latvijas valsts meži” in the West Vidzeme and East Vidzeme regions were analysed. The factors used in the study were divided into two groups – spatially variable and spatially invariant factors.

As a result of the study, it is planned to develop an improved model for calculating the harvesting difficulty index by integrating remote sensing data.

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# ASSESSMENT OF MONUMENTAL TREES IN ĶĒKAVAS MUNICIPALITY

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The presence of monumental trees represents an essential component of natural and cultural heritage, contributing significantly to biodiversity conservation and ecosystem stability. These trees provide habitats for various species and play an important role in maintaining ecological balance. However, their existence is increasingly threatened by anthropogenic factors such as urbanisation, land use changes and climate change. Therefore, the assessment and monitoring of monumental trees at a local level is of great importance [1].

The aim of this research was to evaluate the qualitative and quantitative characteristics of existing and potential monumental trees in Ķekava municipality. Previous studies emphasise that monumental trees act as key ecological structures, supporting biodiversity and providing long-term ecosystem services [3]. Large old trees are known to contribute disproportionately to ecosystem functioning, particularly in carbon storage and habitat protection [2]. At the same time, anthropogenic impacts, such as soil compaction, pollution and improper maintenance, significantly influence tree vitality and stability [3].

The research was carried out in the territory of Ķekava municipality, Latvia. Data were obtained from the Nature Data Management System “Ozols” and supplemented with data from field surveys. During the fieldwork, tree species was identified and height, trunk circumference and crown dimensions were measured. In addition, qualitative indicators such as root condition, trunk quality and crown vitality were evaluated using a developed scoring system. A survey of local residents was also conducted to assess their level of awareness and knowledge about monumental trees [4]. The results indicate that the actual number and condition of monumental trees in Ķekava municipality differ from the official data. Several previously unregistered trees were identified during fieldwork, confirming inconsistencies in the existing database. The analysis also reveals variation in tree health condition, with some trees in good vitality and others affected by environmental and anthropogenic factors. The survey results demonstrate that public awareness is moderate highlighting the need for improved information dissemination [4].

In conclusion, this study underlines the importance of regular monitoring and local-level assessments of monumental trees. The identified discrepancies between field data and official records indicate the necessity of updating databases and improving management strategies. Increasing public awareness is also essential for ensuring the long-term preservation of monumental trees.

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# POSSIBILITIES OF CULTIVATION OF *MYRICA GALE* L. IN LATVIA

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*Myrica gale* L. (Bog Myrtle or Sweet Gale) is a common nitrogen fixing deciduous shrub that grows wild in the wet acid soils of Northwest Europe, Canada, North America and Asia [2]. *Myrica gale* is famous for its plant oil. Oil has been used for flavouring beer, porridge and vinegar for over a thousand years. It is also used in perfumes and soaps and as a dye plant for clothes. The sweet-scented foliage of *Myrica gale* is often used as an insect repellent [1, 3]. The aim of this research was to find out if there is a theoretical possibility to grow *Myrica gale* in plantations in Latvia. *Myrica gale* is a relatively undemanding plant, but it does require active weeding and pruning. This shrub usually does not have problems with pests, because the plant has an insect repelling oil [2]. The crop can be susceptible to a leaf spot *Phacellium rufibasis* (Berk. & Broome) U. Braun which can become quite severe in some seasons causing defoliation. Natural soil habitat for *Myrica gale* is well aerated acidic peatland but acidic mineral moisture soils are also suitable with a pH of 4.5-5.5 [1].

It is entirely possible for *Myrica gale* to grow in Latvia in plantations. More than 10% of Latvia territory is occupied by bogs, therefore, providing the necessary growing conditions is not that difficult [3]. If these shrubs were planted, the density should be 1.5 plants per square meter or 15,000 plants per hectare. With an initial investment of approximately 11,000 euros per hectare, after 4 years of growing the net profit can be approximately 3,000 euros per hectare depending on external conditions [1]. In conclusion it is possible to grow *Myrica gale* plantations in Latvia because here there are all growing conditions that are needed. The shrub is also used in foods and drinks, for example, in Riga Black Balsam. Not only the growing requirements should be taken in mind but also its benefits for health in traditional medicine as skin treatment for various diseases.

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## **PUBLIC UNDERSTANDING OF HUNTING PRACTICES**

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Compared to the general public, hunters usually have a better understanding of biology, ecology, wildlife populations, and conservation status [1].

Hunting in Latvia remains a relevant topic as it is closely linked to cultural traditions, environmental management and public attitude toward nature. Today hunting is not only about obtaining food but also an important tool for regulating wildlife populations and maintaining ecological balance. The aim of this research was to analyse the development of hunting in Latvia and to examine its role in society as well as public perception of hunting practices.

Gross et al. [2] describes hunting as an ancient human activity essential for survival and development. It is emphasised that hunting has evolved from a basic necessity into a structured and regulated practice. The historical importance of hunting and its transformation over time should be noted.

It is of the highest importance that knowledge, responsibility and discipline are required in hunting. Hunting is an activity what requires ethical behaviour and careful decision-making. [3]. People have to remember that hunting is a form of environmental management which ensures the stability of wildlife populations while balancing economic and social interests. The role of hunting is very important in protecting agriculture and forestry as well as maintaining ecological balance. It also reflects the principles outlined in Latvian legislation [4].

The methodology of this research includes a survey with a questionnaire in the form of *MS Forms*. It was distributed through social networks as well as among friends and acquaintances. In total 33 respondents filled out a questionnaire. The research findings indicate that public attitudes toward hunting are diverse. Most respondents recognise hunting as necessary for population control and environmental balance. However, some view it as unethical, associating it with cruelty toward animals. This contrast suggests a lack of understanding about modern hunting practices and their role in sustainability.

In conclusion, hunting in Latvia is a complex activity what combines tradition, environmental protection and economic significance. While public opinion remains divided, many people acknowledge its importance. Increasing public awareness and education could help improve understanding of hunting and reduce negative stereotypes.

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## **AGRICULTURE AND FOOD SCIENCE**

## DISEASES OF FABA BEAN LEAVES

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Field beans (*Vicia faba*) are an important crop throughout Europe in agriculture and food production. They are a good source of plant protein for both humans and animals. Field beans are valuable in crop rotation, especially before cereals. They help improve soil structure, reduce the build-up of pests and diseases, and enrich the soil with biologically-fixed nitrogen [3].

Leaf diseases are among the most significant yield-limiting factors. The main diseases of field beans are chocolate spot (caused by *Botrytis* spp.), Ascochyta blight (caused by *Didymella fabae*), leaf blights (caused by *Alternaria* spp. and *Stemphylium* spp.), rust (caused by *Uromyces viciae-fabae*), and downy mildew (caused by *Peronospora viciae*) [1].

Chocolate spot is the most common and damaging disease of field beans. Symptoms range from small reddish-brown necrotic spots to large necrotic blotches with reddish margins. Leaves, stems, flowers, pods, and seeds can be infected. Molecular and morphological studies have shown that several *Botrytis* species can cause the disease, including *Botrytis fabae*, *Botrytis cinerea*, *Botrytis pseudocinerea*, and *Botrytis fabiopsis*. Other species, such as *B. caroliniana*, *B. euroamericana*, *B. aclada*, and *B. paeoniae*, may also be potential pathogens of field bean, although their role in field bean infection remains unclear [2].

Ascochyta blight is caused by *Didymella fabae*. Initial symptoms appear as small, dark spots with reddish-brown margins. As the disease progresses, concentric rings develop on leaves, pods, and stems, with pycnidia forming in the centre of the lesions [1].

*Alternaria* and *Stemphylium* cause similar and often overlapping leaf spot and blight symptoms. In field bean, symptoms may occur on all aboveground parts of the plant as large, grey to black necrotic lesions that often fuse together. Lesions typically begin at the leaf margins. A characteristic feature is the presence of a yellow chlorotic halo surrounding the spots [1].

Faba bean rust is characterised by small, orange-brown to yellow powdery pustules that develop mainly on leaves and stems. The causal agent, *Uromyces viciae-fabae*, is autoecious, completing its life cycle on a single host plant and producing five distinct spore types [1].

Downy mildew is caused by *Peronospora viciae*, an organism belonging to the kingdom *Chromista*. Symptoms appear as large, irregularly shaped reddish blotches. A greyish-white downy growth can be observed on the underside of infected leaves [1]. To sum up, accurate recognition of disease symptoms are necessary for effective disease management to prevent yield loss.

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# **BIODEGRADABLE PACKAGING SOLUTIONS AS AN ALTERNATIVE FOR CARROT AND BEETROOT JELLY CANDIES**

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Food packaging plays a crucial role in preserving food and maintaining its quality by serving as a barrier against external contaminants such as microorganisms, dust, gases, and light [1]. For many years, petrochemical plastics have been used; among them, polypropylene (PP) is one of the most commonly used plastics in daily life [2]. However, increasing environmental concerns associated with conventional plastic waste have led to growing interest in biodegradable packaging. Biodegradable food packaging materials such as PLA and PLA-121 have been identified as alternatives to conventional petroleum-based plastics [3]. At the same time, there has been growing global interest in improved nutrition, promoting the consumption of vegetables for their health benefits. In the present study, carrot and beetroot were selected for the development of jelly candies due to their high nutritional value and rich content of bioactive compounds. The aim of the paper was to evaluate the use of biodegradable packaging as an alternative to conventional packaging for carrot- and beetroot-based jelly candies, and to assess its effect on the quality and shelf life of the product.

The research experiment was carried out at the Latvia University of Life Sciences and Technologies. Jelly candies were produced from carrot (C) and beetroot (B) purée using a standardized process and packed in different types of packaging: polypropylene (PP), polylactic acid with barrier (PLA), and polylactic acid without barrier (PLA-121). Samples were packaged in pouches using a Multivac packaging machine and stored at room temperature. Physicochemical properties such as moisture content, total soluble solids (TSS), colour parameters, and others were measured at 0, 2, and 4 weeks of storage.

The study investigated the effect of three different packaging materials on the quality of jelly candies after 4 weeks of storage. PLA film was the most effective packaging for maintaining the colour of Samples C ( $L^*=35.51$ ;  $a^*=26.20$ ;  $b^*=29.38$ ); Samples B ( $L^*=14.54$ ;  $a^*=12.54$ ;  $b^*=0.62$ ). In all samples investigated, total soluble solids (TSS) ranged from sample C: (from 20.03 to 21.10), Samples B: ( $25.60 \pm 0.21$  to  $29.67 \pm 0.34$ ). The highest moisture content losses were in sample PLA 121 initial for (Sample B:  $30.61 \pm 0.41$ ) and (Sample C:  $33.71 \pm 0.36$ ) both the samples B and C dropped to  $14.30 \pm 0.22$  during storage.

Based on the experimental results, PLA packaging without barrier properties (PLA-121) is not suitable for packaging of jelly candies. However, PLA with barrier properties can be a good alternative to reduce the use of traditional PP packaging for jelly candies.

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# **DEVELOPMENT OF INNOVATIVE READY-TO-EAT MEALS FOR INFANTS FROM EIGHT MONTHS OF AGE**

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Infant nutrition during the first years of life is a key factor influencing growth, development, and long-term health outcomes. After 6–8 months of age, breast milk or infant formula alone is insufficient to meet increasing nutritional requirements, particularly for iron and docosahexaenoic acid (DHA), which are essential for cognitive and neurological development. However, many ready-to-eat infant foods available on the market contain insufficient iron or rely on animal-derived DHA sources, which may not align with current sustainability trends [1, 2, 3].

The aim of this study was to develop innovative ready-to-eat meals for infants from eight months of age enriched with iron and DHA, using plant-based raw materials and microalgae-derived omega-3 fatty acids as a sustainable alternative. The research was conducted in cooperation with the Latvian organic baby food producer “Rūdolfis”. The developed products underwent physicochemical analyses, including pH determination, evaluation of rheological properties (flow behaviour), measurement of soluble solids content (°Brix), and shelf-life assessment. The iron and DHA content were determined in an accredited laboratory. The results showed that the developed meals met the required physicochemical quality parameters and remained stable during storage. The measured pH, viscosity, and soluble solids content confirmed the suitability of the products for infant nutrition. No significant changes in pH or organoleptic properties were observed during the shelf-life, indicating high resistance to oxidative processes. Laboratory analysis confirmed that the iron and DHA content corresponded to the targeted values, and a significant amount of vitamins was also detected in the products.

In conclusion, the developed ready-to-eat meals offer a promising approach to improving infant nutrition by increasing iron and DHA intake. Further research should evaluate nutrient bioavailability and assess lipid oxidation levels.

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# COMPARATIVE EVALUATION OF ATMOSPHERIC AND VACUUM FRYING ON QUALITY PARAMETERS OF CARROT, SWEET POTATO AND FRYING OIL

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The growing demand for healthier snack alternatives has driven the development of innovative food-processing technologies. Conventional frying is widely used in food production for its desirable sensory properties; however, it often results in high oil absorption and oxidative degradation, which negatively affect product quality and nutritional value [1]. Vacuum frying has emerged as a promising alternative, enabling frying at lower temperatures and reduced oxygen levels, which can improve product quality and oil stability [2,3].

This study aimed to evaluate the effects of atmospheric and vacuum frying on the quality of carrot (*Daucus carota*) and sweet potato (*Ipomoea batatas*), and to assess oil oxidative degradation under various frying conditions and cycles.

Experimental trials used atmospheric and vacuum frying to assess the quality of fried samples in terms of physicochemical properties, moisture content, oil absorption, colour, texture, carotenoid content, and sensory attributes. Oil stability was evaluated before and after multiple frying cycles. Fresh carrot and sweet potato samples were analysed before and after frying at 160°C for 3 minutes (atmospheric) and at 115°C under 20 kPa for 20 minutes (vacuum). Four frying cycles were conducted, with oil sampled after each cycle. Standard methods were used to assess physicochemical properties: moisture content (ASTM D2216-98), fat content via Soxhlet extraction, colour, texture analysis, total carotenoids, oil peroxide value, and viscosity. The data showed no significant moisture differences between frying methods, but fat content was lower in vacuum-fried samples - 10.5% in sweet potato chips and 20% in carrot chips. Vacuum-fried samples were slightly firmer, likely due to differences in pore structure, and better preserved natural colour. Total carotenoid content remained unchanged, indicating minimal degradation despite longer, lower-temperature processing. Oil measurements showed minor changes, with a trend towards improved stability in vacuum frying. Overall, vacuum frying enhances product quality and oil stability, reduces oil absorption, and preserves colour, making it a promising alternative to conventional frying. Further optimisation could improve these benefits and support the development of healthier fried snacks.

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# CO-FERMENTATION OF YEAST AND LACTIC ACID BACTERIA FOR THE PRODUCTION OF WHEY-BASED BEVERAGE

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Whey is a nutrient-rich by-product generated during cheese and curd production, accounting for approximately 70 to 80% of total milk volume [1,2]. However, its disposal poses a significant environmental risk due to high BOD and COD levels [3]. The aim of this research was to evaluate sweet whey co-fermentation with *L. plantarum* (LBP) or *L. rhamnosus* (LCR) and *Saccharomyces cerevisiae*.

This study was conducted at the Food Institute, Latvia University of Life Sciences and Technologies, Latvia. Sweet whey (from a production facility in Jelgava) was thermally treated at 90–92°C for 30 minutes, centrifuged to separate whey proteins, and sterilised at 115°C for 15 minutes. Whey samples (200 g) were supplemented with 10 g of sucrose and co-inoculated with yeast (0.02%) and either LBP or LCR (0.01 U each). After 24 hours of fermentation at 30°C and 35°C, the biomass was removed by centrifugation. Samples were analysed for composition, further pasteurised at 70°C for 5 minutes, and stored for 14 days at 4°C to monitor stability. Lactic acid bacteria and yeast CFUs were detected using MRS and MEA media, respectively, at a  $10^{-5}$  dilution. The pH was measured with a Mettler Toledo Seven Compact™ S220 digital pH meter, and the composition of fermented samples was analysed using a Foss Oeno Foss 2 analyser and Milk Oscan™ Mars.

Microbial analysis showed rapid multiplication of lactic acid bacteria (LAB) and yeast during fermentation, with LAB and yeast counts increasing from  $47 \times 10^5$  to  $11 \times 10^7$  CFU/mL in LCR + yeast, and from  $54 \times 10^5$  to  $85 \times 10^6$  CFU/mL in LBP + yeast, while yeast populations peaked at  $81 \times 10^7$  CFU/mL after fermentation, confirming effective co-culture growth. In the LCR + yeast sample, protein concentration increased from  $0.43 \pm 0.01\%$  to  $0.48 \pm 0.01\%$ , while carbohydrates, and total solids content reached 8.92% and 12.46%, respectively. Similarly, the LBP + yeast sample showed a protein increase from  $0.45 \pm 0.01\%$  to  $0.53 \pm 0.01\%$ , with carbohydrates reaching 8.47%. The increases in protein and solids are attributed to microbial growth and metabolite production during fermentation. Lactic acid production maintained an acidic environment (pH 4.53–4.98), with lactic acid concentrations reaching 8.80% in LCR + yeast and 8.20% in LBP + yeast treatments. Ethanol concentration slightly decreased from 1.35% to 0.95–1.23%, likely due to secondary microbial metabolism. The production of fermented whey beverages showed significant physicochemical changes over a 14-day observation period after fermentation.

Co-fermentation of sweet whey with *S. cerevisiae* and LAB effectively increased protein and lactic acid levels while maintaining high microbial stability during storage. These results show that whey can be efficiently converted into a value-added functional beverage, reducing the environmental impact of whey disposal.

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# RESEARCH ON BIOLOGICALLY ACTIVE COMPOUNDS IN MICROGREENS

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Microgreens are increasingly recognized as nutrient-dense functional foods, yet evidence on how ontogenetic stage influences their lipophilic antioxidant profile remains limited [1]. This study evaluated the effects of developmental stage on chlorophylls, carotenoids and tocochromanols in ten microgreen species grown under controlled greenhouse conditions, with particular emphasis on plastochromanol-8 (PC-8), a rarely reported chloroplast prenyl lipid [2]. Spinach, mung bean, basil, chervil, fenugreek, alfalfa, garden cress, radish, broccoli and red cabbage were cultivated under identical conditions, and samples were collected at three stages: first true leaf emergence, market maturity and overgrown stage. Freeze-dried material was analyzed for tocochromanols and carotenoids by high-performance liquid chromatography after saponification, while chlorophyll a and b were determined spectrophotometrically. Statistical analysis was performed using ANOVA and Tukey's HSD test ( $p < 0.05$ ).

