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of Life Sciences  
and Technologies

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STUDENTS ON THEIR WAY TO SCIENCE  
(undergraduate, graduate, post-graduate students)  
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## **STUDENTS ON THEIR WAY TO SCIENCE**

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The conference is aimed at dissemination of scientific research results, sharing of experience, improvement of foreign language and cross-cultural communication skills, and establishing of international contacts.

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## **AGRICULTURE**

# SPRING OIL-SEED RAPE YIELD AND QUALITY FORMATION IN LATGALE

Jolanta Bule

Latvia University of Life Sciences and Technologies, Faculty of Agriculture, undergraduate, Latvia

Zinta Gaile

Latvia University of Life Sciences and Technologies, professor, Dr. agr., Latvia

Spring oil-seed rape (*Brassica napus*) is mainly grown for seed production in Latvia, but it is also used as green fodder. Rape oil by the fatty acid composition is similar to olive oil and is a valuable supplement for salad, baking and other uses [1]. Yield and quality of rape can be affected by various factors, e.g. sowing time, fertilizing, soil and meteorological conditions. Earlier sown seeds show better scores: better germination, higher yields, etc. [2]. The aim of this work was to evaluate yield of different varieties of spring oil-seed rape and their quality in Latgale. Research on spring oil-seed rape is very important because results from only few studies are documented in Latvia. The study was carried out at the "Agriculture Science Center of Latgale", Ltd in 2017. Eight spring oil-seed rape varieties (see Table) were used. The test was arranged in four replications. During the vegetation period, phenological observations were performed, as well as the plant height was measured, and resistance against lodging was evaluated. Number of plants per 1 m<sup>2</sup> was accounted before harvest, and the length of the vegetation period in days was noted. Yield was determined harvesting the whole plot and weighing the seed yield, later converting it in t ha<sup>-1</sup> at 100% purity and 8% moisture. Following quality indicators were evaluated using analyzer "Infratec<sup>TM</sup> Nova" at AS "Rēzeknes dzirnavnieks" laboratory: oil content, %, volume weight, kg hL<sup>-1</sup>. Thousand seed weight, g, was evaluated using standard method at the laboratory of "Agriculture Science Center of Latgale", Ltd. Data was processed using analysis of variance.

**Spring oil-seed rape yield and quality parameters, 2017**

Varieties	Yield, t ha <sup>-1</sup>	1000 seed weight, g	Volume weight, kg hL <sup>-1</sup>	Oil content, %	Plant height, cm
'Mosaik'	4.12	3.77	66.20	40.00	129
'Majong'	<b>4.54</b>	3.90	62.30	41.00	133
'Swifter'	3.28	3.99	66.60	<b>42.00</b>	<b>188</b>
'Sunder'	3.37	<b>4.08</b>	67.30	40.60	120
'Performer'	4.13	3.83	67.00	41.40	125
'Brander'	4.03	3.99	<b>68.10</b>	38.90	124
'Builder'	<b>4.62</b>	3.75	67.80	40.70	126
Cultus CL'	3.61	3.39	61.50	39.20	124
LSD <sub>0.05</sub>	0.28	0.08	0.25	0.08	3.44

In 2017, spring oil-seed rape showed high yields: five varieties from eight yielded more than 4 t ha<sup>-1</sup>, but the highest yields were provided by the varieties 'Builder' and 'Majong'. Variety 'Sunder' showed the highest 1000 seed weight (4.08 g), but variety 'Brander' – the highest volume weight (68.10 kg hL<sup>-1</sup>). All the varieties showed moderate oil content (at 8% moisture; the highest was that of variety 'Swifter' (42%), but also the 'Builder', which showed the highest yield, provided oil content above 40% (Table) and the 2<sup>nd</sup> highest volume weight (67.80 kg hL<sup>-1</sup>). In general, it can be concluded that the yield and quality of spring oil-seed rape showed good results in Latgale in 2017 and thus this crop can be successfully grown.

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# TEMPERATURE IMPACT ON BEANS (*VICIA FABEA*) SYMBIOSIS EFFECTIVENESS

Ernests Čakāns

Latvia University of Life Sciences and Technologies, Faculty of Agriculture, undergraduate, Latvia

Ina Alsiņa

Latvia University of Life Sciences and Technologies, Dr. biol., Latvia

With increasing sowing area of beans (*Vicia faba*) in Latvia, the interest of effective growing methods and sustainability of environment is becoming more critical than before<sup>1</sup>. In most of the cases plant seed material inoculation with microorganisms is not effective enough to grant a stable and predictable yield of this crop (Werner, Newton, 2005).

The aim of this research is to find out the temperature impact on effectiveness of symbiosis between beans (*V.faba*) and rhizobium (*Rhizobia*) bacteria, as well micorrhiza fungi by two main criteria:

1. Research vegetative growth of beans (*V.faba*) by such parameters: plant height, count of leaves, mass of roots, mass of leaves),
2. Research change of biochemical parameters (phenols, flavonoids, pigment changes in the leaves) of beans (*V.faba*) depending on temperature and use of symbionts on plants.