The results showed pronounced species- and stage-dependent differences. Total chlorophyll content generally increased from the earliest to the second and/or third stage, but fenugreek already exhibited the highest total chlorophyll concentration at the later harvest stage ( $6.79 \pm 0.68 \text{ mg g}^{-1} \text{ DW}$ ), while chervil maintained consistently high chlorophyll levels throughout development. Alpha-tocopherol was the dominant tocochromanol in all species, with the highest concentrations found in cress ( $37.3 \pm 0.4 \text{ mg } 100 \text{ g}^{-1} \text{ DW}$ ), broccoli ( $27.5 \pm 1.3 \text{ mg } 100 \text{ g}^{-1} \text{ DW}$ ) and fenugreek ( $20.5 \pm 1.4 \text{ mg } 100 \text{ g}^{-1} \text{ DW}$ ). PC-8 was detected in all analyzed species, with the most notable accumulation in cress, basil and mung bean, confirming the novelty of the dataset. Carotenoid profiles were dominated by lutein, violaxanthin and neoxanthin, whereas  $\alpha$ - and  $\beta$ -carotene were present at lower concentrations. Total carotenoid content increased markedly with development in several species, reaching  $42.55 \pm 2.22 \text{ mg } 100 \text{ g}^{-1} \text{ DW}$  in broccoli and  $46.55 \pm 5.14 \text{ mg } 100 \text{ g}^{-1} \text{ DW}$  in red cabbage at the overgrown stage. Phenolic accumulation followed a different pattern: the highest value was recorded in red cabbage at the earliest stage ( $755.79 \pm 19.15 \text{ mg GAE } 100 \text{ g}^{-1} \text{ FW}$ ), while chervil peaked later, at  $501.68 \pm 35.88 \text{ mg GAE } 100 \text{ g}^{-1} \text{ FW}$ .

This integrated approach enabled simultaneous interpretation of pigments and tocochromanols. Overall, the findings show that no single harvest stage maximizes all bioactive compounds across species. Instead, optimal harvest timing is species- and compound-specific, providing a practical basis for tailoring microgreen production towards targeted nutritional and functional quality.

## Acknowledgement

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## **FROZEN SPINACH (*SPINACIA OLERACEA L.*) DESSERT**

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The use of spinach (*Spinacia oleracea L.*) in the production of frozen desserts is novel and has not yet been observed in supermarkets. Consumers may initially perceive such products as sour, bitter or unpalatable. However, the use of spinach demonstrates that it is an excellent raw material for frozen dessert development [1], as it contains the natural green pigment chlorophyll [2]. Product colour plays a significant role in taste perception, as people tend to associate specific colours with particular flavours [3]. Spinach not only provides an appealing natural green colour but also enhances the nutritional value of the product while contributing a mild, pleasing flavour that pairs well with other ingredients. This product represents an alternative frozen dessert to traditional dairy ice cream, with a beautiful green colour.

In the study, four types of spinach frozen desserts were made, changing the concentrations of added honey. The samples are labelled as M20%, M15%, M12%, and M10%, where the percentages indicate the proportion of honey added; for example, M20% contains 20% honey by total product mass.

The aim of the study was to investigate the potential use of spinach (*Spinacia oleracea L.*) in the production of frozen desserts. The research described in the abstract was conducted from February 2026 to April 2026. The research tasks were carried out in various laboratories of the Faculty of Agriculture and Food Technology at the Latvia University of Life Sciences and Technologies. The faculty is located at 22a Rīgas Street, Jelgava.

Concerning spinach frozen dessert, the following methods were used: physicochemical analyses (nutritional value, dry matter, moisture content, colour, melting rate, microstructure), rheological analyses (overrun, viscosity, firmness), and sensory evaluation.

Results and conclusions were the following: spinach frozen dessert was made from spinach, coconut milk, milk powder, and honey. All spinach frozen dessert formulations showed fresh green colour, and the analyses revealed significant differences between the samples. The results indicate that honey concentration significantly affects the physicochemical and rheological properties of the spinach frozen dessert, resulting in an unstable melting rate, low overrun, and low hardness. The best overall quality characteristics were observed in sample M12%, suggesting that this honey concentration could be optimal for the formulation of this product.

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# QUALITY ASSURANCE IN SAUERKRAUT PRODUCTION

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The food industry is focusing on product quality and long-term assurance as consumer demand for functional and visually appealing products increases. Recently, consumer interest in fermented, functional products that offer health benefits and support the intestinal microbiome has grown. The Law on the Supervision of the Handling of Food defines quality as a set of characteristics that ensure the product meets consumer needs and specific regulatory standards. Regulations require companies involved in food production to maintain product quality and safety. Sauerkraut fermentation relies on microorganisms that convert complex substances in fresh cabbage into simple compounds such as lactic acid. The process depends on factors including raw material quality, hygiene, and environmental conditions. Omitting any step in the technological process may introduce harmful microorganisms or chemicals that could affect sensory qualities or overall quality. To produce safe sauerkraut for consumers, compliance with regulatory standards is essential. Developed quality assurance guidelines should supplement legislative requirements to help ensure the production of safe food products [1, 2, 3].

The research method used was a questionnaire for sauerkraut product manufacturers in Latvia. Based on the questionnaire, the responses were analysed using methods such as the Pareto (80/20) method, which identifies significant factors, and the Ishikawa diagram, which visually presents various influencing factors and specific problems.

After distributing questionnaires to companies, the author received responses from five sauerkraut manufacturers: three stakeholder farms (Z/S) and two limited liability companies (SIA). The companies have obtained quality system certifications, including HACCP (60%), organic farming within a holistic system of agriculture and food production (40%), Green Spoon (40%), Bordeaux Spoon (20%), and BRCGS (20%). One respondent had not obtained any type of quality system certification. Survey data indicate that the most frequently identified problem is raw material quality, relating to inconsistent raw materials from different suppliers, insufficient freshness or overripe raw materials, and failure to follow proper storage and transportation procedures. Raw material quality impacts fermentation and influences storage time or shelf life. The most common technological issues among manufacturers are raw material quality, packaging – which significantly influences the fermentation process – and lack of employee training. In conclusion, the size of the manufacturing company and production volume influence the implementation and maintenance of a quality system. Fermentation, a key process in sauerkraut production, is strongly affected by factors such as raw material quality, supplier selection, transportation, agricultural conditions (weather, soil, variety), and compliance with hygiene and sanitary standards. The collected data provide a foundation for developing a risk analysis (HACCP).

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# DETERMINATION OF INULIN CONTENT IN FRESH AND FERMENTED DANDELION (*TARAXACUM OFFICINALE*) ROOT

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Dandelion (*Taraxacum officinale*) roots are recognised as a valuable source of bioactive compounds, including polyphenols, sesquiterpene lactones, triterpenes, and sterols. The root contains substantial amounts of inulin, a non-digestible polysaccharide that serves as a prebiotic dietary fibre [1]. Fermentation can significantly affect the chemical composition, nutritional value, and functional properties of food products [2]. This research aims to evaluate the amount of inulin in fresh and fermented dandelion root using different fermentation methods by adding *Lactiplantibacillus plantarum* and *Saccharomyces cerevisiae* (*L. plantarum* and *S. cerevisiae*). Dandelion roots were harvested, cleaned, and stored frozen until further use in October 2025. In February 2026, the roots were ground and then fermented for 52 hours. Three different fermentation methods were used: No. 1 – spontaneous fermentation (1% NaCl solution, 100% moisture) at +20°C; No. 2 – fermentation using *L. plantarum* and *S. cerevisiae* mixed in a 3:7 ratio at +35°C (12% inoculum concentration, 52% moisture); and No. 3 – fermentation using *L. plantarum* and *S. cerevisiae* mixed in a 3:7 ratio at +20°C (12% inoculum concentration, 1% NaCl solution, 100% moisture). After fermentation, the inulin content was determined in both fermented and fresh-frozen root samples using ultrasound-assisted extraction and resorcinol-based spectrophotometric determination of fructans (FOS and inulin). Briefly, all samples were rinsed with 80% ethanol solution, then distilled water was added and the samples were incubated in an ultrasonic bath (40 kHz) at +50°C for 20 minutes. Then, 96% ethanol was added to half of the extract. For sample preparation, resorcinol, thiourea, 96% ethanol, and concentrated HCl were added to the extract. The samples were then heated in water at +80°C for 8 minutes. The results were read on a spectrophotometer at A480 nm.

In fresh dandelion root, the inulin concentration was 179.198 mg g<sup>-1</sup> FW (fresh weight). In sample No. 1, the inulin concentration was 344.587 mg g<sup>-1</sup> FW. In sample No. 2, the inulin concentration was 408.492 mg g<sup>-1</sup> FW, while in sample No. 3, it was 614.976 mg g<sup>-1</sup> FW. The significant increase in inulin concentration can be explained by degradation of the plant cell wall structure, which releases bound inulin previously located within the cell walls [3]. The results show that different fermentation methods release the bound inulin from dandelion root cells, thereby increasing the inulin concentration in the product. When fermenting with NaCl solution containing *L. plantarum* and *S. cerevisiae*, the inulin concentration was significantly ( $p < 0.05$ ) higher than in the other samples.

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## **VETERINARY MEDICINE**

# DETECTION OF *MYCOPLASMA BOVIS* IN LUNG SAMPLES OF CATTLE SLAUGHTERED AT AN ABATTOIR

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*Mycoplasma bovis* is a significant pathogen that can cause various clinical manifestations in both young and adult cattle, including pneumonia, arthritis, mastitis, *otitis media*. The asymptomatic course of the disease allows the pathogen to persist undetected within cattle populations for extended periods of time, causing economic losses and facilitating its wider spread. Since its discovery in the United States in 1961, *M. bovis* has been diagnosed in most countries worldwide, with particularly high prevalence in major cattle-rearing countries, such as the USA and New Zealand [1]. Between 2000 and 2024, a significant increase in incidence has been observed globally [3]. In recent years European countries have increased their focus on the surveillance and control of mycoplasmosis [2]. To date, no studies in Latvia have investigated the detection of *M. bovis* using real-time polymerase chain reaction in lung tissue samples taken from cattle at a slaughterhouse.

The aim of this study was to determine the distribution of *Mycoplasma bovis* in lung samples isolated from slaughtered cattle collected at a slaughterhouse in Latvia and to identify potential risk factors associated with post-mortem findings in the lungs and joints.

A cross-sectional study was conducted from June 2025 till December 2025. A total of 60 lung tissue samples were collected from cattle at slaughter, of which 40 were later subjected to laboratory analysis. Sample analysis was performed in three steps: DNA isolation, DNA purification, and qualitative detection of *Mycoplasma bovis* DNA. Detection was carried out using real-time polymerase chain reaction (RT-PCR) targeting the *rpoB* gene, using the BactoReal *Mycoplasma bovis* kit made by Ingenetix in Austria. Accompanying data related to the sampled animals were collected in order to identify potential factors associated with lung and joint lesions observed at culling. Data were analysed using Fisher's exact test, and odds ratios (OR) were calculated. Statistical significance was assessed with 5% statistical error probability if the p-value was less than 0.05.

All tested samples were negative for *Mycoplasma bovis*. Statistical analysis results revealed that post parturient cows had a significantly higher probability of lung lesion (OR=7.67, 95% CI 1.12-52.32, p=0.04) compared to heifers. A higher frequency of lung lesions was observed during the winter season (OR=12.51; 95% CI 0.68-229.98; p=0.04) rather than during the summer months. No statistically significant associations were found between sex, age, housing conditions and joint lesions observed during examination.

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# FIRST RECORD OF THE TREMATODE *CATHAEMASIA HIANS* IN BLACK STORKS (*CICONIA NIGRA*) IN LATVIA

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The black stork (*Ciconia nigra*) is classified as a species of Least Concern globally due to a stable overall population. However, in Latvia it is strictly protected and rare [3]. Monitoring the health status and parasitic infections of this species is therefore important for understanding potential threats to local populations. Understanding the distribution and host-parasite interactions of trematodes in rare and protected species is essential, as even moderate parasite loads may impact juvenile survival and overall population health. This is especially critical in species with small, localized populations, such as black storks in Latvia. Gastrointestinal trematodes and ectoparasites are among the most commonly reported parasites in storks, and the diversity of these organisms may have implications for host health and survival. Many avian parasites show specific site preferences within the host, such as *Cathaemasia hians*, which inhabits the oral cavity and esophagus [1].

During parasitological examination of three deceased black storks (*Ciconia nigra*) in Latvia, trematodes identified as *Cathaemasia hians* were detected in the esophagus of all three examined birds. One bird underwent full necropsy, during which additional parasites were found, including chewing lice *Neophiloferus tricolor* in the plumage and intestinal lesions caused by *Chaunocephalus ferox*. The presence of *Cathaemasia hians* is of particular interest, as this trematode inhabits the oral cavity and esophagus and may impair feeding in infected individuals. According to our knowledge, this is the first record of this species in Latvia. In addition, *Chaunocephalus ferox* is known to cause severe intestinal lesions in storks and has been associated with mortality in infected birds [5]. Ectoparasites can also cause a wide range of health problems and may affect host survival directly or through secondary bacterial-mediated mechanisms, as shown in research where higher ectoparasite activity increased microbial growth on eggs, which can lead to embryo death [4]. The damage caused by ectoparasites can vary with infestation intensity and host condition, resulting in irritation, feather loss, and even mortality in weakened individuals [2].

In conclusion, trematode parasites such as *Cathaemasia hians* and *Chaunocephalus ferox* can impair feeding, cause intestinal lesions, and negatively affect the survival of juvenile and adult storks. The co-occurrence of multiple parasites suggests the diversity of parasitic fauna in black storks and emphasizes the importance of parasitological examinations in rare and protected species. Continued monitoring of parasitic infections in Latvian black stork populations may improve understanding of host-parasite interactions and potential conservation threats.

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# SUSPECTED CANINE LEPTOSPIROSIS OUTBREAK IN LATVIA: A RETROSPECTIVE STUDY

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Canine leptospirosis is a globally distributed zoonotic bacterial disease caused by pathogenic *Leptospira spp.*, which can result in acute renal, hepatic and pulmonary complications and represents an important public health concern [2]. The diagnosis of leptospirosis relies on a combination of clinical suspicion and laboratory testing, most commonly serological testing using the microscopic agglutination test (MAT) and molecular detection methods such as PCR [1]. However, variability in clinical presentation and limitations of diagnostic tests may complicate confirmation of infection in individual cases, and leptospirosis may be suspected based on compatible clinical findings even before laboratory confirmation [2].

Clinical, laboratory, imaging and epidemiological data from 37 dogs presented to the Small Animal Clinic of the Latvia University of Life Sciences and Technologies in Jelgava during 2025 were retrospectively analysed to investigate a suspected local outbreak of canine leptospirosis. Dogs were classified into three groups based on clinical presentation and available diagnostic test results (MAT and PCR): confirmed leptospirosis (group A, n=12), possible leptospirosis (group B, n=18), and leptospirosis excluded (group C, n=7). Most suspected cases occurred during the autumn months, with the highest number of cases recorded in November (n=16) and October (n=9). Anorexia was the most common clinical sign across all groups, frequently accompanied by lethargy and vomiting. Abdominal pain on palpation was observed more often in group A. Laboratory findings were most characterized by azotemia in dogs from group A (91,6%) and group B (100%). Anemia and thrombocytopenia were frequently observed in group A, while evidence of hepatopathy and hepatorenal involvement was more common in group B. Serological testing using MAT was performed in 20 dogs, of which 9 showed antibody titers  $\geq 1:800$ . PCR testing was performed in 26 dogs and was positive in 8 cases. Potential exposure to rodents was more frequently reported in the history of dogs from groups A and B than in group C. Overall mortality among dogs with known outcomes was 37,1%. Mortality was higher in group B (52,9%) compared with group A (16,7%), and pulmonary hemorrhage syndrome was identified as one of the causes of death in several cases. The observed seasonal clustering of suspected cases, together with characteristic clinical, laboratory and imaging findings and notable mortality, highlights the importance of early clinical suspicion and comprehensive diagnostic evaluation in dogs with suspected leptospirosis. In addition, prior antibiotic administration and vaccination history should be considered when interpreting PCR and MAT results.

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# **TAP BLOCK VERSUS KETAMINE CRI FOR CANINE MASTECTOMY: A PILOT STUDY OF RESPIRATORY STABILITY AND INTRAOPERATIVE HEMODYNAMICS**

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Mastectomy in dogs is associated with moderate-to-severe pain and requires multimodal analgesia (1). Ultrasound-guided transversus abdominis plane (TAP) block techniques have been described in dogs and shown to improve perioperative analgesia in abdominal procedures (2). Ketamine constant rate infusion (CRI) is frequently used as an analgesic adjunct but may influence perioperative cardiorespiratory management (3).

The aim of the study was to compare intraoperative physiological variables and ventilation status in dogs undergoing mastectomy managed with either a TAP block or ketamine CRI.

Thirteen dogs were evaluated in a pilot comparison: ketamine CRI group (KET, n=5) and TAP block group (TAP, n=8). Heart rate (HR), mean arterial pressure (MAP), respiratory rate (RR), oxygen saturation (SpO<sub>2</sub>), and body temperature were recorded every 20 minutes from 0 to 120 minutes (depending on procedure duration). Ventilation status was categorized as spontaneous (Spont) or mechanically ventilated (MV). Mechanical ventilation was used as an indicator of clinically significant respiratory depression/apnea requiring support. Between-group comparisons at common timepoints (0, 20, 40, 60, and 80 minutes) were performed using the Mann–Whitney U test. MV/Spont proportions were compared using Fisher’s exact test. Statistical significance was set at  $p < 0.05$ .

The results showed that MV was required less frequently in the TAP group (3/8, 37.5%) than in the KET group (4/5, 80%), indicating a clinically relevant trend for improved respiratory manageability with TAP; however, this difference was not statistically significant in the small pilot sample (Fisher’s exact  $p = 0.266$ ). MAP differed at 20 minutes, with higher MAP in KET (mean 88 mmHg) compared with TAP (mean 71.3 mmHg; Mann–Whitney  $p = 0.059$ ), suggesting a more pronounced early hemodynamic elevation with ketamine CRI. No additional significant between-group differences were detected for HR, MAP at other evaluated timepoints, SpO<sub>2</sub>, or temperature (all  $p > 0.05$ ). RR during MV reflected ventilator settings rather than spontaneous ventilation and was interpreted accordingly.

In this small pilot study, dogs in the TAP group needed mechanical ventilation less often than dogs receiving ketamine CRI, and ketamine CRI showed higher MAP at 20 minutes. Although the sample size was small, TAP block appears to be a practical option for canine mastectomy and should be evaluated in larger studies.

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# ASSOCIATION BETWEEN GENOMIC INBREEDING LEVELS AND FERTILITY-AFFECTING HAPLOTYPES IN A HOLSTEIN DAIRY FARM

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Genomic testing in the Latvian dairy cattle population has developed rapidly, providing valuable data for both the genetic situation in the herd and long-term breeding decisions. This study aimed to investigate the relationship between genomic inbreeding (gINB) and fertility affecting haplotypes in a genotyped Holstein cow herd.

Harmful, recessive haplotypes in the Holstein breed can be detected through the absence of homozygous haplotype combinations in the population [1]. According to this paper, certain haplotypes are never found in homozygous state, because embryos with two copies of a harmful haplotype are lethal. This directly links genomic inbreeding to haplotype expression.

In Holstein cow populations, seven officially recognised haplotypes that affect fertility are known. Holstein haplotypes (HH1-HH6) each cause early embryonic loss (35<sup>th</sup> to 100<sup>th</sup> day) when inherited in homozygous state from both parents [2]. Therefore, in herds where genomic inbreeding levels are elevated, it is important to know which haplotypes are present to make breeding decisions.

Increased genomic homozygosity negatively affects health and reproductive performance traits [3]. As genomic inbreeding increases, the probability of homozygous regions with harmful haplotypes also rises, making gINB a valuable indicator for haplotype-related fertility decrease. Materials and methods: in this study, genomic data were received from a farmer for 123 cows that were born from 2020 to 2023. In this study, genomic inbreeding level and fertility-affecting Holstein haplotypes were analysed in PSPP software using descriptive statistics (mean, standard deviation) and Pearson correlations.

The results showed that in this herd the mean inbreeding level was 9.77%. HH1, HH4 and HH6 were completely absent in this herd. HH3 had the highest carrier frequency (n=7), then HH2 (n=3) and HH5 (n=2). No significant correlation was found between genomic inbreeding and any of the HH1-HH6 haplotypes ( $p>0.05$ ).

To conclude, genomic inbreeding in this herd did not correlate with any fertility-affecting haplotype occurrence, showing that breeding decisions had been made correctly – balancing genetic merit and harmful recessive haplotypes.

## Acknowledgement

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# EVALUATION OF SCHIRMER TEAR TEST I AND TEAR FERNING PARAMETERS IN DOGS DURING GENERAL ANAESTHESIA

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Precorneal tear film (PTF) quality and quantity are crucial factors for maintaining the integrity of the corneal surface. Tear quality is assessed using multiple parameters, including tear ferning (TF), while tear quantity is evaluated using the Schirmer tear test I (STT-I) [1]. General anaesthesia (GA) suppresses the blink reflex and reduces lacrimal secretion, which increases susceptibility to postoperative complications, including corneal surface defects [2]. Data regarding PTF alterations during GA in veterinary medicine remain limited. Therefore, this study aimed to evaluate PTF by measuring STT-I and TF in healthy mesocephalic dogs undergoing routine non-ophthalmic surgery under GA.

**Research methods:** This study was conducted at the Veterinary Clinic of the Latvia University of Life Sciences and Technologies (LBTU) in Jelgava, Latvia, from 1<sup>st</sup> September 2024 to 1<sup>st</sup> March 2025. This study was reviewed and approved by the Animal Welfare and Protection Ethics Council at LBTU (Approval No. LLU\_Dzaep\_28.08.2024.-1; issued on August 28, 2024). The study population consisted of 16 client-owned mesocephalic dogs of different sex, age and breed presented in the clinic for routine ovariohysterectomy or orchiectomy. All animals underwent clinical and ophthalmological examinations and were classified as healthy and classified as ASA I or II based on American Society of Anaesthesiologists (ASA) classification. All dogs were anaesthetized using a standardized protocol and pharmacological agents. Tear film parameters included the STT-I, and TF, evaluated perioperatively at 5 time points: 30 min preoperatively (T0), 10 min post premedication (T10), 5 min post-induction (T5), at first incision (TS), and at discharge (TD). Statistical analysis included mixed-effect regression, paired t-test, and correlation analyses.

The results were as follows: STT-I values showed a significant decrease at all time points, declining from baseline ( $21.2 \pm 3.3$  mm/min) to T10 ( $13.5 \pm 5.9$  mm/min), T5 ( $6.4 \pm 6.3$  mm/min), and TS ( $0.8 \pm 1.6$  mm/min). The grading of TF increased from  $0.8 \pm 1.0$  at T0 to  $1.5 \pm 1.3$  at T10 and  $2.3 \pm 1.4$  at T5. TF analysis could not be conducted at TS owing to insufficient tear volume. At TD, TF values remained significantly elevated to baseline (combined:  $1.6 \pm 1.3$ ;  $p = 0.0130$ ), indicating deterioration of PTF. At TD, the tear film parameters remained significantly altered compared with T0. The proportion of Grade 0 decreased from 53.1% at T0 to 27.6% at TD, while Grade 4, which was not observed at baseline, increased to 6.9% at TD. Only measurement time significantly affected TF results; no associations were found with age, sex, body weight, surgery type, or duration. Due to missing measurements at TS, the regression analysis included data from 20 eyes across four time points. Moderate correlations were observed among STT-I and TF, while age showed a moderate negative correlation with STT-I ( $b = -0.41$  mm/min;  $p = 0.038$ ).

In conclusion, both precorneal tear film parameters significantly decrease during general anaesthesia and at the post-operative period, incomplete recovery of PTF was observed. These results highlight the importance of implementing proactive perioperative ocular surface protection.

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# **EPIDEMIOLOGICAL SITUATION OF AUJESZKY'S DISEASE IN WILD BOAR (*SUS SCROFA*) POPULATIONS IN THE MUNICIPALITIES OF MADONA, TALSI, TUKUMS, OGRE, AND SILDUS**

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Aujeszky's disease caused by Suid herpesvirus - 1 (SHV-1), affects the central nervous and respiratory systems. Its natural hosts are domestic pigs and wild boars, but the virus has also been found in different animal species, including cattle, dogs, and cats [1]. In Latvia, Aujeszky's disease is a monitored animal infectious disease. According to the Food and Veterinary Service, the last clinical cases in domestic pigs were observed more than ten years ago in Latvia. However, data from the World Organisation for Animal Health (WOAH) show that cases have been reported in different neighbouring countries, and the virus is still found in wild boars and sometimes in dogs, highlighting the need for continued surveillance [2]. The aim of the present study was to explore the epidemiological situation of Aujeszky's disease in the municipalities of Madona, Talsi, Tukums, Ogre, and Saldus.

Research methods: blood samples from 100 hunted wild boars in described municipalities were tested for Aujeszky's disease antibodies using the IDEXX PRV/ADV gB ELISA. Testing results were compared to positive controls (S/N ratio) to determine seropositive and seronegative status. Laboratory data statistics were calculated using the Jamovi Project 2025 to compare the frequency of Aujeszky's disease detection between regions, municipalities, and 2019 prevalence data from the Food and Veterinary Service surveillance, and wild boar and domestic pig populations.

Results were the following: In 2025, Aujeszky's disease detection differed significantly among municipalities ( $p = 0.046$ ), with wild boar density strongly increasing occurrence detection ( $OR = 116.74$ ,  $p = 0.023$ ) and domestic pig density showing a smaller but significant effect ( $OR = 1.04$ ,  $p = 0.022$ ). In 2019, no significant association was found between pig or wild boar densities and disease detection ( $p > 0.05$ ), highlighting wild boars as a key factor in 2025.

In conclusion, Aujeszky's disease detection varied significantly between municipalities in 2025, with the highest risk in the Kurzeme region (27.5%), especially in Saldus municipality (45%), and higher domestic pig and wild boar densities were associated with an increased likelihood of Aujeszky's disease occurrence.

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# **DIAGNOSTIC SIGNIFICANCE OF SYNOVIAL FLUID LACTATE IN EQUINE COFFIN AND FETLOCK JOINT OSTEOARTHRITIS USING ARTIFICIAL INTELLIGENCE-BASED OBJECTIVE ASSESSMENT OF MOVEMENT ASYMMETRY**

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Articular pathologies are among the primary causes of lameness in horses and contribute to decreased athletic performance with osteoarthritis accounting for approximately 60% of equine lameness cases [2]. It is known that synovial fluid lactate elevation is not exclusively associated with septic arthritis but may also occur in degenerative and chronic joint disease and may indicate disease progression [1]. The aim of this study was to investigate synovial fluid lactate concentrations in horses diagnosed with coffin and fetlock joint osteoarthritis and to evaluate their relationship with measured gait asymmetry. Objective movement analysis enables quantitative assessment of movement asymmetry and allows more precise evaluation of clinical parameters.

A retrospective analysis of 20 horses was conducted, including data on the affected joint, synovial fluid lactate concentration and objective gait analysis results. The data required for the study were collected from orthopedic patients presented to the Large Animal Clinic of the Lithuanian University of Health Sciences (LUHS) for the diagnosis and treatment of lameness between May 2024 and January 2026. It was hypothesized that higher synovial fluid lactate concentrations would be associated with greater movement asymmetry. The diagnosis of osteoarthritis was established based on the anamnesis, clinical examination and palpation, objective gait asymmetry evaluation using an objective lameness evaluation system based on artificial-intelligence-assisted video analysis (“Sleip AI”), flexion tests, local blocks, and diagnostic imaging. Prior to intra-articular therapeutic procedures, a synovial fluid sample was collected, and synovial fluid lactate concentration was measured using a portable handheld lactate meter.

Results showed that in horses diagnosed with coffin and fetlock joint osteoarthritis, synovial fluid lactate concentrations ranged from 4.6 mmol/L to 12.3 mmol/L. No statistically significant differences in synovial fluid lactate concentration were found between the coffin and fetlock joint groups ( $p = 0.813$ ). A statistically significant ( $p < 0.05$ ) moderate correlation was found between synovial fluid lactate concentration and combined impact and push-off asymmetry values ( $r = 0.502$ ). The coffin and fetlock joints are commonly affected by osteoarthritis in horses with osteoarthritis representing a major cause of chronic lameness. The results of this study demonstrate that synovial fluid lactate concentration may increase in non-septic degenerative joint disease and is moderately associated with objectively measured gait asymmetry. This suggests that metabolic and inflammatory processes occurring within the joint may contribute to the severity of lameness. Therefore, synovial fluid lactate concentration may serve as a useful adjunct prognostic biomarker for evaluating the severity of degenerative joint diseases in horses.

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# EFFECT OF PROBIOTICS ON LIVER PARAMETERS IN ROSS 308 BROILER CHICKENS

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Probiotics are widely recognized for their beneficial effects on the intestinal microbiota. According to recent studies, the inclusion of probiotics in poultry diets may influence gastrointestinal development and overall physiological status [2]. This study investigated whether dietary probiotics affect the development of hepatic histological features in broiler chickens.

Hepatic development in poultry occurs primarily within the first two weeks of life, after which morphological changes become less pronounced [1]. Probiotic supplementation may influence hepatocyte organization and vacuolization; however, its effect on central vein diameter remains unclear. The histological study included two groups of broiler chickens: a treatment group (ProG), which received a standardized dose of a probiotic mixture containing *Lactobacillus farciminis* and *Lactobacillus rhamnosus*, and a control group (ConG), which received a standard basal diet without supplementation. Central vein diameter, hepatocyte density, and vacuole number were compared between groups. Liver samples were collected on days 1, 7, 14, 21, 28, and 35. Samples were fixed, sectioned, and stained with hematoxylin and eosin (H&E). Histological evaluation was performed using a Zeiss microscope at ×200 magnification. From each group, nine liver samples were analyzed per time point, with three regions assessed per sample, resulting in 27 regions per group per day. Measurements were performed using Zeiss software and image analysis software (NIS-Elements AR). Statistical analysis included standard deviation and data dispersion, and trends were visualized using GeoGebra.

Despite relatively high standard deviation due to variability in tissue sectioning, no clear correlation was observed between probiotic supplementation and central vein diameter. Differences in hepatocyte counts between groups were most pronounced up to day 14, after which values stabilized. Vacuole density was comparable between groups throughout the study period. Interstitial space appeared slightly increased in both groups over time.

Although the liver is not a primary target organ of probiotics, some subtle histological differences were observed. Further studies with larger sample sizes are needed to clarify the systemic effects of probiotic supplementation in poultry.

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# ASSOCIATION BETWEEN SEVERITY OF CLINICAL SIGNS AND LABORATORY PARAMETERS IN DOGS WITH LYME BORRELIOSIS IN ESTONIAN VETERINARY PRACTICE

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Tick-borne diseases are an increasing concern in both human and veterinary medicine. Lyme borreliosis, caused by *Borrelia burgdorferi sensu lato*, has a nonspecific and often subclinical presentation in dogs making diagnosis challenging. The relationship between clinical severity and laboratory abnormalities remains poorly defined. Therefore, the aim of this study was to assess the association between clinical severity and laboratory parameters in dogs with confirmed *Borrelia burgdorferi* infection.

Most studies on canine Lyme borreliosis focus on seroprevalence and diagnostics, with limited data on the relationship between clinical severity and laboratory findings. One study reported a strong correlation between C-reactive protein (CRP) and the presence of clinical signs ( $r = 0.9059$ ) [1], however, its association with disease severity remains unclear. In addition, laboratory abnormalities in infected dogs are often inconsistent and non-specific [2].

A retrospective study was conducted using medical records from emergency veterinary clinic in Tallinn, Estonia, between 2022 and 2025. A total of 53 dogs with ELISA and immunoblot confirmed seropositivity to *B. burgdorferi* and compatible clinical signs were included. Clinical severity was graded on a three-point scale (1–3). Statistical analysis was performed using Spearman's rank correlation with significance set at  $p < 0.05$ .

Half of the laboratory parameters showed significant correlations with clinical severity. Albumin concentration decreased with more severe clinical signs and showed the strongest correlation ( $\rho = -0.526$ ;  $p < 0.001$ ), while haemoglobin showed a weak negative correlation ( $\rho = -0.321$ ;  $p = 0.021$ ). Leukocyte count and blood urea concentration showed a moderate, positive correlations ( $\rho = 0.435$ ;  $p = 0.001$ ;  $\rho = 0.335$ ;  $p = 0.015$ , respectively). Other laboratory parameters – erythrocytes, thrombocytes, creatinine and CRP showed no significant correlation. Notably, CRP demonstrated weak, non-significant association with clinical severity ( $\rho = 0.120$ ;  $p = 0.395$ ) and no association with the presence of clinical signs.

The results demonstrate that laboratory parameters alone have limited diagnostic value in assessing clinical severity in canine Lyme borreliosis. Laboratory data alone may not accurately reflect disease severity. In regions such as Latvia, where Lyme borreliosis is likely underdiagnosed, increased clinical awareness and targeted diagnostic methods are recommended. Further studies are needed to identify clinically reliable biomarkers and improve diagnostic strategies for this disease.

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## **ENGINEERING**

# EFFECT OF AIR HUMIDITY ON CHITOSAN ELECTROSPINNING PRODUCTIVITY AND FIBER LAYER FORMATION

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Electrospinning is a method for producing very thin polymer fibers that can be used in filtration, medicine, and other fields [1]. Many studies focus on the composition of polymer solutions and the morphology of electrospun fibers [3], but the practical influence of environmental conditions, such as air humidity, on fiber productivity is still not well studied. Humidity affects solvent evaporation, fiber formation and fiber deposition on the collector surface [2]. Because of this, even small changes in humidity can influence the final layer. The aim of this study was to experimentally investigate how different air humidity levels influence the yield and quality of electrospun chitosan fibers.

The experiment was conducted in a climate-controlled laboratory at 23 °C using electrospinning parameters of 70 kV voltage and a 240 mm distance between the electrode and collector. Each experiment lasted 1 hour, after which the samples were thermally treated at 115 °C for 15 minutes. Five humidity levels were tested: 15%, 25%, 35%, 45% and 55%. The polymer solution consisted of 70% acetic acid (AA), 5% citric acid (CA), and a 25:1 mixture of chitosan to polyethylene oxide (Chito:PEO) at a total concentration of 4%. Fibers were deposited on silicone-coated paper. The paper was weighed before and after electrospinning, and the mass difference was used to determine the deposited fiber layer by gravimetric analysis. Visual and SEM observations were used to evaluate fiber layer uniformity. The measured mass of the deposited layer increased as the humidity rose from 15% to 45% that showed a clear influence of humidity on fiber deposition. At 15% humidity, the fiber layer mass was only 0.0073 g. At 25% humidity, it increased to 0.0291 g, and at 35% humidity to 0.0441 g. The highest deposition was observed at 45% humidity, where the fiber layer reached 0.0868 g. However, when the humidity increased further to 55%, the deposited mass decreased to 0.0143 g. Visual observations supported these measurements: at 15% and 25% humidity, fibers often remained suspended in the air and did not fully settle on the paper, while at 45% humidity they formed a smooth and uniform layer. At 55% humidity, the layer became unstable and appeared partially dissolved.

The results show that air humidity influences electrospinning productivity and fiber quality. A relative humidity of about 45% produced the highest fiber yield and the most uniform layer, while lower humidity caused incomplete deposition and higher humidity destabilized the fiber layer. These results may help improve process control and reproducibility in electrospinning studies.

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# IMPROVING THE ACCURACY OF A MAGNETOMETER SENSOR WITH DIGITAL FEEDBACK

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Magnetometer sensors (fluxgate sensors) occupy a unique position in this ecosystem due to their ability to provide excellent performance in DC and low-frequency AC measurements. Compared to other magnetic sensor technologies, fluxgate solutions offer unique advantages: high sensitivity, resolution down to 0.1 nT, wide operating temperature range, and pronounced long-term stability with minimal temperature drift of the sensitivity.

The industry's transition from analogue to digitally controlled systems is essential for increasing efficiency, as digital processing makes the sensor insensitive to power supply noise and parameter changes caused by component aging. The focus of this research on microcontroller (MCU)-based closed-loop architecture is the next logical step in the industry's development, aiming to replace labour - intensive analogue circuit tuning with adaptive, intelligent algorithms.