Research experiment has been carried out at the Institute of Soil and Plant Sciences, Latvia University of Life Sciences and Technologies. Research has been done by using fitocamera with adjustable temperature, lighting and moisture regime. For the research two varieties of beans have been used – *Vicia faba* var. *major* 'Karmazyn' and *Vicia faba* var. *minor* 'Fuego'. Experiment was held in two different regimes of temperature and lighting. For the experiment the following kinds of researched beans were used:

1. *Rhizobium leguminosarum* strain 23,
2. *Rh. leguminosarum* strain 407,
3. Mycorrhiza preparation,
4. *Rh. leguminosarum* strain 23 + mycorrhiza,
5. *Rh. leguminosarum* strain 407 + mycorrhiza,
6. In variant of control were used seeds with sterilised surface.

During the research by collecting growth increase and overview data on change of physical dimensions of plants it was concluded that no significant differences between various kinds of researched plants were observed. By analysing the data of biochemical parameters from beans (*V.faba*) using research equipment, it was found out that no essential differences have been observed by comparing results from various kinds of growth conditions of researched plants.

Based on the data collected from the research and by comparing results at different growth temperature and light regimes, as well various researched plants it has been concluded that temperature of plant growth was a critical factor for every kind of the researched plant. Temperature had a significant effect on development of beans (*V.faba*).

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# PHOSPHORUS ACCUMULATION IN SOILS UNDER DIFFERENT TILLAGE SYSTEMS

Ainis Daumanis

Latvia University of Life Sciences and Technologies, Faculty of Agriculture, undergraduate, Latvia

Ilze Vircava

Latvia University of Life Sciences and Technologies/ Institute of Soil and Plant Sciences, director, Dr. geol., Latvia

Phosphorus (P) is one of the most important plant nutrients and has important role in agriculture to achieve high yields. It is the ninth most abundant element in earth crust but in most soils plant available P is in deficit [1]. To fix the P deficit in soil farmers use mineral fertilizer, which is produced from non-renewable P rich mineral resources. Using mineral fertilizers P binds to soil and can become plant unavailable. P which is easily soluble gets only partially used by plants [2].

The aim of this study is to investigate phosphorous compounds and accumulation in soil under different tillage systems. Samples for analyses were collected in long-term from the experimental field of the training and research farm „Pēterlauki” at the Latvia University of Life Sciences and Technologies, where economic and environmental aspects of conventional and reduced tillage systems have been studied since 2009. Soils are rich in carbonates and grain-size composition is clayey-loam and loam. Soil samples were taken from eight experimental fields where half was tilled traditionally with plow and half with disk harrow. Soil samples were taken from 0–20 cm and 20–40 cm depth. Extraction was carried out with soil auger. Plant available P concentration was determined with Egner-Riehm method. Plant unavailable mineral P in clay fraction < 2  $\mu\text{m}$  was determined with X-ray fluorescence (XRF) spectrometer. The regional importance of this study is optimization of P fertilizer usage provided with knowledge about soil P resources and correct P test method application [3].

Preliminary results show pH dependence on tillage method – lower values (6–6.8) characteristic to samples from reduced tillage fields, but higher values (6.4–7.3) to samples from conventional tillage fields. The correlation between pH and plant available P ( $P_{\text{av}}$ ) was not determined, whereas  $P_{\text{av}}$  and mineral P ( $P_{\text{m}}$ ) concentration was observed with predominance in topsoil layer. The difference between topsoil and subsoil layers of P content are with high amplitude ( $P_{\text{av}}$  (topsoil/subsoil) 1.1–8.7,  $P_{\text{m}}$  (topsoil/subsoil) 1.2–4.6) and is dependent on crop rotation history and there is no direct correlation between tillage method and accumulation of  $P_{\text{av}}$  and  $P_{\text{m}}$ . Supposedly pH changes caused by tillage system in long term could indicate other P prevalence regularities. However, we believe, that long-term tillage systems in monitored fields had minor influence on soil composition by three reasons: bedrock composition, topography, climate and good agricultural practice, however pH changes in future could have influence on soil chemical composition including phosphorous.

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# MELON AND WATERMELON MALE BLOSSOM BIOCHEMICAL COMPOSITION

**Jānis Halzovs**

Latvia University of Life Sciences and Technologies, Faculty of Agriculture, undergraduate student,  
Latvia

**Ina Alsiņa**

Latvia University of Life Sciences and Technologies, Institute of Soil and Plant Sciences, Dr. biol.,  
professor, Latvia

Latvia is the farthest region in the North where it is possible to grow watermelons and melons. The seeds come from Western Europe and Asia, which are natural growing areas of cucurbits. The watermelon and melon cultivation is one of the most perspective industries of non-traditional agriculture [4]. It is possible to cultivate cucurbit plants in greenhouses and open fields in Latvia's climatic conditions [1]. Melon *Cucumis melo* L. is an important horticultural crop, and blossom yield is significant perspective for industries of fresh salad and food additive production.

During the study 500 plants of watermelons and melons were grown in the greenhouse from seeds. Melon and watermelon male blossoms were collected from plants seven times per season. The collected flowers were analyzed for their biochemical composition, such as vitamin C, total chlorophyll, dry matter and carotenoids with spectrophotometry method and titrimetric method.

The obtained results show that watermelon and melon male blossom yield contains vitamin C, total chlorophyll, dry matter and carotenoids. The melon male blossoms contain higher vitamin C amount, but watermelon male blossoms contain higher dry matter and carotenoid amount than melon male blossom material. More research is needed to develop watermelon and melon male blossom yield quantity and use in food as a new and innovative product.