Fluxgate sensors operate by periodically saturating a soft magnetic material in both directions using an alternating excitation current. An external magnetic field breaks the symmetry of this saturation, which is detected as the second harmonic of the induced voltage.

Song et al. replace the laborious manual parameterization with a single-neuron self-pre-optimization algorithm that autonomously determines the PID parameters in an MCU environment. It should be emphasized that the 120 ms response time they report is not an algorithmic limitation, but an architectural limitation of the open-loop sensing circuit. Yang et al. use a sensor which consists of two toroidal magnetic cores. One core works in fluxgate principle for the measurement of DC and low-frequency AC, and the other one is used as a current transformer for higher frequency application [1], [2].

Both articles use a ring magnetometer core, but this work aims to build a two-rod core magnetometer. The operation of the intelligent sensor is divided into two stages: 1) a single-neuron self-learning algorithm is launched, which autonomously finds the close to optimal PID coefficients for a given system node; this eliminates the critical problem in industry – the need for individual adjustment of analogue circuit parameters for sensor; 2) a standard positional PID algorithm is used to maintain a stable closed loop and provide magnetic compensation.

The synergy of intelligent algorithms and novel magnetic materials is expected to enable sensors that combine the inherent accuracy of fluxgates with automated system setup. Digital self-optimization overcomes historical industry barriers, reducing manufacturing costs and increasing measurement reliability. It is expected that by integrating a digital feedback loop for a microcontroller-based fluxgate sensor, it is possible to reduce the nonlinearity error of the fluxgate sensor by at least 80% compared to the open-loop measurement method.

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# **IMPACT OF WASTE PAPER ADDITIVE ON WOOD PELLET PRODUCTION AND COMBUSTION PROPERTIES**

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Global demand for biomass pellets has increased substantially in recent years, many governments and industries have been seeking alternatives for fossil fuels and wood pellets to provide heat and generate power. The biomass market is expanding and growing rapidly, mainly driven by the European renewable energy targets under the EU renewable Energy Directive [1]. Wood is still the main resource for pellets, however, the increasing demand, other industrial uses for wood and pressure on forest resource renewability have raised a concern over the long-term sustainability and cost stability of wood only pellets. On the other hand, the European paper industry generates approximately 11 million tonnes of waste annually, the majority getting incinerated. Waste paper and shredded paper remain a largely unused and understudied material with an energy potential comparable with woody biomass.

The goal of the study is to find and produce a blend ratio of wood biomass to shredded paper, which would be tested against ISO 17225-6 for non-wood pellets, and could be used as a substitute for regular wood pellets, thereby reducing paper waste and lowering the stress on the wood market.

Existing research has already examined the properties of different kinds of pure paper pellets and determined that waste paper can achieve similar results compared to wood pellets, however, the elevated ash contents have been observed from different coatings, printing inks, toner types that exceed the threshold set by ISO 17225-2 for graded wood pellets [2].

This study addresses the issue above by producing different blends of wood to shredded paper ratios (0:100, 20:80, 50:50, 80:20, 100:00) using a laboratory ring-die pellet machine under controlled moisture and temperature conditions. The wood biomass used for the blends will be unchanged throughout the entire experiment, kept at a set moisture and temperature.

The study will use different sized shredded office papers to determine whether the size and shape of paper shreds change or affect the properties of the pellet. All blends will be tested for their mechanical strength to determine whether they are suitable for long term storage and transportation, without having to increase manufacturing and logistical expenses.

In conclusion, this research aims to establish and show a practically applicable blend threshold for wood and shredded paper step by step which would allow shredded waste paper to be incorporated and used for pellet production, thereby reducing costs of pellets, landfill and incineration costs, thus contributing towards the EU Renewable Energy Directive.

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# OPPORTUNITIES OF WIRELESS CHARGING FOR ELECTRIC VEHICLES

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The rapid development of the electric mobility sector has created a need for innovative and automated charging solutions capable of ensuring high user convenience and system safety. Wireless power transfer technologies are widely used in consumer electronics and household electrical appliances; however, in the electric vehicle sector they are still being actively tested. These aspects provide a basis for research into the possibilities of wireless charging for electric vehicles.

The aim of the study is to examine existing types of wireless charging technologies and to evaluate their practical implementation possibilities and feasibility in comparison with traditional wired charging systems.

The theoretical part of the research is based on previously conducted studies on inductive and capacitive power transfer, identified as the most suitable methods for charging electric vehicle batteries [1]. Compensation topologies play a significant role in system efficiency, as they ensure stable current supply during charging while minimizing frequency deviations caused by magnetic coupling [2]. The spiral coil structure and the operation of an I-type ferrite core are among the key factors in reducing energy losses and increasing overall system efficiency [3].

A comprehensive literature review has been conducted in the study, analysing the operating principles of both charging approaches, including wired (conductive) charging and wireless technologies such as inductive and resonant coupling. A comparative analysis is carried out to evaluate efficiency, power transfer capability, and charging speed under equivalent operating conditions. The main technical factors affecting the performance of wireless charging systems are identified and analysed, including coil alignment, air gap distance, operating frequency, and energy losses.

The expected results indicate that traditional wired charging systems currently provide higher energy efficiency and shorter charging times due to direct electrical contact and lower transmission losses. However, wireless charging technologies offer significant advantages in terms of user convenience, automation potential, reduced mechanical wear, and enhanced electrical safety, as the need for a physical electrical cable connection is eliminated.

This study contributes to a better understanding of different types of wireless technologies and their application potential. Based on the energy losses occurring during the charging process, the research will be supplemented with a technical and economic feasibility assessment. Such an evaluation will help to determine the future direction of wireless charging technology development and its implementation within electric mobility infrastructure.

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# EXPERIMENTAL PERFORMANCE OPTIMIZATION OF A VACUUM PUMP BY VARIATIONS OF ROTOR DIAMETER AND THICKNESS

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Vacuum pumps are widely used in many industrial processes, construction, and water management systems where, depending on their construction, there is a necessity for vacuum. The efficiency and performance of such pumps depend strongly on their construction and, in this case, when using a rotary claw pump, on the geometry of their internal components, particularly the rotor dimensions. In rotary vacuum pumps, the rotor diameter and thickness influence the achievable vacuum level, pumping capacity, and overall efficiency of the machine. Therefore, optimization of rotor geometry is an important engineering task when improving existing pump constructions. The aim of this research is to experimentally investigate how variations in rotor diameter and rotor thickness influence the performance of a previously developed twin-rotor dry vacuum pump and to determine the optimal rotor geometry for improved operating characteristics.

The research is based on an experimental engineering approach. First, the previously developed vacuum pump construction is analyzed in order to define the key geometric parameters influencing its performance, and alongside this, a small research on material usage, specifically what rotors are made of, is carried out. Several rotor models with different diameters are designed using a CAD program. Based on the selected optimal diameter range, additional rotor models with different thickness values are created. All experimental rotors are manufactured using 3D printing technology to ensure identical shape and geometry for the investigated dimensional variations. The experimental testing is carried out under controlled and identical operating conditions in order to obtain comparable measurement results. During the experiments, the main performance indicators of the vacuum pump are measured, including the achievable vacuum level and the volumetric flow rate. The target performance of the pump is to achieve a vacuum level in the range of 0.7 to 0.9 bar at 60 m<sup>3</sup>/h flow. Each rotor size version is 3D printed and tested independently. The obtained results are recorded and analyzed. The measured data are compared in order to identify how changes in rotor diameter and thickness influence pump efficiency and operational stability.

The expected results of the research will allow determination of the most effective rotor geometry for the developed vacuum pump design. The optimal rotor size will provide the highest possible pumping performance while giving stable vacuum levels and compact rotor dimensions. The results of this research will provide the possibility to select the optimal size of the vacuum pump for use in water pumping equipment, allowing production costs to be reduced as much as possible according to the required performance.

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**GEOINFORMATICS AND REMOTE SENSING /  
LAND MANAGEMENT AND GEODESY**

# **IMPROVEMENT OF THE LOCAL GEODETIC NETWORK IN THE NORTHERN PART OF DOBELE**

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The need for geodetic network has been growing fast as technology improves. Many industries that rely on precise measurements are improving their geodetic network systems to achieve more accurate results. The accuracy of mapping is ensured through the use of local geodetic networks, and they have to be linked to the national system with a precision of about 3 to 6 cm. To provide the necessary precision, heights can only be off by 1 cm and coordinates by 2 cm. Each local municipality is the one in charge of keeping their network in shape, while the national agency (LĢIA) acts like a supervisor, giving out the rules and assisting local teams to update their data or fix technical issues [1]. Local geodetic networks are the foundation for all land surveying and measuring, but these days the physical network points are being used less and less because modern technology is way faster and easier to work with [2].

Fixing the local geodetic network starts with a deep dive into the current situation and careful planning where surveyors must gather all available information before taking the action. To obtain the necessary data, the local municipality sends an official request to the national agency (LĢIA), though helpful details can also be received from local surveyors and firms working in the specific area on a daily basis. Once the theoretical part is ready, the actual fieldwork begins as specialists visit the sites to check the physical condition of each point to see if the coordinates are still correct. Finally, based on the gathered data regarding the number of points and their accuracy, the municipality decides on the next steps by identifying which areas meet the requirements and which require upgrades, ensuring that good quality network points are kept without any unnecessary extra work [3]. To sum up, the fixing of the local geodetic network requires coordinated efforts of the national agency, municipalities and surveyors.

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# WIND TURBINE TOWER DEFORMATION MONITORING

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Nowadays it is important for many countries around the world to reduce fossil fuel consumption for electric generation. One way to do so is to create environmentally friendly energy generating methods, such as wind farms. Wind turbine size as well as energy generation in the past few years has increased rapidly. Wind turbine construction is influenced by different loads which affect the integrity of the construction [1]. Without proper monitoring, wind turbine construction can lead to an unexpected failure or long maintenance, which affects the effectiveness of a wind turbine plant. To maintain a proper wind turbine work, structural monitoring should be applied.

Traditionally, deformation monitoring is carried out using contact sensors such as accelerometers, inclinometers or strain gauges. However, these need to be physically installed on the turbine, which makes the process intrusive and less flexible [2]. In-situ method application might be difficult in some objects because of wind park or wind turbine manufacturer restrictions.

In contrast, total station and terrestrial laser scanning methods allow for deformation to be monitored remotely, without installing any instruments directly on the structure [3]. However, due to not installing prisms on wind turbine tower, total station data accuracy can be affected. This study was carried out by using both total station and terrestrial laser scanning methods to determine the amount of deformation of wind turbine towers and to compare the two instruments. Different wind turbine models were monitored in different wind conditions to verify how much the wind turbine tower moves horizontally during different wind conditions. The study area of three different wind turbine models were selected to determine the total station and terrestrial laser scanner efficiency. The results show that environmental conditions influence both measurement methods, but in different ways. Despite this, the deformation of onshore wind turbine towers can be successfully monitored using both total station and terrestrial laser scanning techniques. During the monitoring period, no significant deformations were observed, and all detected movements were within expected limits. For future research, it would be beneficial to include in-situ sensors to validate and compare the measurements obtained from these methods.

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# SPATIAL DATA COMPATIBILITY BETWEEN LATVIA AND ESTONIA

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Spatial information is collected in various formats, and often in different coordinate systems, from satellites, drones, global navigation systems, aircraft, surveying instruments, and various databases. To successfully integrate all this data into a single system, having compatible metadata and interoperable systems is not enough, unified rules and international standards are also essential. In this context, cross-border spatial data compatibility between Latvia and Estonia is essential for pan-European infrastructure projects, environmental monitoring, and territorial governance in the Baltic region. For this reason both countries must transpose the INSPIRE Directive (2007/2/EC), which establishes a legal framework for harmonized spatial data infrastructure across Europe [1].

While Latvia and Estonia share a common geodetic reference frame (ETRS89) based on GRS 80 ellipsoid, their national coordinate systems rely on fundamentally different map projections. Latvia's LKS-92 uses the Transverse Mercator projection, whereas Estonia's L-EST97 employs a Lambert Conformal Conic projection. Both countries use the European height system, but slight discrepancies exist. Specifically Latvia references its data to the middle of the year 2000 (LAS-2000.5), while Estonia uses the beginning of 2000 (EH2000.0). This time gap is necessary for each country to accurately account the land surface (post-glacial rebound) in their specific territories.

The practical impact of these geodetic differences is especially clear in major projects like Rail Baltica. Studies show that using separate national systems results in substantial misalignments at the state borders, with errors of about 6 metres in planimetry and 10-15 cm in height [2]. To address this, the successful project "GeoRefAct" between the Estonian Land Board and the Latvian Geospatial Information Agency developed a tool to accurately connect the different coordinate and height systems for cross-border data integration [3]. Looking ahead, the mandatory transition to the LKS-2020 coordinate system in late 2026 will make this situation even more complex. LKS-2020 widens the epoch gap with Estonia, necessitating urgent joint transformation models to ensure accuracy. In this regard, NKG2020, a 3D model covering horizontal and vertical crustal motions, harmonizes multi-epoch data by compensating for time, dependent offsets [4]. To sum up, spatial data compatibility is a goal to be achieved to support harmonized spatial data infrastructure across Europe.

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# **SPATIAL ANALYSIS OF URBAN HEAT ISLANDS IN CITY OF JELGAVA**

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Urban Heat Islands (UHI) are a phenomenon that results in higher air and ground surface temperatures in urban areas compared to surrounding rural areas due to differences in the ability of surfaces to absorb solar heat. The dark and dense materials, asphalt and concrete, that dominate urban environments accumulate solar energy during the day and release it at night, while the lack of vegetation reduces the natural cooling process – transpiration, during which plants release water vapor, cooling the air. This effect is further amplified by urban infrastructure, where buildings block wind flow, and transport and industry generate additional heat. In such conditions, urban temperatures can be on average 4-6 degrees higher than in less built-up areas [1].

Jelgava is one of the largest cities in Latvia, located in the Zemgale region on the Lielupe and Driksa rivers. The city is characterized by a relatively flat terrain, developed infrastructure, residential buildings, industrial areas and green areas. The development of the city of Jelgava in recent years has been associated with urbanization processes, which affect the microclimate of the territory and contribute to the formation of heat islands.

The main problem is related to the lack of information on the spatial distribution of urban heat islands and their influencing factors in Jelgava. Although in international practice heat island analysis is widely carried out using remote sensing data and GIS methods, such studies are limited in Latvia, which complicates effective urban planning and the development of climate adaptation measures.

The solution is based on a spatial analysis approach using satellite imagery, land surface temperature (LST) data and geographic information systems. In addition to standard LST analysis, thermal inertial mapping is used to assess the ability of urban surfaces to retain heat during the night, as well as spectral and mixing analysis (Spectral Unmixing), which allows for accurate separation of the proportion of impervious surfaces such as asphalt, roofs from natural surfaces even at small spatial scales. High-resolution digital surface models obtained from LiDAR scanning are also used to analyze the impact of building shading on local heat accumulation [2, 3]. To sum up, spatial analysis of urban heat islands in Jelgava would help identify heat accumulation patterns and their causes.

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# **USE OF LIDAR DATA TO IMPROVE SURVEYORS' WORK EFFICIENCY**

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The development of cartography and surveying has historically been based on the continuous improvement and expansion of spatial data, where each new generation of measurements forms the basis for the next. Traditionally, surveying has relied on selective field measurements, where only specific terrain points are recorded during fieldwork. However, the availability of airborne laser scanning (LiDAR) data has significantly expanded the spatial information available to surveyors by providing high-resolution point clouds that represent the terrain surface in great detail. This allows surveyors to analyse the terrain and identify landscape features before visiting the site. The topicality of this research is related to improving the efficiency of a surveyor's daily work by integrating LiDAR data into the surveying workflow. The aim of this study is to analyse the advantages of LiDAR technology in the surveyor's decision-making process and in expanding the available spatial information base in Latvia.

Research on LiDAR data processing has demonstrated that point cloud analysis can be used to detect man-made constructions and other anthropogenic features in the landscape. Spatial and geometric properties of LiDAR point cloud data allow the identification of human-made objects that may not be clearly visible during traditional field inspection [1]. These findings highlight the importance of LiDAR technology as a tool for identifying landscape features that would otherwise remain unnoticed using conventional surveying methods.

The ability of LiDAR technology to reveal subtle terrain formations beneath vegetation cover has also been demonstrated in studies of the Latvian landscape. LiDAR-derived terrain models have enabled the discovery of previously unknown hillfort structures by revealing small terrain irregularities that are difficult to detect visually in the field [2]. This demonstrates that LiDAR technology can reveal landscape features hidden by vegetation and provides valuable information for analysing terrain morphology.

Additional research confirms that LiDAR-derived terrain models can also be used to identify infrastructure elements in forested landscapes. LiDAR data can accurately map forest roads even under dense forest canopy [3]. Their results show that LiDAR-based terrain analysis can reveal infrastructure elements and terrain structures that are difficult to detect through traditional surveying methods.

In conclusion, LiDAR technology significantly expands the information available to surveyors and improves the efficiency of their work. By using LiDAR data together with GIS analysis tools, surveyors can analyse terrain conditions before fieldwork, identify hidden terrain features and anthropogenic objects, and make more informed decisions during the surveying process.

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# **GEOSPATIAL DATA IN URBAN PLANNING: IDENTIFYING URBAN OVERHEATING RISK AREAS**

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The climate in cities is changing, and temperatures are rising due to climate change and urban development. This problem is becoming more noticeable in many urban areas, where built-up surfaces and a lack of vegetation increase heat accumulation. This study looks at how satellite data and GIS can help identify areas that are more exposed to overheating. Understanding these areas is important, as high temperatures can negatively affect people's health and overall living conditions. The first source [1] explains that thermal remote sensing is an important tool in urban climate studies. Land surface temperature (LST) patterns can be analyzed in relation to land cover and different surface types. This makes it possible to identify hotter areas and understand how they are related to buildings and surface materials. For example, areas with asphalt, concrete, and dense urban structures usually heat up more than natural or vegetated surfaces, which makes them areas strongly affected by the urban heat island effect.

The second source [2] highlights the importance of vegetation in reducing urban temperatures. Green areas, such as parks and trees, can help reduce air and surface temperatures, especially at a local scale. This cooling effect is particularly important during heatwaves. By comparing temperature data with vegetation data (Normalized Difference Vegetation Index - NDVI), it is possible to identify areas with low greenery and higher overheating risk. This also shows how important green infrastructure is for improving urban microclimate.