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# METHODS OF SOIL CHEMICAL MODIFICATION FOR Highbush BLUEBERRY PLANTATIONS

Oskars Heimanis

Latvia University of Life Sciences and Technologies, Faculty of Agriculture, post-graduate student,  
Latvia

Aldis Karklins

Latvia University of Life Sciences and Technologies, Dr. habil. agr., professor, Latvia

Highbush blueberries are becoming more and more popular for Latvian commercial growers as well as for hobby gardeners. Therefore demand for high quality planting material is increasing steadily. Highbush blueberries (*Vaccinium corymbosum* L.) have specific requirements for soil properties important for high quality planting material production. Fen peat soils usually are the best soils for highbush blueberries. Unfortunately such soils are located in specific regions and not always are present in the proximity of the holding where the plantation of blueberries is expected to establish. Some mineral soils are also suitable for blueberry cultivation but some ameliorative measures should be undertaken. The main problems for mineral soils are high soil pH especially in places where parent material is calcareous or groundwater contains calcium and magnesium (or both). The second limitation factor is low organic matter content in soil. Normally soil pH KCl for good highbush blueberry growth is around 4.5 and organic matter content above 6% [1]. In Latvia as well as in other European countries most popular soil modification method for highbush blueberry plantations is addition of acid sphagnum peat in the surface (0 – 40 cm) soil layer [2]. It is quite expensive method and not always helps to lower pH down to desirable level. Our proposed method is the use of other materials (chemicals), which could produce the acid reaction products and lower the soil pH. Some of them are acid forming mineral fertilisers: ammonium sulphate, urea and potassium alum; the other – orthophosphoric acid used as additive to the irrigation water [3]. Our research was divided in two parts. The first part: investigation of soil properties at the farm “Gulbji”, where commercial establishment of blueberry plantation is planned. Soil samples from the farm premises were taken and model greenhouse experiments in 5 kg pots were performed. Soil was mixed with above mentioned additives and composted in 15–18°C temperature for some months. The second part of the experiment: soil samples from the farm were taken again and filled in 4 kg plastic pots. Seven variants (control + different treatments) in six replicates were made. Indicator plants (blueberry seedlings) were planted in each pot. Different soil additives may change the fertility status of the soil, e.g. soil nutrient availability, especially for phosphorus and also for nitrogen [4]. Therefore monitoring of plant available phosphorus and nitrogen was carried out during the experiment.

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# DEVELOPMENT OF WHEAT STEM BASE DISEASES DEPENDING ON CROPPING SYSTEMS

**Jānis Kaņeps**

Latvia University of Life Sciences and Technologies, Faculty of Agriculture, undergraduate student,  
Latvia

**Biruta Bankina**

Latvia University of Life Sciences and Technologies, Dr. biol., Latvia

Wheat stem base diseases are widespread and economically important. These diseases are caused by many different causal agents, mainly *Fusarium* spp. and *Oculimacula* spp., which can result in complex infection. The wide variety of causal agents makes wheat stem base disease management very difficult [1-3].

The aim of this study was to estimate the incidence of wheat crown rot depending on the soil tillage system and on the crop sequence in 2012 – 2017, except 2014. The two factorial field experiment was established at the Research and Study farm 'Peterlauki' of the Latvia University of Life and Technologies: A – soil tillage system (1 – traditional soil tillage with ploughing at the depth of 22–24 cm, 2 – reduced soil tillage with disc harrowing up to the depth of 10 cm); B – crop sequence (continuous wheat; wheat-oilseed rape; wheat-oilseed rape-barley-faba beans). The incidence of stem base diseases was assessed before yield harvest.

Level of stem base disease was influenced mainly by agroecological situation of the year. Disease incidence varied from 48.7% in 2013 to 92.3% in 2017. It is difficult to explain the variation in incidence because of the wide variation of interactions between pathogens and agrometeorological conditions. Soil tillage did not significantly impact the incidence of stem base disease. In contrast, crop sequence produced a considerable effect on disease development. The incidence of wheat stem base disease was significantly lower in variants with crop sequence, as compared to variants with continuous wheat rotation (66.3% and 75.6%, respectively). The impact of crop sequence was more pronounced in variants with minimal soil tillage.

Future investigations are necessary. The gathered data are still insufficient to make final conclusions on factors which influence wheat stem base disease development in Latvia.

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## SALEP ORCHIDS IN TURKEY

**Hatice Kübra Akgün**

Niğde Ömer Halisdemir University, Faculty of Agricultural Sciences and Technologies, undergraduate student, Turkey

**Emre Aksoy**

Niğde Ömer Halisdemir University, Faculty of Agricultural Sciences and Technologies, asst. prof. Dr., Turkey

*Orchidaceae* is the largest flowering plant family in the world. *Orchidaceae* family contains approximately 736 genera and 28000 species [1]. There are 24 genera and approximately 128 orchid taxa in Turkey [2]. Salep is obtained by collecting the tubers of approximately 120 species of tuberous orchids belonging to the genera *Aceras*, *Anacamptis*, *Barlia*, *Comporia*, *Neotinea*, *Dactylorhiza*, *Himantoglossum*, *Ophrys*, *Orchis*, and *Serapias* of *Orchidaceae* family [3]. After a few operations, tubers become a powder, which is used for making hot salep drink, drugs and traditional Maraş ice-cream. In Turkey, salep powder is obtained from 25 orchid species. Salep orchids are collected in 5 major regions of Turkey: North Anatolia (Kastamonu, Tokat), South-west Anatolia (Muğla), South Anatolia (Antalya, Mersin), South-east Anatolia (Kahramanmaraş, Adıyaman, Malatya) and East Anatolia (Van, Muş, Bitlis) provinces [3]. Salep orchids are under the threat of extinction in Turkey. Although many orchid species are protected by law in recent years, still the tubers of salep orchids are being inserted in soil [4]. In Turkey, every year 15 to 20 tons of salep powder is produced and it destroys 30 to 40 million orchids from the nature [3].

For protecting biodiversity, some efforts should be made to cultivate salep orchids, including endemic species. Some field studies and practical works should be carried out in order to cultivate salep orchids in field conditions. Thus it is necessary to prevent tuber disruption made unconsciously in nature.

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# EFFECT OF COMMERCIAL HUMIC PREPARATIONS ON THE YIELD FORMATION OF SPINACH

**Elīza Ilze Malceniece, Inita Legzdiņa, Roberts Lepsis**

Latvia University of Life Sciences and Technologies, Faculty of Agriculture, undergraduate students,  
Latvia

**Ina Alsīņa**

Latvia University of Life Sciences and Technologies, Institute of Soil and Plant Sciences, Dr. biol.,  
professor, Latvia

Humic substances are known to influence positively plant growth and nutrition [1]. Merchants offer a variety of humic preparations for plant productivity and improvement of qualitative properties [2]. The aim of the research is to evaluate the effects of these commercial humic preparations on spinach growth, development, changes in biochemical composition and crop formation.

For the trial the spinach variety 'Matadors' and the following humic preparations: ECO humin, Cytokinin Pro, Biohumus extract, Kelpak and Lignohumate were used. Trials were carried out by the 2<sup>nd</sup> year students of Horticulture during the course of Plant physiology in autumn of 2017. Trials were set up at the experimental greenhouse of the Institute of Soil and Plant Sciences. Spinach was grown in vegetation pots (volume 5 L) with 5 seedlings per pot in a mixture of peat substrate and vermiculite. The experimental crops were treated with humic preparations, but the control plants were watered by water. During the growing period, the experimental plants were treated three times with the humic preparations, and once both the experimental and control plants were fertilized with fertilizer Kristalon Orange (NPK-6-12-36). The plants were treated according to the manufacturer's recommended dosage. During growth in spinach the content of ascorbic acid and pigments in leaves, the amount of reducing sugars in plant leaves, water retention ability, plant mass, leaf number, dry matter content in leaves, FDA and dehydrogenase activity, plant leaf reflectivity were determined.

The results have shown that the use of Lignohumate and Cytokinin Pro affect the amount of ascorbic acid and reducing sugars in spinach leaves. The increase in spinach mass was found as a result of Lignohumate, Cytokinin Pro and Biohumus extract use, but the mathematical treatment of data does not substantiate the relevance of the impact. The amount of dry matter in spinach is positively influenced by the Eco Humin. The amount of pigments in spinach leaves, FDA and dehydrogenase activity were not significantly affected by humic preparations.

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# **MORINGA (*MORINGA OLEIFERA* LAM.): FAST, FEASIBLE AND MAGICAL BIO-FORTIFICATION METHOD**

**Sabina Mamedova**

Nigde Omer Halisdemir University, Faculty of Agricultural Sciences and Technologies, Department of Agricultural Genetic Engineering, undergraduate, Turkey

**Irina Sivicka**

Latvia University of Life Sciences and Technologies, Faculty of Agriculture, lecturer, Mg. agr., Latvia

Malnutrition is a major health concern in the world. 40% of pregnant women and infants have iron (Fe) deficiency anemia. One out of three women and one out of five men are affected from osteoporosis caused by insufficient calcium uptake. 11% of children are facing scurvy disease due to lack of vitamin C. A large number of the population suffering from eye diseases in the world is due to insufficient intake of vitamin A. More than 20% of children in Eastern part of the world are facing diseases like marasmus and kwashiorkor due to lower protein uptake. All these problems can be solved by a 'miracle' tree (moringa). More than 300 diseases can be treated using moringa, which leaves are bio-fortified with various nutrients. Moringa is used in different countries all over the world as an alternative treatment of the nutritional deficiencies. It is used as fresh vegetable in Pakistan. Hence, it will be a suitable alternative agricultural product to treat malnutrition. Fresh moringa leaves can be used in salads, dressings or as tea, whereas dry powder of moringa seeds or leaves can be used in baking or cooking in order to bio-fortify the food products. Additionally, moringa seeds can be used as an oil source alternative to olive oil in cooking because of the high level of protein and iron.

This plant grows very fast, so it can reach 20 cm height in 4 weeks, and a new plant can be recultivated from one seed again and again after the harvest of the previous generation. It benefits from regular pruning when young to stimulate growth, keep it bushy and keep all the usable parts within easy reach, leaves and beans for fresh consumption or drying, twigs for cuttings, collection of seed etc. It responds well to mulch, water, and fertilizer and can be used itself as a very high nutrient fertilizer. Although not harmed by frost, it can be killed to the ground in freezes. It can recover, sending out new shoots from the ground. It seems to thrive in impossible places - near the sea, in bad soil and in dry areas.