The third source [3] emphasizes the role of spatial data and Geographic Information Systems (GIS) in understanding urban climate processes. It highlights the importance of remote sensing for analysing temperature patterns and spatial differences in urban environments [3]. Based on this, GIS tools can be used to combine different datasets and create maps that show overheating risk areas. Such maps are useful for urban planners, as they help to identify priority areas where actions like increasing vegetation or changing surface materials could reduce heat stress.

Remote sensing and GIS together provide a useful way to study urban overheating. These methods help support better planning and more sustainable city development. In the future, this approach could be applied to different cities to improve urban environments and reduce climate-related risks.

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# **THE USE OF UNMANNED AERIAL VEHICLES FOR REMOTE ASSESSMENT OF BRIDGE CONDITION**

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Bridge infrastructure is gradually deteriorating, which creates ongoing challenges for transport and government institutions responsible for its maintenance. In most cases, bridges are inspected every two years, however, in practice traditional inspection methods can be slow and sometimes insufficient for identifying all structural issues [1]. These inspections are based on visual assessment, which may lead to subjective results depending on the inspector's experience. Additionally limited accessibility to certain structural components can result in incomplete evaluations and overlooked defects [3].

In recent years, the use of non-destructive testing (NTD) together with unmanned aerial vehicles (UAVs) has gained popularity for bridge monitoring. From a practical perspective, UAVs make it easier to access complex or hard to reach parts of bridges. It is also helping to reduce inspection time and overall costs [1]. UAVs significantly improve safety as inspectors can operate them remotely without direct exposure to hazardous environments. According to the recent research, drone-based inspections provide a flexible and efficient way to collect high quality data [2]. The aim of this study was to conduct a thorough review of how unmanned aerial vehicles (UAVs) are applied in bridge condition monitoring [1].

The study used remote sensing methods like visual imagery, infrared thermography, LiDAR, and additional sensors. In addition, the study compared several aspects of UAV applications in bridge inspections such as ease of use, accuracy, cost effectiveness and data collection tools [1]. Most UAV based monitoring methods use images and videos together with the computer vision to find surface damage. More advanced approaches can also go beyond surface checks and analyze how a structure behaves. For example, they can monitor vibrations to better understand how the structure moves and behaves [2]. Finally, some of the limitations of both UAV and NTD technologies are discussed together with possible directions for future development in this field.

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# FLOOD RISK MAPPING AND DEVELOPMENT OF CRISIS MANAGEMENT SCENARIOS FOR THE CITY OF RUJIENA

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The recent decades have shown significant changes in climate such as intensive precipitation over a short period of time with increasing reoccurrence, milder winters with short or absent periods of snow cover and ice formation. In addition, changes have happened in general land-use patterns with increased urbanization and decreased share of forested and natural areas. These conditions have led to an increased risks of flooding not only on local, but also on a regional and national levels. Floods are one of the most powerful natural disasters, which can directly cause significant damage to both inhabited areas and infrastructure [4].

By combining remote sensing and hydrological knowledge, which complement each other, it is possible to evaluate risks of flooding and create flood inundation maps [5]. Since floods are a recurring natural hazard, this type of information makes it possible to plan solutions in emergency situations, as well as to take timely preventive measures to minimize the damage caused by floods [3]. The Hydrologic Engineering Centre's River Analysis System (HEC-RAS) is used for flood risk modelling, which is based on hydrological data allowing to obtain visual information to be displayed with hydraulic validity, to hydraulic datasets with digital terrain models and field measurements to determine specific features of terrain, river geometry, and other spatial parameters, it creates an opportunity to showcase the effects of flooding events in a unified model [1].

To perform hydrological calculations, it is necessary to use formulas to obtain more accurate results by determining hydrological quantities using mathematical statistical methods (Pearson III probability distribution for determining maximum discharges and Gumbel probability distribution for determining maximum discharges). Therefore, to perform calculations on a river, a hydrometric observation station must be available. If there is none or the observation data period is shorter than 25 years, empirical formulas with isoline maps should be used [6]. Such information is valuable for timely provision of effective flood risk management solutions by identifying critical areas. This type of information also enables civil protection to take timely preventive measures by constructing appropriate hydrotechnical structures to reduce the potential damage caused by floods.

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# **IMPACT OF REDUCED FINAL FELLING AGE ON RUNOFF AND WATER QUALITY: MODELLING HYDROCHEMICAL PROCESSES IN THE BĒRZE RIVER CATCHMENT**

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Forests cover approximately 53% of Latvia's territory, making forestry of great importance for the country's economy and environment [1]. Beyond timber production, forests are critical regulators of runoff and nutrient cycling. Proposed amendments to the Latvian Forest Law which include reducing the final felling age to 51 years for spruce, birch, and black alder, and to 31 years for aspen, may substantially change runoff and nutrient cycling [4].

Clear-cutting increases surface runoff and nutrient losses to water bodies. Harvesting machinery compacts soil and can raise surface runoff by 74 -125% [3]. Tree removal reduces nutrient uptake, while increasing runoff, soil mineralization, and decomposition of logging residues promote nitrogen and phosphate leaching [2]. Studies in Finland and Sweden show that concentrations of total nitrogen, nitrate, ammonium and phosphate rise after clear-cutting, usually peaking about 3 years later and returning to pre-harvest levels within 6 years [2].

To assess such impacts, the study used the HYPE (Hydrological Prediction for the Environment) model developed by the Swedish Meteorological and Hydrological Institute. HYPE is a semi-decentralized, process-based model that simulates water discharge and nutrient dynamics. Clearcutting scenarios are represented by changing land use parameters. The study area is the Bērze River catchment area (872 km<sup>2</sup>), where the model has previously demonstrated the ability to represent runoff and nutrient dynamics under local conditions, providing a scientific basis for possible impact of reduced felling age on water resources [5].

It should be concluded that reducing the minimum final felling age in Latvia will likely negatively impact water resources, increasing nutrient losses. The HYPE model applied in the Bērze River catchment will allow for the quantification of this impact in Latvian conditions, providing evidence-based support for forest and watershed management in Latvia.

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# THE IMPACT OF HYDROPOWER PLANTS ON HYDROLOGICAL REGIME AND FLOODPLAIN EXPANSION IN THE DUBNA RIVER

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Due to climate change and man-made modifications of river systems, the hydrological regimes of Latvian rivers are changing at a fastened pace. One of the most important factors affecting hydrological regimes is construction and operation of hydroelectric power plants (HPPs). These HPPs change natural water flow dynamics in rivers and introduce other negative consequences within basins. The aim of this study was to analyze the changes caused by HPPs on river hydrology and inundated territories. The river selected for this study is the Dubna River as its spring floods flood residential areas on a regular basis affecting the well-being of local inhabitants.

The theoretical background of this study is based on the study that addresses alterations of the hydrological regime. Poff et al. presents the ELOHA framework (Ecological Limits of Hydrologic Alteration), which provides an explanation on how human activities, including the development of hydroelectric power, disrupt natural processes of rivers [1]. The study shows the importance of thresholds of environmental flow when assessing the viability and impacts of river regulations. Based on this study, it is possible to evaluate the impact of HPPs on the seasonal discharge of Latvian rivers. Magilligan and Nislow analyze hydrological changes that were caused by dams and explain that regulated rivers often experience reduced peak flows, altered the timing of flood and increased upstream water accumulation [2]. The data gathered is relevant for such a river as Dubna, where rapid water level fluctuations during spring thawing periods can greatly increase flooding. It is emphasized by the authors that small and medium basins are far more sensitive to HPPs induced changes, which perfectly aligns with the characteristics of the basin of the Dubna river.

Zarfl et al. provides a global view on the rapid expansion of hydroelectric power infrastructure and its effects on river systems [3]. The research shows that even small HPPs can significantly change sediment transport, channel morphology and floodplain connectivity. These insights support the need for detailed modelling of flood dynamics in rivers that are being regulated.

Grill et al. further demonstrate the effects caused by river fragmentation as related to dams [4] thus reinforcing the necessity of assessing flood risks in territories that are populated and are located close to riverbanks that are being regulated, as is the case of the Dubna River.

The reviewed literature indicates that operation of HPPs can mitigate or intensify flooding depending on hydrological conditions and management. The Dubna River highlights the system, where naturally occurring spring floods are combined with regulated flow creating risks for the surrounding residential areas. This research will help to improve the understanding of hydrological alterations and development of flood risk management solutions.

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# TOWARDS STANDARDISED VOLUME CALCULATIONS FOR MINERAL EXTRACTION

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Regulation No. 570 by the Cabinet of Ministers of the Republic of Latvia specifies particular cases in which mineral resources extractors must prepare and submit “Mineral Extraction Volume Calculation Act”, accompanied by a topographic plan documenting the before/after situation, as set out in Annex 10 [1]. Although the annex requires a short explanation of the applied methods and technical means, it does not prescribe a unified calculation methodology. Consequently, identical input data processed in different software or with different settings may yield different volume estimates, particularly in complex terrain, where the choice of surface representation (TIN vs GRID) and raster resolution can measurably affect computed volumes [3]. This is important because the declared extracted volume is used as a basis for payments related to mineral extraction, including the natural resources tax, and methodological variability may therefore translate into unequal tax bases. Thee national-level oversight has also pointed to weaknesses in governance of extraction of mineral resources and the transparency of related reporting, indicating the need for more verifiable workflows [3]. Previous research in quarry environments shows that measured volumes and calculated results may differ depending on the surveying method and the surface model used, which supports the need for systematic comparison of methods and tools [2].

The aim of this research was to compare extracted-volume calculation methods and software tools (open-source and proprietary) and to identify approaches that are most suitable for Annex 10 reporting in terms of accuracy, traceability and reproducibility. Surveying data will be obtained from a case-study site (quarry) and surface models will be produced as TIN and raster DEM/DSM representations, and volumes will be computed using alternative approaches, e.g. cut/fill between two surfaces (pre- and post-extraction), volume relative to a reference plane, and sectional/profile-based calculation. For each workflow, software versions and key parameters (cell size, triangulation constraints, filtering, and boundary polygon) will be documented.

The expected outcome is a practical recommendation for a minimum reproducible submission package for Annex 10: (1) raw measurement data (surveyed points or point cloud), (2) processed surface models and boundary data and (3) a concise metadata protocol describing the calculation method, software, versions, and parameter values. Such standardisation would strengthen comparability of reported extracted volumes, enable third-party verification, and support supervisory control.

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# **THE IMPORTANCE OF PHOTOGRAMMETRY AND LASER SCANNING TECHNOLOGIES IN THE DOCUMENTATION OF BUILDINGS AND CULTURAL HERITAGE**

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The surveying of cultural heritage and structures has evolved from manual sketches and measuring tapes in the early 20<sup>th</sup> century to today's digital technologies. This evolution provides high precision documentation, which is critical for building research, restoration, engineering analysis and ongoing monitoring.

Photogrammetry utilizes high resolution photographs taken from various angles with at least 60% image overlap. This method allows for the calculation of objects' 3D shape, providing a realistic visual texture. It is indispensable for documenting building facades, decorative elements and colour layers. Data acquisition can involve high resolution stationary cameras or unmanned aerial vehicles [1].

Laser scanning measures the distance to objects' surface using laser beams, resulting in a dense point cloud. To ensure accuracy during the scanning process, control points are used; these are placed throughout the site to precisely merge data from individual scanning station to a single coordinate system. A distinction is made between stationary scanning (used for building interiors and complex structures) and mobile scanning (used for urban environments and large-scale building volumes [2].

The use of both technologies allows for the precise detection of structural deformations, cracks and wear that would go unnoticed using traditional surveying methods. Digital 3D models serve as the foundation for accurate plan drawings, documentation and preservation of cultural heritage. Modern surveying methods not only make work more efficient but also create a unique digital archive.

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## **ENVIRONMENT AND WATER MANAGEMENT**

# **THE DISTRIBUTION OF IRON AND COBALT CONTAMINATION IN LAKE LIEPĀJA AND ITS SEDIMENTS**

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Lake Liepāja is a lagoon-type lake located in Latvia and included in the Natura 2000 protected areas network. The lake is an important habitat for birds, aquatic organisms, and protected plant species, as well as a popular recreation site for local residents. However, increasing urbanisation and agricultural activities may lead to higher levels of environmental pollution in water bodies. Heavy metals in freshwater ecosystems may affect water quality, aquatic organisms, and human health [1].

The aim of this study is to evaluate iron (Fe) and cobalt (Co) contamination in Lake Liepāja. Water and sediment samples were analysed from 15 sampling locations distributed across the lake. The results were compared with international environmental guidelines and findings from previous scientific studies on heavy metal pollution in aquatic ecosystems [2].

The results show that contamination levels in water are generally lower than in lake sediments. At the same time, pollution levels vary across different parts of the lake. The study found that high concentrations of iron and cobalt do not occur at the same sampling points. In several cases, iron concentrations exceeded recommended limits up to three times, while cobalt concentrations remained below the permissible limits at all sampling locations. Scientific studies indicate that increased iron levels may negatively influence fish health and water quality, while heavy metals in water can also create potential risks for humans [3, 4].

Possible pollution sources include nearby agricultural land, the historically active metallurgical industry in the northern part of the lake, and the influence of the port city environment. These findings suggest that contamination is caused by several human activities rather than a single source.

Overall, the average concentrations of iron and cobalt in the lake water do not exceed international guideline values. However, locally higher concentrations were observed, especially in sediments. The results highlight the importance of continued monitoring to better understand pollution processes and protect the lake ecosystem.

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## PFOS AND PFOA CONCENTRATIONS IN THE DAUGAVA RIVER BASIN

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Per- and polyfluoroalkyl substances (PFAS) are a group of persistent synthetic chemicals widely used in industrial and consumer products. Among them, perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA) are two of the most widely studied compounds due to their environmental persistence, mobility, and potential risks to ecosystems and human health [1,2]. These substances are highly resistant to degradation and can remain in aquatic environments for long periods. Although PFOS and PFOA belong to the same chemical group, they differ in structure and environmental behaviour. PFOS generally shows a stronger tendency to associate with particles and sediments, whereas PFOA is typically more mobile and predominantly occurs in the dissolved phase in aquatic systems [4].

The aim of this study was to evaluate PFOS and PFOA concentrations in the Daugava River basin in the territory of Latvia and to assess their spatial distribution at the basin scale. Monitoring data from 24 stations located throughout the river basin were analysed, covering the period from 2017 to 2025.

The analysis focused on comparing concentration levels across different monitoring stations and identifying spatial patterns. Data visualisation techniques were used to present concentration ranges and highlight areas with elevated values. The results show that PFOS and PFOA are detected at multiple locations within the Daugava River basin. Similar findings have been reported in Nordic and Baltic surface waters, where PFOA and PFOS are widely distributed at low concentrations [3]. Although certain stations exhibit higher maximum concentrations, most monitoring sites indicate relatively low but detectable levels. However, the overall distribution pattern suggests that PFOS and PFOA contamination in the Daugava River basin is primarily diffuse rather than linked to a single dominant point source. This pattern is consistent with the known environmental behaviour of PFOA and PFOS as persistent and widely dispersed contaminants [1].

In conclusion, the study provides a basin-scale overview of PFOS and PFOA concentrations in the Daugava River. The results highlight the importance of continuous monitoring and spatial analysis for understanding the distribution of persistent pollutants in large river systems.

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# **CONCENTRATION OF LITHIUM (LI), BORON (B) AND MOLYBDENUM (MO) IN THE WATER AND SEDIMENTS OF LAKE LIEPĀJA**

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During the last decades, urbanization and industrial development have increased pollution pressure on aquatic ecosystems. Anthropogenic activities contribute to the accumulation of metals in surface waters and sediments, which may negatively affect water quality, ecosystems, and human health. As pollution sources increase, concerns about their environmental impact are also growing [1]. Lithium (Li), molybdenum (Mo), and boron (B) may pose risks to living organisms at elevated concentrations. Lithium can affect metabolism and the nervous system, molybdenum may cause health disorders in toxic amounts, while excessive boron may negatively affect the reproductive system and overall health [1, 2, 3].

The study was carried out in Lake Liepāja, located in western Latvia near the Baltic Sea coast. A total of 15 water samples and 14 sediment samples were collected from different locations in the lake. Element concentrations were determined using inductively coupled plasma mass spectrometry (ICP-MS). The aim of the study was to determine the concentrations of lithium, molybdenum, and boron in water and sediments and to identify possible pollution sources.

The results showed noticeable variation between sampling sites. In water, the lowest concentrations were 1.664 µg/L for lithium, <0.1 µg/L for molybdenum, and 11.45 µg/L for boron, while the highest reached 19.440 µg/L, 0.6348 µg/L, and 420.70 µg/L respectively. In sediments, the lowest concentrations were 12.469 mg/kg for lithium, 0.390 mg/kg for molybdenum, and 31.948 mg/kg for boron, whereas the highest reached 34.605 mg/kg, 3.576 mg/kg, and 152.897 mg/kg.

The results indicate that the distribution of these elements in Lake Liepāja is influenced by anthropogenic pollution sources, with higher values observed near industrial areas. Although most concentrations do not exceed critical levels, locally elevated values highlight the need for continued monitoring and further investigation of pollution sources.

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# **NICKEL AND COPPER CONCENTRATION AND THEIR EFFECT ON LAKE LIEPĀJA WATERS AND SEDIMENTS**

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Surface water bodies in Latvia play an important ecological, environmental and social role. To preserve their ecological value, these water bodies must remain clean and environmentally safe for aquatic organisms, animals and humans. The quality of open water bodies often reflects the environmental condition of the surrounding area, and increasing attention is being paid to pollution caused by heavy metals. Heavy metals occur naturally in the environment at low concentrations; however, human activities can increase these concentrations and cause environmental problems [2].

The aim of this study is to analyse the spatial distribution of nickel (Ni) and copper (Cu) in the water and sediments of Lake Liepāja and to evaluate their potential environmental impact.

This research examines the distribution of nickel and copper in Lake Liepāja using georeferenced sampling data collected within the lake. Previous studies indicate that the distribution of heavy metals in aquatic ecosystems can vary depending on environmental conditions and pollution sources [2]. The analysed data show that nickel concentrations in Lake Liepāja water range from 0.16 to 1.53 µg/L, while in sediments they range from 14.74 to 30.42 mg/kg. Copper concentrations in water vary from 0.05 to 40.91 µg/L and in sediments from 11.41 to 92.72 mg/kg [1].

Samples were collected systematically across Lake Liepāja to obtain as accurate a representation of pollution distribution as possible. Water samples were taken at a depth of 0.2–0.5 m below the surface, while sediment samples were collected from a depth of 0.00–0.20 m. Heavy metal concentrations were analysed using ICP-MS with NIST-traceable calibration [1]. The results show significant spatial differences in heavy metal concentrations across the lake. Certain areas demonstrate elevated concentrations of nickel and copper, while other locations show values closer to natural background levels. These differences may be influenced by hydrological conditions, sediment accumulation processes and potential anthropogenic pollution sources entering the lake.

In conclusion, the study highlights the uneven spatial distribution of heavy metals in Lake Liepāja. Identifying areas with higher concentrations is important for understanding possible pollution sources and supporting effective environmental management of coastal water bodies. Continuous monitoring of heavy metals in water and sediments is necessary to assess long-term environmental risks and maintain the ecological quality of the lake.

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# **DISTRIBUTION OF CHROMIUM AND MANGANESE IN THE WATER AND SEDIMENTS OF LAKE LIEPAJA**

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Lake Liepāja is one of the most important mesotrophic lakes characterized by brackish water plant species and is included in the NATURA 2000 protected areas as well as in the list of internationally important bird areas (IBA). More than 100 bird species nest in the lake area, and two European Union protected habitats as well as approximately 40 rare and protected plant species have been identified within its territory. Valuable meadow habitats are located on the eastern shore of the lake [2]. Historically, this lake has been affected by industrial activity, urban wastewater, and diffuse agricultural pollution, which has resulted in contamination of sediments and water with nutrients and trace elements [1]. The aim of this study is to investigate the distribution of chromium and manganese pollution in Lake Liepāja using geographically referenced data collected in the lake area in July 2024 [1]. Results from a previous study of Lake Liepāja sediments indicate that elements such as Cr and Mn are present in excessive amounts in the northern part of the lake, most likely due to metal processing industry activities and the washing out and erosion of contaminated sediments from other sources [3].

Water samples were collected from the upper 0.3-0.5 m layer, while sediment samples were collected at a depth of 0-20 cm. Element analysis in water and sediment samples was performed using inductively coupled plasma mass spectrometry (ICP-MS) with NIST-traceable calibration standards [1]. The analysed data show that chromium concentrations in the collected lake water samples range from  $<0.1$  to  $0.42 \mu\text{g L}^{-1}$  and in sediments from 29.73 to  $95.37 \text{ mg kg}^{-1}$ . Meanwhile, manganese concentrations in lake water samples range from 12.44 to  $691.63 \mu\text{g L}^{-1}$  and in sediments from 395.65 to  $3867.13 \text{ mg kg}^{-1}$  [1]. The results obtained during the study indicate minimal and uneven contamination by chromium in water, whereas chromium concentrations in sediments may indicate anthropogenic influence. The results for manganese concentrations in Lake Liepāja water indicate local manganese release from sediments or inflow from surrounding areas. Moreover, manganese concentrations in sediments often coincide with higher chromium concentrations, suggesting possible common pollution sources. Overall, the study highlights that the pollution distribution is uneven, which may be related to pollutant inflow from urban or agricultural areas. Considering that heavy metals accumulate in sediments, they are observed there in higher concentrations than in water. Further monitoring is necessary to identify locations in the lake with higher heavy metal concentrations, determine possible pollution sources, and promote effective environmental management of the water body while preserving the ecological quality of the lake.

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# IMPACT OF DRAINAGE RUNOFF USED FOR IRRIGATION ON SURFACE WATER QUALITY

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Agricultural drainage systems are essential for maintaining stable and productive crop production under temperate climate conditions, as they regulate excess soil moisture and improve field workability [1]. However, these systems also act as significant pathways for diffuse pollution, transporting nutrients such as nitrogen (N) and phosphorus (P) from agricultural land into surface water bodies. This process contributes to eutrophication, degrades water quality, and negatively affect aquatic ecosystems [1]. Increasing environmental requirements and the need for sustainable water resource management highlight the importance of developing innovative solutions that can reduce nutrient loss while improving nutrient use efficiency.

One potential approach is the reuse of drainage runoff for irrigation. Drainage water contains leached nutrients, the concentration of which depends on precipitation, soil properties, and fertilization practices. On average, annual N loss ranges from 10 to 40 kg ha<sup>-1</sup>, while P loss ranges from 0.1 to 10 kg ha<sup>-1</sup>. By collecting and reusing this water for irrigation, some of these nutrients can be returned into the agricultural cycle, reducing the need for mineral fertilizers and limiting nutrient discharge into surface waters. This approach aligns with the principles of the circular economy and integrated water resource management [2].

The aim of this study was to evaluate the impact of using drainage runoff for irrigation on nutrient leaching and surface water quality. The hypothesis states that the reuse of drainage water can provide a significant nitrogen input for crops while simultaneously improving surface water quality.

The results indicate that drainage water reuse has the potential to significantly reduce nutrient losses and enhance nutrient cycling in agricultural systems. By recycling nutrients through irrigation, reliance on mineral fertilizers can be decreased while maintaining crop productivity. In addition, this practice may reduce N and P loads entering surface waters, thereby improving overall surface water quality. The study demonstrates that drainage water reuse is a promising and sustainable solution for mitigating diffuse pollution and improving water resource management in agricultural landscapes.

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# **LEAD AND ALUMINIUM CONTAMINATION IN THE SEDIMENTS AND WATER OF LAKE LIEPĀJA AND THEIR POTENTIAL IMPACT ON THE ECOSYSTEM**

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Heavy metal pollution is characterised by toxicity, persistence in the environment and the ability to bioaccumulate, which may cause harmful effects on ecosystems and human health. The main sources of heavy metals are anthropogenic activities such as industrial emissions, wastewater discharge and agricultural activities [2]. When heavy metals accumulate in aquatic organisms, they can be transferred through the food chain to other animals and humans [3]. Lake Liepāja and its surrounding area are designated as a nature reserve and an important bird habitat, therefore maintaining good environmental quality and monitoring pollution levels in this area is particularly important [1].

The aim of this study was to determine lead and aluminium concentrations in the water and sediments of Lake Liepāja and to assess their potential impact on the ecosystem. Water and sediment samples were collected from 15 sampling sites in Lake Liepāja and its surrounding area in July, 2025. The chemical analysis of the samples was carried out using Inductively Coupled Plasma Mass Spectrometry (ICP-MS).

The results show that the average lead concentrations in water did not exceed the established limit values. However, higher lead concentrations in sediments were observed in locations associated with historical or current industrial activity. The highest lead concentration in sediments (214 mg/kg) was detected at two sampling sites: in the boat cooperative area near industrial territories and in the Ālande River before it flows into Lake Liepāja. Elevated lead levels are likely related to storm water runoff from nearby industrial areas.

The highest aluminium concentration in the water (171.2 µg/L) was recorded in the south-western part of the lake within the EU Habitat 3140 area, where the presence of aluminium in the water may partly originate from natural sources. The highest aluminium concentration in sediments (39 g/kg) was found at the Rumba polder pumping station, where seasonal water pumping may cause sediment resuspension, as well as in the Ālande River before it enters Lake Liepāja. The results highlight the importance of regular environmental monitoring in order to identify potential pollution sources and ensure the protection and sustainable management of aquatic ecosystems.

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# RESEARCH OF SODIUM AND MAGNESIUM CONCENTRATIONS AND SEDIMENTS IN LAKE LIEPĀJA WATERS

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Lake Liepāja is one of the largest coastal freshwater bodies in Latvia and is included in the Natura 2000 network of protected areas. Despite its ecological importance, the lake has been exposed to long-term anthropogenic pressures, including metallurgy, ship-repair industries, urban runoff and diffuse agricultural pollution. These activities have increased concentrations of various trace elements and metals, such as lithium, lead, iron and arsenic, as well as major ions including sodium and magnesium in surface waters and bottom sediments [1]. Elevated sodium and magnesium levels are of concern because increased ionic loads may alter freshwater chemistry and contribute to ecosystem degradation [2]. High-magnesium waters may also negatively influence soil structure and agricultural productivity [3]. The aim of this research was to analyse sodium and magnesium concentrations and associated sediments in Lake Liepāja, identify their potential sources, and evaluate their impact on the lake ecosystem.

The study was based on the analysis of published georeferenced datasets on sediment and surface water element concentrations [1]. Sampling sites were located in areas influenced by industrial activity, urban effluents and agricultural runoff. Sodium and magnesium concentrations were evaluated against typical freshwater background levels to determine whether elevated values are linked to anthropogenic pressures and how they affect physicochemical conditions in the lake.

The results show that sodium and magnesium concentrations at several sampling sites exceed typical freshwater background values. Higher levels were observed near former industrial zones and areas affected by urban drainage and agricultural inputs. The findings indicate that legacy industrial contamination, together with ongoing activities such as road salt application and agricultural drainage, contributes to ionic enrichment in the lake, potentially causing increased salinity and stress for aquatic organisms.

In conclusion, sodium and magnesium concentrations in Lake Liepāja are associated with both historical and current anthropogenic pressures. Continuous monitoring and improved management of urban and agricultural runoff are essential to protect the ecological integrity of this Natura 2000 freshwater ecosystem.

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# INFLUENCE OF FOREST STAND SPECIES COMPOSITION ON RUNOFF WATER QUALITY

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Water is an essential natural resource, which holds an important significance both for human daily needs and also for ecosystem functioning. Nowadays one of the main global problems is water quality, quantity and availability. In many regions these problems are closely related to land use practices, which influence the amount and composition of surface runoff and nutrient transport to water bodies. The aim of the research was to assess how the runoff quality may change depending on forest stand species composition based on previously conducted studies. Studies show that the type of land use is a very important factor that influences the runoff quality. The main pollutants are plant nutrients – nitrogen (N) and phosphorus (P), which mainly comes from agricultural land and urbanized areas. These nutrients can enter water bodies through surface runoff and drainage systems and can significantly affect water quality. This pollution is often seasonal. Pollution from urbanized areas in the form of P is more noticeable during summer and autumn, while N losses from agricultural land are usually lowest during summer and increase during wetter seasons [1].

It is important to note that a negative correlation has been observed between forest areas and the leaching of plant nutrients. This indicates that forest areas can act as natural buffers and reduce water pollution coming from agricultural land and urbanized areas. Forests also play an important role in the water cycle. Forest ecosystems regulate hydrological processes by influencing infiltration, water retention and runoff formation. They also support groundwater recharge, which reduces the risk of soil erosion and soil degradation [2]. To function effectively and provide benefits for water cycle, forest ecosystems require diversity. Forest stands composed of various species, create conditions closer to natural forest. Mixed-species forest stands create variation in root depth and soil structure, which improves water infiltration and reduces the risk of soil erosion [3]. Forest ecosystems therefore have an important place in protecting soil health, supporting groundwater recharge and regulating nutrient leaching. To sum up, previous studies show that forest ecosystems help maintain water quality and regulate the water cycle, and they may reduce water pollution compared with other land use types. Diversity of tree species can enhance these ecological functions and improve the stability of hydrological processes.

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# ARSENIC AND ANTIMONY CONTAMINATION IN WATER AND SEDIMENTS OF LAKE LIEPĀJA

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Heavy metal and metalloid pollution in aquatic ecosystems is a significant environmental issue because these substances can accumulate in sediments and persist in the environment for long periods. This may negatively affect water quality, aquatic organisms and ecosystem stability. Arsenic and antimony are potentially toxic elements that can enter water bodies through anthropogenic activities such as industrial processes, transport and resource extraction. Lake Liepāja is a shallow lagoon-type lake in western Latvia that is sensitive to pollution due to its hydrological conditions and surrounding urban areas. The aim of this study was to evaluate arsenic and antimony concentrations in the water and sediments of Lake Liepāja, with particular focus on sampling points L9 and L15.

The research was based on water and sediment samples collected in August 2024 from several monitoring locations in Lake Liepāja. The study used available datasets on chemical element concentrations in lake water and sediments. The concentrations of arsenic and antimony were analysed and compared between sampling locations and evaluated using available environmental guidelines and background concentration values.

The results indicate that the highest concentrations were detected at sampling site L15. In sediment samples, arsenic reached 10.809 mg/kg and antimony reached 3.636 mg/kg. In water samples, concentrations of 1.885 µg/L for arsenic and 0.136 µg/L for antimony were observed [1, 2]. Although these values do not exceed typical guideline levels for water quality, they suggest localised contamination within the lake. Sediment data also show accumulation of these elements. Natural background concentrations are usually around 5–10 mg/kg for arsenic and 0.2–1 mg/kg for antimony, which indicates that the measured values, especially for antimony, may reflect anthropogenic influence [3].

The findings suggest that elevated concentrations at sampling locations L9 and L15 may be related to historical industrial areas, extraction sites and nearby transport infrastructure. These factors may contribute to the transport and accumulation of heavy metals in lake sediments. Continuous monitoring is therefore important to better understand pollution sources and potential long-term environmental risks.

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## **CIVIL ENGINEERING**

# HEMP SHIVES SPHERIFICATION AND DETERMINATION OF THERMAL CONDUCTIVITY BY TRANSIENT PLANE HEAT SOURCE

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The European Union aims to achieve climate neutrality by 2050, which will present new challenges for all sectors of the economy. Currently, resource scarcity and climate change are global issues, and cannabis is considered a potential crop for sustainable development [2]. Cannabis is a plant with a wide range of applications. Its use dates back thousands of years, from textile production in ancient China to the development of modern pharmaceutical products.

Hemp contains 37% cellulose, 16.5% hemicellulose, 21.8% lignin, 5% pectin, 8.9% extractives, 10.8% ash, silicon dioxide, tannin, and other components [1]. Removing fibres from hemp yields hemp shives. It is planned to convert hemp shives into spheres by adapting the “Caleva” spherification method. The process involves six stages: grinding hemp shives, preparing mixtures, extrusion, sphere formation, sphere drying, and fraction detection [3]. Hemp shives are similar to wood; therefore, producing spheres requires powerful machinery. The variety of samples results from different ground hemp shive fractions (0.25 to 0.75) and additives used (potato starch, calcium oxide). The material will acquire a new form, which will facilitate on-site work: reduced manual labour, faster installation, consistent density, less dust, and improved job safety and comfort.

The physical properties of the resulting spheres are determined, including density, sphericity, and thermal conductivity. Using ImageJ and a camera, it is possible to analyse the shape, diameter, area, and perimeter of the spheres. ImageJ analysis showed that most samples (35.2%) ranged from 0.51 to 0.70, indicating that most objects are moderately circular but not close to perfect spheres. Irregular particles can also pass through the sieve if they have a specific orientation. During sieving, the particles move and pass through openings with the smallest projection.

TPS-3 was used to measure thermal conductivity. The TPS-3 device uses the transient plane source method to test the thermal conductivity, thermal diffusion, and volumetric heat capacity of solids, pastes, and powders [4]. Initial results showed that the thermal conductivity ( $\lambda$ ) of spheres without additives ranged from 0.113 to 0.124 W/(m·K), with larger fractions (0.75 mm) yielding lower thermal conductivity compared to finer fractions (0.25 mm).

In the future, hemp could partially replace trees; hemp fibres and shives can be used to make paper, thermal insulation, plates, and biopolymers. Hemp grows for about 4–5 months and can yield four times more fibre per hectare than trees. Despite these benefits, hemp is not suitable for load-bearing structures.

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# **ADVANCING RESILIENCE: TECHNOLOGIES FOR PROTECTING BUILDINGS FROM HURRICANES AND EXTREME WINDS**

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This study examines technologies and strategies that enhance building resilience to hurricanes and strong winds. Due to the increased frequency of these events, it is important for structures to withstand such hazards. The aim is to analyse existing technologies and strategies for protecting buildings from hurricanes and extreme winds.

Aerodynamic building design reduces the wind force exerted on buildings. The Wind Retrofit Guide for Residential Buildings emphasises that roof geometry and orientation are critical factors in minimising wind-related damage: correctly designed and oriented roofs reduce wind pressures on structural components, improving overall building performance during hurricanes [1].

Research conducted by the Insurance Institute for Business & Home Safety (IBHS) demonstrated that buildings with unprotected openings experienced substantially greater damage than those equipped with impact-rated components. Their wind-testing experiments showed that once windows or doors failed, internal pressure increased dramatically, placing additional uplift forces on roofs and structural connections [3].

Roof reinforcement commonly includes the use of stronger truss or rafter connections, hurricane straps or clips, and sheathing attachments that secure the roof to the wall framing. These connections improve a building's resistance to uplift forces caused by high winds. Studies conducted by the National Institute of Standards and Technology (NIST) showed that properly anchored roof assemblies significantly reduced roof failure during extreme wind events, highlighting the importance of continuous load paths from roof to foundation [2].

In conclusion, the study of the previous research found that no single design strategy is sufficient to protect buildings from extreme wind events. The most effective solutions result from integrating aerodynamic design with a continuous and impact-resistant building envelope, while strengthened roof-to-wall and wall-to-ground connections significantly improve a building's ability to withstand hurricanes and extreme winds.

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# **IMPACT OF VOC EMISSIONS FROM RECYCLED BUILDING MATERIALS ON INDOOR ENVIRONMENTAL QUALITY**

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Volatile organic compounds (VOCs) emitted from construction materials are a significant factor affecting indoor environmental quality and human health, particularly in modern energy-efficient buildings with reduced ventilation rates. With the increasing implementation of circular economy principles in the construction sector, recycled materials are being used more frequently, raising concerns about their emission behaviour and potential risks for indoor air quality. Previous studies indicated that VOC emissions depend on material composition, production processes, and environmental conditions, while recycled materials may exhibit altered emission patterns due to structural and chemical changes [1, 2, 3]. Therefore, this research aims to evaluate the impact of mechanical recycling processes on VOC emissions from commonly used building materials and to assess their implications for indoor environmental quality.

The study used an experimental approach with datasets that reflect realistic VOC emission trends reported in the scientific literature. The study included particleboard, medium-density fibreboard, laminate flooring, polyurethane insulation, painted gypsum board, and PVC flooring. Mechanical recycling processes were simulated to represent real-world conditions, including shredding, thermal exposure, and material reprocessing. For each material group, ten measurements were collected. A one-way ANOVA was used to assess differences between initial and recycled materials. The results indicate that VOC emissions vary significantly after recycling and depend strongly on material type. Particleboard showed the highest increase in emissions, approximately 37.8%, while gypsum-based materials demonstrated a decrease of around 15.4%. Polymer-based materials, including PVC, also showed increased emissions after recycling. These changes can be explained by structural degradation, thermal effects, and the release of previously trapped compounds during recycling processes.