How to grow moringa in your backyard? First, measure an area of land 4.1 m<sup>2</sup> to recondition the soil in the measured area by digging 20 cm deep and mixing the soil with equal proportion of manure and filling it back into the pit. Second, water thoroughly and allow the resulting mixture to decompose for six weeks. Next, divide the pot into four beds by crossing with a piece of board. Finally, sow your moringa and harvest after 60 days of growth.

Therefore, a high yield can be achieved from cultivation of one seed in controlled conditions. The long-term outcome of this proposed project is the treatment of malnutrition problems in the world by a fast, feasible, sustainable and magical bio-fortification method.

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# DETERMINATION AND USE OF SOIL TOTAL NITROGEN IN FERTILISATION PLANNING

**Mara Mazure**

Latvia University of Life Sciences and Technologies, Faculty of Agriculture, post-graduate student,  
Latvia

**Aldis Karklins**

Latvia University of Life Sciences and Technologies, Dr. habil. agr., professor, Latvia

The European Union Nitrates Directive and Latvian regulations require considering all possible sources of nitrogen available for crops before decision is made for the use of manure and commercial fertilisers. Soil is the main source of the nitrogen pool and therefore it is important to quantify the amounts which are present in soil and which could be released in a plant available form. Researchers are using different chemical and biological methods suitable for laboratory and field conditions, but not always they give good response or many of them are unpractical for farm conditions. Therefore, an indirect soil nitrogen supply assessment methods are raising interest, because they are more practical and useful for farmers when fertiliser planning is performed [1].

The group of researchers from the Faculty of Agriculture are doing field experiments where performance of different nitrogen rates is tested for the main crops – winter and spring wheat, winter and spring rape, barley. Experiments are located in different places of Latvia where soils differ in terms of their fertility level. During vegetation soil samples were collected for determination of total nitrogen, mineral ( $\text{N-NH}_4 + \text{N-NO}_3$ ) nitrogen, soil pH and humus content. Combining these parameters with general soil indices it is proposed to develop indirect soil nitrogen supply indicators. Data from field experiments (crop yield, N content in yield, yield quality parameters) give possibility to determinate the real crop nitrogen requirement. Therefore, indirect estimates are possible to compare with the real data set. This is so called soil nitrogen apparent recovery, which afterwards is possible to use for fertiliser planning [2].

Several researchers are giving different algorithms how to use indirect calculations of soil nitrogen supply and nitrogen apparent recovery. However, these indirect methods are highly site-specific; they work only in specific conditions. Therefore it is important to develop them or at least validate using local data. One of the tasks of my research is to check its performance for local conditions using soil sample data bank of the Institute of Soil and Plant Sciences. This data bank contains hundreds of samples with analysed parameters useful for derivation of indirect soil nitrogen pool estimation.

We suppose that above-mentioned research will give the possibility to develop simple and practical method of soil nitrogen supply estimation, useful for fertiliser planning on farm level and not requiring additional complicate procedures. This will raise interest for farmers to make nitrogen planning more accurate and site-specific. Therefore, nitrogen management will give not only additional agronomic and economic value but also environmental benefits.

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# GROWTH PARAMETERS ANALYSIS OF CHAROLAIS CALVES DEPENDING ON AGE OF DAM

**Dace Meldere**

Latvia University of Life Sciences and Technologies, Faculty of Agriculture, post-graduate student,  
Latvia

**Daina Jonkus**

Latvia University of Life Sciences and Technologies, professor, Dr. agr., Latvia

The growth of beef calves on preweaning performance depends also of dam milk production [2,4]. Usually the best results from creep feeding generally occurs when calves are born to poor milking cows or first-calf heifers [2]. Researchers found that the age of dam significantly affected birth weight and the further growth and development [1,3]. The aim of this research is to analyse the weight and daily gain of Charolais calves born from different age of dam.

The research was carried out under production conditions. Calves of pure breed Charolais were born in 2017. Data of birth weight, adjusted preweaning weights at age of 30 and 90 days, and adjusted weaning weight at the age of 200 days were analysed. The average daily gain was calculated for each growth period from the birth to the age of 30, 90 and 200 days. Suckling cows in the herd calved between the end of March to the end of June. During the winter period in the cattle shed suckling cows were fed with hay and silage. In the research were analyzed the growth parameters of 29 calves born from the first parity, 13 calves born from the second parity and 29 calves born from the fourth parity. The average age of the first calving was  $26.1 \pm 0.43$  months. The average weight of suckling cows 3 months before calving were significantly different. Heifers had significantly ( $p < 0.05$ ) lower weight (683.9 kg) than cows in the second and fourth parity (respectively 780.5 and 857.5 kg).