Mechanical recycling processes can significantly influence VOC emissions from building materials. Although recycling supports sustainability and resource efficiency, it may negatively affect indoor air quality if emission characteristics are not properly evaluated. Therefore, VOC emission assessment should be integrated into circular construction strategies and material certification systems. Future research should focus on experimental validation and the development of standardised methods for evaluating emissions from recycled materials.

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## **LANDSCAPE ARCHITECTURE**

# **LANDSCAPE RESEARCH OF THE REHABILITATION CENTRE 'LĪGATNE'**

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The landscape of rehabilitation institutions plays a significant role in supporting the emotional and physical recovery of patients. The aim of the research was to assess the existing landscape structure of the "Līgatne" Rehabilitation Centre and develop a functional and psychologically supportive improvement proposal that strengthens the healing character of the centre's environment. The introduction outlines the relevance of healing landscapes in modern rehabilitation practice and emphasizes the growing need to ensure a calm, accessible and nature-based outdoor environment for both patients and staff.

The descriptive part of the research incorporates theoretical sources addressing healing landscapes and biophilic design. According to Kellert [1], environments that integrate natural materials, vegetative elements, views to nature and organic spatial forms have been shown to reduce stress and support the restoration of emotional balance. These principles form the theoretical basis for evaluating the existing situation in the "Līgatne" Rehabilitation Centre. Additionally, international examples of rehabilitation institutions demonstrate how outdoor spaces can function as extensions of therapeutic programmes by integrating sensory gardens, accessible circulation networks, water elements and planting structures that encourage movement, exploration and rest [2].

The centre's landscape was analysed through site visits, photographic documentation, functional mapping and assessment of the spatial, ecological and perceptual qualities of the area. The study revealed two major issues: the lack of dedicated outdoor spaces for staff and patients, and the mixing of tourist flows due to the presence of the historical underground bunker, which significantly disturbs the tranquillity needed for rehabilitation. A detailed inventory of existing elements showed that many structures and plantings are outdated, visually unappealing or no longer functionally adequate. However, the natural setting provides strong potential for developing a healing landscape.

The conclusion of the research presents a development proposal which integrates biophilic design principles [3], introduces new circulation patterns, improves accessibility and ensures a clearer separation between tourists and patients. The findings demonstrate that thoughtful landscape planning can significantly improve the therapeutic value of rehabilitation environments and contribute to a more holistic healing process.

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# **A MULTI-DIMENSIONAL ACCESSIBILITY MATRIX FOR EVALUATING URBAN RIVERFRONT QUALITY: THE CASE OF THE DAUGAVA RIVER IN RIGA**

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Urban rivers and waterfronts are essential structural elements of the urban environment, supporting ecological balance, public well-being, and cultural identity. In Riga, the Daugava functions as the spatial backbone and symbolic axis of the city. Despite its significance, the riverfront is often assessed fragmentarily, with primary emphasis on physical accessibility, while visual, emotional, and ecological aspects remain underexplored. The aim of this research is to develop an accessibility assessment matrix for evaluating the Daugava riverfront as a complex urban landscape. The methodological framework is based on landscape architecture theory, urban perception studies, and sustainable planning approaches. The research builds on the author's previous study, where the Daugava is analysed as a multifunctional spatial system combining ecological, social, and cultural values [3]. This highlights the importance of understanding the river not only as a physical structure, but also as a lived and perceived landscape, while revealing the need for a more structured evaluation method.

The study is supported by international riverfront development research, which identifies accessibility as a key principle, including physical, visual, and experiential access to water [4]. Urban perception theory shows that visual structure, legibility, and spatial orientation significantly influence how people experience space [1]. Landscape identity research further demonstrates that people's relationship with place is shaped by memory, belonging, and emotional attachment [2]. At the same time, integrated river planning approaches highlight that urban rivers should be understood as interconnected ecological and spatial systems, where accessibility, environmental quality, and urban structure must be addressed simultaneously [5]. The developed matrix consists of four interrelated groups of criteria: visual, emotional, physical accessibility, and ecological quality. It includes 41 criteria evaluated on a five-point scale to reduce subjectivity and enable comparison between riverfront segments. Data were obtained through field surveys in 22 neighbourhoods along the Daugava using Survey123 (a GIS-based survey tool), complemented by expert interviews and public perception analysis.

The results show that physical accessibility alone does not determine riverfront quality. In some areas, high visual accessibility does not create emotional connection, while in others ecological potential remains underused due to fragmented access and weak spatial continuity. The proposed matrix provides a transferable analytical tool for landscape architects and urban planners, supporting a holistic approach to riverfront development.

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# **TRANSFORMATION OF THE KAROSTA CANAL PROMENADE**

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The aim of the research was to study the transformation of the landscape space of the Karosta Canal promenade in Liepāja, evaluating its development directions in the context of Liepāja. The study examines the historical development of the city of Liepāja and the Karosta district, along with their transformation processes. A detailed study has been conducted of the landscape space of the northern embankment of the Karosta Canal, identifying its development potential. A development concept has been elaborated, including functional zoning and landscaping solutions that highlight Karosta's industrial heritage while creating a contemporary recreational public space.

The following methods have been used. 1) Survey method in nature: the study of the landscape space, collecting the necessary materials, 2) Cartographic method: the study of the historical development of the city by comparing historical maps, 3) Visually graphic method: preparation of graphic materials, 4) Sociological survey for focus groups: collection of opinions of residents and guests of the territory and preparation of proposals for the development of the territory.

The research came to the conclusion that the Karosta Canal promenade has a strong landscape and recreational potential, but at the moment it is not fully used due to poor infrastructure, lack of amenities, weak spatial structure, and limited accessibility. The survey results showed that residents support the development of the area and highlight the importance of creating a safe and continuous promenade, providing recreation areas and lighting, and preserving the natural and cultural-historical character of the site. Overall, the analysis showed that for the area to develop successfully, a clear and well-planned spatial solution based on sustainable principles and a balance between active and passive recreation is needed.

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## **SOCIAL SCIENCES**

# **INTEGRATION OF SUSTAINABILITY CRITERIA INTO THE ANALYSIS OF ECONOMIC GROWTH INDICATORS**

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The assessment of economic growth has traditionally been dominated by indicators such as gross domestic product (GDP), which reflects the volume of economic activity but does not fully capture the quality of societal development. Nowadays, increasing importance is placed on sustainable development aspects, which encompass not only economic but also social and environmental factors. Consequently, the “Beyond GDP” approach has gained prominence in academic literature and policy planning, emphasizing the need to complement traditional indicators with sustainability metrics. The aim of this study is to evaluate the possibilities of integrating sustainability criteria into the analysis of economic growth indicators and to develop an extended GDP model.

The theoretical framework of the study is based on the findings of Joseph E. Stiglitz, Amartya Sen, and Jean-Paul Fitoussi (2009) regarding the limitations of GDP and the need to broaden the assessment of economic development, as well as the works of Simon Kuznets (1934) on the nature of national income indicators. In addition, Thomas Piketty’s (2014) research on income inequality and its impact on economic development is incorporated. The study employs monographic, analysis and synthesis, deduction, and comparative analysis methods, as well as descriptive statistics, time series analysis, and coefficient analysis. The empirical part examines Latvia’s economic and sustainability indicators over the period from 2015 to 2024, using data from international organizations and statistical databases. The study also evaluates the interrelationships between economic growth and sustainability indicators, including income inequality, poverty risk, and environmental indicators.

The results of the study indicate that economic growth indicators, particularly GDP, do not provide a comprehensive picture of societal development, as they fail to account for income distribution, social welfare, and environmental impact. The analysis confirms that in Latvia, similarly to other countries, the dynamics of economic growth do not always coincide with improvements in sustainability indicators. It was found that income inequality and social indicators significantly influence the quality of development, while the analysis of environmental indicators highlights the need to assess the long-term impact of economic growth. Based on the obtained results, the study develops an extended GDP model that integrates economic, social, and environmental indicators into a unified analytical framework. The conclusions emphasize that traditional economic growth indicators are important but insufficient for assessing sustainable development. The integration of sustainability criteria provides a more comprehensive understanding of a country’s development and its quality. Thus, the extended approach can serve as an important tool in economic analysis and policymaking, promoting balanced and sustainable development.

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# **THE ROLE OF SUSTAINABLE FINANCE IN ACHIEVING THE SUSTAINABLE DEVELOPMENT GOALS**

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In the past decade, global society has faced a range of environmental challenges, including rising carbon emissions, global warming and climate change, which have created pressure to increase more sustainable and innovative solutions. In this area, sustainable finance plays a key role in driving a variety of innovations aimed at achieving environmental sustainability and sustainable economic growth.

Over time, sustainable development has evolved from a simple idea to an action plan, initially with 8 goals, and now with 17 goals covering the entire world. Research on this topic has gradually grown in both number and volume, demonstrating the relevance and growing impact of sustainability on the world. A component and indicator of the concept of sustainability is sustainable finance, through which progress and achievement of goals become easier and more feasible [1]. Sustainable finance plays a significant role in linking circular economy goals with financial inclusion. Integrating sustainable finance into financial institutions allows countries to accelerate the achievement of the Sustainable Development Goals, while promoting economic development and social justice [2]. The availability, inclusion and strengthening of sustainable financing in the national economy and development provide competitive advantages, reduce social and economic gaps, and improve macroeconomic and long-term indicators.

Recognizing the power of sustainable finance in accelerating environmental, social and governance progress, the Republic of Latvia issued its first Sustainability Bond issue in December 2021 [3]. In 2024, the volume of sustainable investments in the world reached 3151 billion EUR, an increase of more than 10 times compared to 2015. Although the volume and number of investments are on a progressive trend, the average return of sustainable funds in 2024 was 0.8%, while the return of traditional funds reached 1.5% [4].

Although sustainable finance and investments are a very important catalyst towards achieving sustainable development goals and balancing environmental, social and governance indicators, there are still several factors, such as climate change management risks, political and social resistance and financial underperformance of ESG strategies, that do not allow for the complete exclusion of the importance and permanence of traditional finance.

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# OVERCOMING POVERTY AS A PILLAR OF SUSTAINABLE DEVELOPMENT

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One of the key goals of sustainable development is the eradication of poverty. Poverty remains a significant social and economic challenge both globally and in Latvia, affecting various social groups and limiting opportunities for development. The aim of this research was to analyze poverty as a barrier to sustainable development and to evaluate possible approaches to its reduction.

Meeting basic needs is essential for human development and social participation. According to statistical data, in February 2026, there were 42,825 individuals in Latvia with officially recognized low-income status [1]. Due to strict income thresholds, many individuals remain excluded from support. This indicates that the true number of low-income individuals is substantially higher, underscoring the necessity of a more comprehensive assessment of the actual situation. Addressing poverty requires both investment in material resources and individual willingness to improve living conditions.

Analysis of literature and policy documents shows that poverty is closely linked to social exclusion and structural inequalities, particularly through limited access to education and employment opportunities [2]. Certain social groups, including people with disabilities, elderly individuals and families with children, face a higher risk of poverty and exclusion [3]. This highlights the importance of targeted social support and inclusion policies.

In 2025 significant financial resources were allocated in Latvia to address poverty, while additional funding has been earmarked for 2026 to support families with children and ensure the provision of social services [2]. Analysis of information sources indicates that poverty reduction is strongly influenced by investment in human development and is recognized as a priority in Latvia 2030 and other policy documents. In conclusion, poverty reduction requires a comprehensive approach that combines financial support with investments in education, skills development and labour market participation.

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# **ADVANCING CIRCULAR HOUSEHOLDS IN LEISURE AND TRAVEL: A RESEARCH LANDSCAPE ANALYSIS AND FUTURE AGENDA**

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Households play a vital role in consumption, with their practices closely linked with environmental stress and sustainability issues, including high raw material use, waste generation and climate change [1]. For instance, in 2022, households accounted for a notable 8.9 % share of total waste in the European Union [3]. However, households hold the potential to contribute to addressing the environmental and sustainability issues through the adoption of circular and responsible consumption practices. Accordingly, implementation of effective circular strategies within household consumption domains to become more circular is crucial to improve the circular consumption patterns, minimize the waste generation, reduce the carbon footprint and strengthen the nation's circular economy system. Circular Households integrate circular economy principles and practices into the entire management of the household, including the systemic organization and optimization of household resources and activities to reduce waste and make the most efficient use of resources throughout the whole household consumption system [2]. The study aims to map the current landscape of research on circular households and identify both scientific and applied studies, including those addressing circularity in Latvian households within the leisure and travel consumption domains and delineate key directions for future research. The study employs a qualitative research method of systematic literature analysis using recently published academic research and applied research data from 2015 to 2025, using Latvia as the case study.

Findings from the secondary data indicate that Latvia's per capita raw material consumption in 2023 substantially exceeded the EU-27 average, as evidenced by its position above the corresponding benchmark line [4]. From a circular economy perspective, these resource-intensive behaviours contribute to increasing household carbon footprint and high waste generation in Latvia. Moreover, leisure and travel are significant household consumption domains driving raw material usage and waste generation. From a circular economy perspective, these areas remain largely unexplored in both scientific and practical research. Consequently, scientific and applied research on circular economy practices at the household level has focused more on domains such as food and textiles. Therefore, to address this situation, it requires identifying circular practices at households in leisure and travel from the decision-making process to actual household behaviours, offering the bottom-up perspective of the circular economy approach. The research provides evidence on gaps in both scientific literature and practical applications within the leisure and travel sectors, promoting future studies on household behavioral changes in the circular economy, with particular emphasis on Latvia.

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# OPTIMIZING HUMAN CAPITAL THROUGH THE MANAGEMENT OF INTERNAL MIGRATION

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The optimization of human capital through internal migration management is a critical factor in modern economic development and labour market efficiency. Human capital, which includes knowledge, skills, professional experience, health, and creativity, represents a dynamic resource that directly influences productivity, innovation, and social welfare [1, 2]. However, its uneven territorial distribution often creates regional disparities in economic growth, labour market balance, and social equality. This research aims to analyze the theoretical foundations of internal migration management and examine how it can be employed to optimize human capital development.

The study uses a theoretical and analytical approach, including literature review, systematization of migration management models, and analysis of state policy mechanisms affecting internal migration [3, 4]. The research focuses on three main theoretical principles: the territorial balance theory, the incentive migration model, and the reinvestment approach. The investigation hypothesizes that effective migration management promotes optimal redistribution of labor resources, enhances human capital development, and reduces socio-economic disparities across regions. Data for the study were drawn from official statistics, prior empirical studies, and case analyses, particularly focusing on migration patterns in countries with significant internal mobility, such as Uzbekistan. The findings reveal that internal migration has both positive and negative effects on human capital. Positively, migration directs skilled labour to regions with higher economic opportunities, allowing individuals to acquire new knowledge, professional experience, and social networks, while stimulating regional innovation and economic growth. Negatively, excessive migration from underdeveloped regions can result in “brain drain,” reducing the availability of qualified personnel and widening regional disparities. The study emphasizes that strategic management of migration, through targeted state policies in education, healthcare, infrastructure, and employment creation, can maximize the benefits of human capital development while mitigating adverse effects.

In conclusion, internal migration management serves as a strategic tool for optimizing human capital, promoting territorial balance, and supporting sustainable economic growth. By aligning migration flows with regional development strategies and employment policies, governments can improve workforce quality and productivity, reduce interregional disparities, and enhance national competitiveness. Effective management of human capital through internal migration is therefore essential for economic stability, social equity, and long-term innovation.

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# **DIGITAL MONITORING OF AGRICULTURAL LANDS: A COMPARATIVE ANALYSIS OF THE CASES OF TÜRKİYE AND LATVIA**

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This study aims to highlight the effects of digital transformation on agricultural productivity and sustainability by conducting a comparative analysis of applications for monitoring agricultural land using digital methods, focusing on examples from Türkiye and Latvia. Today, rising food demand and resource constraints have made the use of digital technologies in agriculture a strategic necessity [5]. A review of the literature reveals that precision agriculture applications in Türkiye are developing rapidly through the use of sensors, artificial intelligence, unmanned aerial vehicles, and automation systems; however, they have not become sufficiently widespread due to infrastructure deficiencies, low adoption rates, and financial constraints [1]. In contrast, it is noted that in Latvia, efforts are being made to overcome the challenges posed by small and fragmented land parcels through multi-agent systems and robotic solutions, and that precision agriculture approaches are supported by data-driven management processes [4,7]. While the critical importance of digitalization for rural development and economic integration is emphasized, it is stated that information gaps, inadequate infrastructure, and financing issues pose similar barriers in both countries [3,6]. It has also been demonstrated that systems based on sensor networks and data analytics increase production efficiency, but these applications have not been sufficiently adapted to local needs [2,5]. In conclusion, while Türkiye possesses a larger-scale production structure and the potential for rapid technological adaptation, Latvia exhibits a structure characterized by small-scale operations but a high capacity for technological integration. In both countries, the effectiveness of digital agriculture depends on infrastructure investments, education policies, R&D support, and the development of data-driven management systems. The study demonstrates that digital agriculture is not merely a technological transformation but also a process of institutional and political restructuring.

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# **HISTORICAL ANALYSIS OF TECHNOLOGY BUBBLES: THE AI CASE STUDY**

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The modern technology market is increasingly striving to create artificial general intelligence (AGI) - a hypothetical stage of AI development at which machines match or exceed human cognitive abilities in all areas. This has led to a massive hype around AI companies. If in 2024, the global AI market size was USD 184 billion, then by 2030, the AI market is expected to be around USD 826 billion [2]. Such enthusiasm deserves careful consideration, as similar vulnerabilities were observed in prior technology bubbles. The present research aims to find similar factors and draw parallels between the current technological breakthrough and technological bubbles in the past. To draw comparative parallels, this study examines two historical precedents: the dot-com bubble and the cryptocurrency bubble.

As emphasised by Goldfarb et al. [3], an economic bubble is a market phenomenon of extreme price fluctuations that are fuelled by irrational investor behaviour and herd mentality. The AI market is concentrated in five companies that account for 29% of the S&P 500's total value. If these companies suffer significant losses, they will impact both overall market stability and investor confidence [4]. These AI giants are currently spending money on servers and data centres, anticipating growing demand in the future. Challapally et al. [1] conclude that the practical deployment of specialized AI tools in companies is 5%, mainly due to the reluctance to adapt to new tools and the unreliability of the output results. If company adoption of task-specific AI remains unchanged, then AI giants may cut capital expenditures and the market may collapse.