Dams of the first parity had offspring with significantly lighter birth weight ( $p < 0.05$ ) than dams of the second and fourth parity (respectively  $49.1 \pm 0.68$ ,  $53.9 \pm 1.78$  and  $53.8 \pm 1.19$  kg). Older dams gave birth to heavier calves which also gained up faster to weaning in all growth periods than calves from younger dams. Calves born from the first parity had the highest average daily gain at the age from birth to 200 days ( $1341.4 \pm 29.80$  kg), but the lowest – at the age from birth to 30 days ( $1151.9 \pm 46.99$  kg). Comparing the second and fourth parity the highest daily gain had calves born from dams in the second parity from birth to 200 days ( $1407.9 \pm 37.68$  kg). Similar results have also been observed in another study [1, 3].

Though calves born from the first parity dams had significantly worse growth parameters than older dams, further in the growth period the significant difference between parities was not determined. This proves that a well-grown first lactation suckler cow can be milky and the live weight at weaning age of calves was not significantly different from older dams.

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# MEDICINAL PROPERTIES OF SOME *ARTEMISIA* SPECIES FROM KAZAKHSTAN

Assem Otashova

North Kazakhstan State University named after M. Kozybayev, Faculty of Natural and Agricultural Sciences, undergraduate, Kazakhstan

Irina Sivicka

Latvia University of Life Sciences and Technologies, Faculty of Agriculture, lecturer, Mg. agr., Latvia

By origin, about 40% of all pharmaceutical drugs are based on botanicals [2]. Despite the fact, that official medicine more accepts powerful synthetic medicaments, interest about medicinal plants is growing. The flora of Kazakhstan is characterized by a variety of herbal raw materials for medicine. Many of these medicinal plants can be cultivated for industrial needs. The genus *Artemisia* has a big potential in this sphere. Also extensive thickets of sagebrush, which is the common name of several species of *Artemisia* genus, are found only in Kazakhstan.

Santonica or wormseed (*Artemisia cina* Berg & C.F. Schmidt ex Poljakov), in local language “darmina”, is one of the most interesting, but not widely studied local medicinal plants. It contains santonin, a sesquiterpene lactone, which is used as an anthelmintic (for killing of parasitic worms). Leaves, stems, and buds are used in local phytomedicine. These plant parts contain from 2 till 7% of santonin [3].

Citvar or citrine wormwood (*Artemisia santonica* L.) is an endemic plant that grows in the South Kazakhstan region, in the valley of the Syr Darya river. The raw material of this medicinal plant is available and cheap. With a curative purpose, only inflorescences with buds or whole grass can be used [1]. In medicine, tinctures and salves are used as an external anesthetic for bronchial asthma, neuralgia, lumbago, gout and burns [4]. The sprouts of citvar contain essential oil (2%); the general components are cineole, camphor and carvacrol. In addition to anti-inflammatory properties, citrine wormwood has significant analgesic and antitumor properties. The compound guaiazulene has strong anti-inflammatory effect, helps to weak allergic reactions. Also plant contains cineol and darmen and has antibacterial and antiseptic properties. Citvar is used as an irritant in the treatment of rheumatism, neuralgia bronchial asthma, eczema, x-ray burns and other diseases [4].

One of the most important properties of sagebrush is the effect on the cause of the disease – it does not mask the symptoms of the disease like many drugs, but eliminates its root cause.

In Kazakhstan, the sagebrush becomes as the object of scientific research [1]. It is possible to isolate a lot of biologically active compounds. In near future the chemical studies of sagebrush will enable to create highly effective drugs with a wide therapeutic spectrum.

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# YIELD AND QUALITY CHANGES OF FIELD BEAN (*VICIA FABEA*) VARIETIES AFFECTED BY TREATMENT WITH NITROGEN FIXING BACTERIA

Artis Pakalns

Latvia University of Life Sciences and Technologies, Faculty of Agriculture, undergraduate, Latvia

Zinta Gaile

Latvia University of Life Sciences and Technologies, professor, Dr. agr., Latvia

In accordance with the European Parliament and Council Regulation No 1307/2013, since 2015 Latvia introduced Greening practices which contributed to diversification of crops. Field beans have become the most popular crop, and they are very suitable for greening in cereal-based crop rotations. Area of field beans in Latvia has increased almost 12 times during 2012 to 2016. *Rhizobium* bacteria infect the roots of leguminous plants and form nodules. *Rhizobium* bacteria supply the host plant with nitrogen, but the plant provides nutrients and energy for the bacteria [1]. It has been reported that inoculation with indigenous *Rhizobium leguminosarum* bv. *viciae* significantly increased the growth and seed yield of faba beans [2]. The aim of this research was to study changes in yield and yield quality when field beans were inoculated with *Rhizobium* treatment (RB-1) in comparison with untreated variant (RB-0). Inoculation with *Rhizobium* bacteria was considered factor A. Seven cultivars were used in this work – factor B (B1 – B7: ‘Laura’, ‘Boxer’, ‘Isabell’, ‘Fuego’, ‘Fanfare’, ‘Taifun’ and ‘Vertigo’). Two year experiment was established in well-cultivated *Endocalcaric Abruptic Luvisol*, silt loam at LLU MPS “Pēterlauki” in 2016 and 2017, but this paper analyses only the results of 2017, as the results of 2016 were analysed a year before [3]. *Rhizobium leguminosarum* strain 407 was used for inoculation (RB-1). Yield was detected directly combining the whole plot. Yield components were detected from sample sheets, and 10 randomly chosen plants from every plot were analysed. Crude protein content (CP, %) was detected by Infratec Analyser 1241, but 1000 seed weight (TSW, g) and volume weight (VW, g L<sup>-1</sup>) by standard methods. For data processing analysis of variance was used. Temperature and moisture conditions were suitable for high field bean yield formation in 2017.

Extremely high average field bean yield was obtained in 2017 (Table); inoculation showed a tendency to increase average yield, but this increase was insignificant ( $p = 0.16$ ). Similarly, yield components – pods and seeds per plant – were insignificantly increased in inoculated variant ( $p = 0.1$  and  $0.26$ , respectively). Values of seeds per pod<sup>-1</sup> and TSW were insignificantly higher in variant without inoculation, but those of VW and CP – similar (Table).

**Field bean yield, yield components and quality parameters at “Pēterlauki”, 2017**

Inoculation variants	Yield, t h <sup>-1</sup>	Pods per plant	Seeds per pod	Seeds per plant	TSW, g	VW, g L <sup>-1</sup>	CP, %
RB-0	8.90	15.29	3.35	50.81	623.19	789.93	30.20
RB-1	9.17	16.40	3.27	53.51	617.66	790.11	30.17
p-value	0.16	0.10	0.16	0.26	0.49	0.92	0.80

Conclusions are similar to those drawn a year before – inoculation with the *Rhizobium leguminosarum* strain 407 does not guarantee a significant yield and quality increase.

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# DEVELOPMENT OF WHEAT LEAF DISEASES DEPENDING ON FERTILIZATION AND SOIL TILLAGE IN CONTINUOUS WHEAT SOWINGS

**Kintija Peksa**

Latvia University of Life Sciences and Technologies, Faculty of Agriculture, post-graduate student,  
Latvia

**Biruta Bankina**

Latvia University of Life Sciences and Technologies, Faculty of Agriculture, Dr.biol., Latvia

Wheat is one of the most beneficial and widely produced crops globally, including also Latvia. An intensive wheat cropping system requires high rates of nitrogen fertilization; therefore, continuous wheat sowings and reduced soil tillage become increasingly popular in Latvia. These farming practices can increase the risk of disease development including wheat leaf diseases. Tan spot (caused by *Pyrenophora tritici-repentis*) and Septoria leaf blotch (caused by *Zymoseptoria tritici*) are the most widespread and harmful wheat diseases [1]. Development of these diseases at some point is associated with different systems of soil tillage and with the amount of nitrogen; however, this influence can vary [1], [3].

The aim of this study was to evaluate the influence of nitrogen (N) rates and soil tillage on the development of winter wheat leaf diseases.

The field trials were conducted at the Study and Research farm "Peterlauki", Jelgava, in the vegetation seasons of 2015/2016 and 2016/2017. Two-factor trials were established: A – N fertilization (eight different rates of nitrogen were applied – N0–N240); and B – soil tillage (1 – ploughing; 2 – without ploughing). Diseases were assessed every week, their severity and incidence was noted, and the area under disease progress stairs (AUDPS) was calculated.

Tan spot and Septoria leaf blotch dominated in both seasons; other leaf diseases practically did not occur. The severity of Septoria leaf blotch did not pass 3% in any of the trials, and the low level of this disease did not allow evaluating the impact of agronomic practices. Soil tillage without ploughing increased the severity of tan spot. In 2016, in plots with N0 nitrogen rate and with ploughing, the AUDPS value for tan spot reached 208, but without ploughing it was 34% higher; in plots with N180 rate and with ploughing, the AUDPS value was 180, but without ploughing – 42% higher. Whereas in 2017, in plots with N0 nitrogen rate and with ploughing, the AUDPS value for tan spot was only 12, but without ploughing – 34% higher; in plots with N180 rate and with ploughing, the AUDPS was 25, but without ploughing – 19% higher. The results showed that there were no statistically relevant differences; however, a tendency was observed that the increase in N fertilization rate decreased the level of leaf diseases.

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# FACTORS CONTRIBUTING TO DEVELOPMENT OF TAN SPOT AND SEPTORIA LEAF BLOTCH

**Terēze Stanka**

Latvia University of Life Sciences and Technologies, Faculty of Agriculture, post-graduate student,  
Latvia

**Biruta Bankina**

Latvia University of Life Sciences and Technologies, Faculty of Agriculture, Dr.biol., Latvia

Plant diseases are one of the most important reasons causing significant yield losses in crop production. It is important to understand the biology, ecology and contributing factors of diseases to limit successfully the potential damage.

Tan spot caused by *Pyrenophora tritici-repentis* is the most widespread wheat leaf disease that has caused significant yield losses since the beginning of the 21st century. Rapid appearance of the disease started after the increase in wheat sowing areas in Latvia [1]. The pathogen keeps developing and overwinters on plant residues with ascospores, which causes primary infection. During the vegetation season, it can spread by conidia several times. Many researchers have established that the severity of tan spot depends on the amount of residues on soil surface and it is promoted by reduced soil tillage in combination with continuous wheat sowings [2, 3]. Temperatures of 25–28 °C and frequent rainy days promote disease development [4].