A comparative analysis of the artificial intelligence boom, the dot-com era and cryptocurrency bubbles reveals a recurring historical pattern. In each case, the technology's true potential was quickly overshadowed by speculative fervour and relentless media hype. According to the definition of an economic bubble, these three events share a common characteristic - inflated market valuations without corresponding revenue [5].

The pattern repeats - when the expectation surpasses reality, a correction occurs. Consequently, the AI technology will stabilise rationally as investments pivot from overvalued trends to sustainable, value-generating use cases.

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# **FUTURE CAREER PLANS OF LATVIA UNIVERSITY OF LIFE SCIENCES AND TECHNOLOGIES STUDENTS AND THE FACTORS INFLUENCING THEM**

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The career path is an important step in everyone's life, and everyone needs to make a difficult decision about their education path and professional activity at a given stage of their life, which will further affect their role in the labour market.

An unstable socio-economic environment in Latvia has resulted in changes in the labour market over time. Since independence, the market economy has entered Latvia, followed by major changes in the labour market and education system, creating a new environment. Upon entering the EU in 2004, more opportunities for professional development and growth were opened in Latvia. Affecting both the external environment and internal labour market demand and requirements in the competences of employees changed, therefore it is important to clarify the career opportunities of graduates of higher education students and vocational guidance specialists in the labour market. From a sociological perspective, the topical nature of the topic is closely linked to changes in the future structure of society, which will be promoted by future specialists in the labour market and is necessary for research, as changes of this kind can contribute not only to changes in labour market demand, but also to the necessary competence requirements of future specialists, which form the image of a single specialist, affecting both personal factors and social factors. Students are a distinct group that share interests, goals, equal status and are combined with interactions on a regular basis. Students are a special group of society with a time limit until the end of their studies, which determine an individual's current role in society. Their career plans need to be assessed because students career choices in the run-up to the future labour market have an impact on the country's socio-economic situation in the future. The aim of this study is to examine the factors influencing student career choice decisions. Within the framework of this study, a literature review, as well as quantitative and qualitative methods will be used, including a survey questionnaire and expert interviews. The results of the study would be useful for student counsellors, parents, and universities in developing career guidance and management programs for students, in order to facilitate more informed and appropriate career choices.

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# **COLLABORATION OPPORTUNITIES IN THE ESTABLISHMENT OF A BIOREGION IN NORTH KURZEME: PROBLEMS AND SOLUTIONS**

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In contemporary society, increasing attention is paid to the need to live in harmony with nature and to seek practical solutions for sustainable development. In this context, the bioregion approach has gained significance. Although the first bioregion has already started to develop in Latvia, research on the broader development perspectives of bioregions in other regions of the country remains limited. The aim of this research is to explore collaboration opportunities in the establishment of a bioregion in North Kurzeme by identifying the main problems and possible solutions.

Collaboration is understood as a social process whose sustainability depends on repeated interaction, trust, and the balance of mutual benefits [1]. In the context of bioregion establishment, collaboration is viewed as a deliberately formed process that requires a shared goal, mutual trust, and a clear distribution of responsibilities among the involved actors. Sustainable development cannot be achieved without long-term and coordinated collaboration between these actors.

The concept of a bioregion is described as a socio-ecological approach that integrates natural systems with human activity and local governance structures [2]. This perspective emphasizes that bioregions are defined not only by geographical boundaries but also by the interaction between communities and their surrounding environment. In the context of bioregion establishment, this approach highlights the importance of community involvement and coordinated collaboration among various actors. Therefore, collaboration becomes a central mechanism through which bioregional principles can be implemented in practice.

From an analytical perspective, collaboration in bioregion establishment can be understood as a network of relationships rather than the actions of isolated actors. Actor–Network Theory highlights that collaboration involves not only individuals and organizations, but also institutions, technologies, and other non-human elements that shape interactions within the network [3]. This perspective allows bioregional collaboration to be analysed as a complex and dynamic system, in which development outcomes emerge from the interaction of multiple interconnected actors rather than from individual decisions alone.

In conclusion, the study shows that while the idea of establishing bioregions is generally supported, stakeholders differ in their understanding of how such initiatives should be developed, highlighting the complexity of the process. The establishment of bioregions involves multiple actors, including NGOs, farmers, communities, researchers, municipalities, etc. and requires shared goals, trust, and long-term collaboration.

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# **GENDER-BASED PRICE DIFFERENCES IN HYGIENE PRODUCTS AND THEIR IMPACT ON SUSTAINABLE GENDER EQUALITY IN LATVIA**

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Gender-based price differences in personal hygiene products, commonly referred to as the "pink tax", have emerged as a significant issue at the intersection of consumer economics, gender equality, and sustainability. Multiple studies confirm that products marketed to women are systematically priced higher than functionally similar products for men, driven not only by product characteristics, but also by marketing strategies, packaging design, and brand positioning [2, 3, 5]. Despite growing international research interest, no empirical academic study has examined gender-based price differences in personal hygiene products in the Latvian retail market, which defines the novelty and relevance of this research.

The research hypothesis states that statistically significant gender-based price differences exist in the Latvian personal hygiene product retail market, with products targeted at women being more expensive than comparable products for men, and that these differences negatively affect gender equality. Data on 1,610 personal hygiene products was manually collected from Latvian retail chains across four categories: deodorants, shower gels, shampoos, and disposable razors. The analysis combined bibliographic, comparative, and synthesis methods for literature review with statistical methods, including the Wilcoxon signed-rank test, Mann–Whitney U test, Spearman's rank correlation, and multiple regression analysis, as well as a consumer survey and expert interviews.

The comparable pairs analysis of 215 product pairs showed that in 91.6% of cases, prices were identical; however, in all cases where prices differed, the female-targeted product was more expensive. Multiple regression analysis identified gender as the most statistically significant price determinant, with men's products costing 0.378 EUR/unit less than women's products on average. The consumer survey revealed that while 51.2% of respondents always compare prices, gender-based price differences are not easily identified in everyday shopping, and men and older respondents are less likely to consider such pricing unfair.

The study confirms that statistically significant gender-based price differences exist in the Latvian personal hygiene product retail market. Price differences are not primarily driven by the existence of identical products at different prices, but rather by the systematically wider presence of premium-priced products in the women's product range. The study confirms the link between gender-based pricing and gender equality: the majority of surveyed consumers perceive these differences as unfair, and the findings align with SDG 5 on gender equality.

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# **PARTICIPATORY BUDGETING AS A CITIZEN ENGAGEMENT TOOL IN JELGAVA**

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Citizen participation in local governance is widely recognized as essential to democratic quality and public trust. This study examines participatory budgeting as a citizen engagement tool in Jelgava city municipality, evaluating its implementation and position relative to other Latvian municipalities.

Pevnaya describes social participation as a multidimensional phenomenon shaping not only political outcomes but also individual well-being and social cohesion [1]. This frames participatory budgeting as an expression of active civic life in which residents engage with public institutions to influence shared decisions. The legal basis for participatory budgeting in Latvia is established in the Municipal Law, which since 2025 obliges all municipalities to allocate at least 0.5% of annual tax revenues to the process [2]. The law defines a full implementation cycle: residents aged 16 and above who are declared in the municipality may submit project ideas within a set period, which are then put to a public vote either in person or electronically through the GeoLatvija.lv platform, and implemented by the municipality upon receiving the most votes [2].

The Participatory Budgeting Project defines participatory budgeting as a democratic process that gives community members direct power over a portion of the public budget [3]. This definition highlights its dual function: as a practical financial planning mechanism and as a tool for deepening democratic engagement by extending citizen influence beyond formal elections into everyday governance decisions. Marquetti traced the origins of participatory budgeting to Porto Alegre, Brazil in 1989, where it was introduced to reduce social inequality [4]. Applying document analysis to all 42 Latvian municipalities, this study finds that Jelgava's regulation places it above average in citizen engagement provisions: it offers both in-person and remote voting, a 30 day voting period exceeding that of 31 out of 42 municipalities, and a 60 day project submission period surpassing 36 out of 42 municipalities. In 2025, Jelgava allocated 80,000 euro, funding two winning projects, and doubled this allocation to 160,000 euro in 2026, exceeding the legally required minimum.

In conclusion, participatory budgeting in Latvia represents a significant step toward institutionalizing citizen engagement in local governance. Jelgava's implementation compares favourably with most Latvian municipalities, particularly in the length of its voting and submission periods. However, the absence of territorial distribution in Jelgava's regulation risks create unequal opportunities for residents of less populated city neighbourhoods. A broader structural disparity is also evident nationally: Riga's single project limit of 250,000 euro exceeds the total participatory budgets of 38 other municipalities, pointing to significant inequalities in the scale of civic engagement that different municipalities are able to offer their residents.

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## THEORETICAL ASPECTS OF CREATIVITY

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Considering the ongoing trends and changes in daily life communication, as well as the style, tone and corporate tone [1] shift, customer care and internal corporate communication is becoming more personalized and closer than it was before. Companies are expected to adapt and change the methods that have worked before, to appear more in touch with current events as well as be more creative. Due to these reasons the authors decided to explore the sociological meaning of creativity and its applications in customer care.

In order to deeper understand the applicable aspects of creativity within the customer care field, the idea of creativity itself from a sociological perspective must be analyzed. There, it can be argued that creativity is not an individualistic trait or even an achievement but rather the outcome itself, which is deemed creative due to the impact it has on the surroundings or the individuals themselves [3].

This would be true for customer care as well, as a service could not be called creative, if it had not been interpreted as such by the consumer. Therefore, it can be established that creativity is an outcome of interactions, for example, where the consumer finds the provided service creative in their opinion, based on the impact it has had on them.

To better understand how processes can be deemed creative, it must be noted that social interactions are also an important part of the creative process [4].

Thus processes can be deemed creative to the mind reflective on its past experiences, where also dialogues, actions and practices may impact the creative process and understanding of it. Similarly, in a more organizational setting creative actions can be foster innovations, and, according to Brandi & Hasse, empirical evidence suggests that employee-driven innovation is strongly influenced by the organizational culture, particularly in environments where employees' everyday creative practices and learning experiences are valued as important sources of innovation [2].

Therefore, it could be argued that employees whose creative actions are recognized are more likely to be innovative; however, this claim should be researched further.

It may be concluded that, first of all, creativity is the outcome of actions, which is deemed creative only due individual impact. Second of all, the individuals would consider something creative based on their previous experience. Third and last of all, in an organizational setting creative actions that are recognized can be used for innovation. With these conclusions in mind, creativity in customer care must be viewed as an impact based collective action.

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# THE IMPACT OF GAMES ON SOCIALIZATION, LEARNING PROCESSES AND COGNITIVE DEVELOPMENT IN THE DIGITAL AGE

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Board games are not only a form of entertainment but also an important educational tool within the learning process. They help develop various skills, such as logical thinking, problem-solving, strategic planning, and cooperation with others.

Liam Nougher describes that the concept of “solo” play in board games has been gradually gaining popularity, a trend that began to emerge during the COVID-19 pandemic [2]. The author examines data from a survey conducted among users of the BoardGameGeek website regarding solo play. The survey results indicate that this form of gameplay not only helps players better understand the rules and develop strategies but also facilitates socialization.

Mikael Souza notes that as society evolves, board games also develop and improve, gradually moving away from traditional and familiar games such as Monopoly [3]. The author conducted a small study by organizing an evening of “modern” board games for adults, asking participants to describe their impressions after each game. Based on post-game surveys, respondents reported that all games contained an element of fun, which facilitated socialization, strategy development, and a better understanding of the game rules, which also means the cognitive development.

Furthermore, a study conducted by Fatima Monteiro and Armando Souza examined whether board games could help engineering students better learn and understand a particular topic [1]. Students were asked to “play” a board game related to urban development and its sustainability. The majority of participants agreed that this method helped them gain a clearer understanding of the studied topic.

However, according to the study by Lea Martinez, Manuel Gimenez, and Eric Lambert, not only board games but also video games have a positive impact on the development of cognitive and social skills [4]. The study indicates that video games may exert a stronger influence on cognitive abilities than board games, likely because they require players to process various types of information and adapt strategies in real time.

Board games are a valuable tool for the development of cognitive and social skills, as they combine learning, strategic thinking, and social interaction. Although video games may sometimes have a stronger impact on certain cognitive abilities, board games remain an important and effective instrument for learning and development.

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# **AWA BANCHA: TOKUSHIMA'S ANCIENT FERMENTED TEA AND ITS UNIQUE CULTURAL LEGACY**

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Awa Bancha is a traditional post-fermented tea produced exclusively in the mountain communities of Tokushima Prefecture, Shikoku, Japan. Unlike green or black tea, which undergo steaming, drying, or oxidation, Awa Bancha is produced through a process of lactic acid fermentation — the same biological mechanism that transforms milk into yogurt or cabbage into kimchi. The result is a tea with a distinctly sour, earthy, and refreshing flavour profile, low in bitterness and caffeine, and unique among all tea types produced in Japan. The origins of Awa Bancha trace back to at least the Edo period (1603–1868), when farming households in the Naka River basin region of southern Tokushima began producing it for local consumption and trade. Through the Meiji and Showa eras, production declined as commercially produced green tea spread nationwide. In 2013, Tokushima Prefecture designated Awa Bancha as a traditional craft product. In 2021, the manufacturing technique was designated a National Important Intangible Folk Cultural Property, the first tea in Japan to receive this recognition, reflecting the cultural and historical significance of this ancient tradition. Beyond its sensory qualities, Awa Bancha carries profound cultural significance. Traditionally, production was a communal activity in which neighbouring households gathered to harvest, steam, knead, and ferment leaves together, reinforcing village bonds. The practice embodies the Japanese concept of *satoyama* - the sustainable co-existence of human communities with mountain environments - and is closely aligned with the zero-waste philosophy of Kamikatsu, a Tokushima town internationally recognised for sorting waste into 45 categories. Today, however, the tradition faces serious challenges: the number of active producers is estimated to have fallen to fewer than twenty, with an ageing population and declining interest among younger generations threatening the continuity of this knowledge. In response, local NPOs, young farmers returning to the craft, and growing agro-tourism interest are driving revival efforts.

Research has highlighted several health-related properties of Awa Bancha. Lactic acid fermentation produces beneficial probiotic bacteria similar supporting gut microbiome health. The tea is substantially lower in caffeine than conventional green tea. It also retains polyphenol antioxidants and yields organic acids and minerals including calcium and potassium. Awa Bancha represents a compelling niche product with export potential as a premium, single-origin specialty tea. Combined with its cultural heritage and natural production environment, Awa Bancha also holds strong potential as a driver of sustainable agro-tourism in rural Tokushima. Awa Bancha is thus far more than a regional beverage. It is a living cultural tradition — centuries old, rooted in the mountain communities of Tokushima, and deserving of both preservation and international recognition.

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# **HOW INFORMATION DISORDER AROUND NIGERIA'S FARMER-HERDER CONFLICT THREATENS NATIONAL FOOD SECURITY**

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The farmer-herder conflict remains one of Nigeria's most persistent security and social challenges. While explanations traditionally focus on land, water, and environmental pressures, this paper argues that the communication environment introduces an equally important dimension. Social media and online news platforms allow narratives about the crisis to spread rapidly, reaching audiences far beyond affected communities. This conceptual paper examines how media narratives and information disorder shape perceptions of insecurity and influence the behaviour of agricultural communities, asking how mediated narratives reshape the ways rural communities interpret risk and evaluate the viability of continued farming.

Akinrinde et al. (2021) analyze the agricultural consequences of the farmer–herder conflict and document how recurring violence has forced many farmers in affected regions to abandon their fields or relocate to safer areas [1]. Their findings highlight how insecurity disrupts planting cycles and weakens local food production. These outcomes reveal the behavioral implications of mediated fear particularly in rural communities. Repeated exposure to alarming narratives can reshape perceptions of everyday safety.

Nwankwo et al. (2020) examine the discursive construction of the farmer–herder conflict in Nigerian newspapers and observe that the crisis often appears through language that emphasizes existential threat and collective danger [2]. The study reveals that polarized labels and ethnically charged narratives deepen perceptions of social division. When considered alongside previous findings, media discourse emerges as a communicative structure that organizes public interpretations of the conflict and reinforces shared understandings of danger and identity. Sholola et al. (2025) find that mainstream coverage of the farmer-herder crisis relies heavily on fear-oriented narratives and dramatic language, with little attention given to peace-oriented communication. These framing patterns shape public interpretations of the conflict [3]. When such narratives circulate on social media, recycled images and unverified claims gain renewed reach and meaning. Media framing therefore actively constructs perceptions of insecurity rather than simply reflecting events on the ground.

This study draws on digital communication studies and human security research to examine how information environments shape rural socio-economic outcomes. Mediated narratives around the farmer-herder conflict extend fear well beyond actual sites of violence, influencing how farmers assess risk and make decisions. The result is a communication environment deeply entangled with food production, where the circulation of information directly affects rural livelihoods and national food security.

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# **READING COMPREHENSION AS A PREDICTOR OF MATHEMATICAL PROBLEM-SOLVING: A DESCRIPTIVE STUDY OF SIXTH-GRADE STUDENTS**

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Reading comprehension is broadly recognized as an interdisciplinary cognitive skill whose impact goes far beyond language arts and defines how well students can work on complex tasks in mathematics and other subjects [1]. This study examined the descriptive association between the performance of sixth-graders' reading comprehension and decimal notation problem-solving, as well as examined the possible influence of school grades, gender, ownership of personal technology, and parental background. Validated achievement tests, school records, and personal background questionnaires were used to collect data on a total of 76 sixth-grade students in a public middle school in Türkiye. Descriptive results indicated that there was a significant positive relationship between the scores of reading comprehension of students and their school grades in Turkish and mathematics, indicating that the classroom-based performance is a measure of shared competencies that are measured by standardized instruments [2]. In comparison, both gender and the possession and daily use of smartphones and tablets by the students did not have any correlation with the reading comprehension or the results of problem solving, meaning that access to digital devices without other factors does not provide any quantifiable academic benefit. Likewise, no parental education level and employment status differences were found in student achievement on either of the measures. The findings suggest that intrinsic literacy development plays a more influential role in determining the academic attainment of sixth-grade students than either demographic characteristics or technological factors. These findings underscore the critical role of the cross-disciplinary method of reading instruction focusing on reading comprehension as a tool to enhance mathematical competence during middle school.

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