Septoria leaf blotch caused by *Zymoseptoria tritici* is the most devastating wheat disease globally, especially in regions with frequent precipitation. In Latvia, the pathogen occurs almost every year at the early growth stages, but a significant level is reached only in years when intensive rain and wheat stem elongation take place simultaneously [1]. Some researchers have noted “at least 10 mm in 3 days” as a high risk condition. There is an impact of previous crop as well, but not as significant as precipitation [5]. The latent period of *Zymoseptoria tritici* is 3–4 weeks, but for *Pyrenophora tritici-repentis*, it is only 5–8 days [6]. Both pathogens take the same ecological niche, which explains why tan spot dominates over Septoria leaf blotch under the same optimal conditions. Compared to other wheat diseases, varieties have a minimal impact on the development of leaf blotches [5, 6].

Agricultural practice, including soil tillage, crop rotation and varieties, influences the development of wheat leaf blotch diseases. However, in various cases, meteorological conditions have proved to be more important. Research results show that it is necessary to take into account biological peculiarities of pathogens for planning disease control.

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# SOIL FERTILITY TESTING FOR FERTILIZER RECOMMENDATIONS

**Uldis Stepins**

Latvia University of Life Sciences and Technologies, Faculty of Agriculture, undergraduate student,  
Latvia

**Aldis Karklins**

Latvia University of Life Sciences and Technologies, Dr. habil. agr., professor, Latvia

Soil testing and fertility evaluation is prerequisite for fertilisation planning and crop growing. Necessity for soil testing especially for farmers located in so called highly vulnerable zones concerning the protection of waters against pollution caused by nitrates from agricultural sources is focussed also in administrative documents [2]. Different methods are possible to use for soil fertility assessment. The aim of the study is to compare two schemes offered by service providers in Latvia focussed on soil fertility testing and fertiliser use recommendations.

As it is stated in the administrative act [2] soil testing should be realised by service provider who analyses soil samples in the accredited laboratory. Other procedures, e.g. soil sampling methods, data processing and interpretation, fertilisation recommendation, etc. are out of control. Therefore several service providers are active in Latvia offering this service for farmers and using rather different approach and strategy. Of course, for a farmer the final goal from the practical point of view is to obtain the highest possible yield with good quality parameters by spending minimum resources – e.g. fertilisers. In such situation agronomic, economic and environmental consequences will be reached [4].

For comparison of above mentioned consequences two service providers were selected to test the soil fertility status and, based on the obtained results, draw recommendations for fertiliser use in the selected fields of the farm *Stoli* Saldus district. Afterwards field was divided in two parts and in each part the fertilisers were applied according those recommendations. Faba bean was the crop grown in 2017 and the yield quality was tested after harvesting. Several agronomic, ecologic and economic parameters (plant nutrient removal and balance, crop response to fertilisers, NPK utilisation rate, and cost analysis) were calculated and evaluated.

The first service provider was State Plant Protection Service which has been providing soil fertility assessment already since 1950-ies using methodology recognized by Ministry of Agriculture [1]. The second service provider was *SIA AGRICON* operating in Latvia recently [3]. Both service providers offer relatively different approach, methodology as well as final result in terms of fertiliser quantity and composition recommended for use on the same field.

The fertiliser norms recommended by *SIA AGRICON* were significantly higher including also use of lime and magnesium, and therefore were much more expensive. Despite the differences in the fertiliser use the obtained yield was quite similar: 3.941 and 3.536 t ha<sup>-1</sup>.

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# LUPIN SEEDS FOR PIG FATTENING

Nelda Žentiņa

Latvia University of Life Sciences and Technologies, Faculty of Agriculture, undergraduate student.

Latvia

Lilija Degola

Latvia University of Life Sciences and Technologies, Dr.agr, asoc. professor, Latvia

Most of farms use soya beans for pig fattening. Soybean meal is widely available feed for pigs. It has high biological value and digestibility, and considerable energy content. However, in recent years, soybean meal has become very expensive, but pig price what farms get for 1kg is very variable and sometimes it may not make profit. That's why farmers are looking for alternative protein source for pig fattening. One of the alternatives is lupin seeds, what is valuable source of protein and it's cheaper than soybean meal.

The aim of the research is to evaluate the effect of lupin seeds in pig diets on performance of pigs, carcass and meat quality.

For the research pigs were divided in two groups; in each group were ten pigs which were selected from the same breed piglets. Three weeks after weaning, piglets started to feed with different protein source meals. One pig group was fed with soybean meal (SBM) and the other with lupin seed meal (LSM). Every week pigs were weighed, taken control of weight gain and amount of eaten feed.

The results showed that daily live weight gain in the first stage for SBM pig group was  $468 \pm 5.37 \text{ g d}^{-1}$ , but for LSM pig group was  $419 \pm 5.61 \text{ g d}^{-1}$ , and showed significant ( $p < 0.05$ ) difference. The daily live weight gain in the second stage for SBM pig group was  $885 \pm 4.1 \text{ g d}^{-1}$ , for LSM pig group was  $831 \pm 3.5 \text{ g d}^{-1}$  and the difference was not significant. The fattening period to get 100 kg live weight for SBM pig group was 58 days, but for LSM pig group it was six days more - 64 days. Pig carcass indicators: muscle area, for SBM pig group was  $53.6 \text{ cm}^2$ , but for LSM pig group it was  $52.7 \text{ cm}^2$ ; internal fat for SBM pig group was 1.2 kg, but for LSM pig group it was more than 0.5 kg. Total fat content in *longissimus* muscle was  $1.9 \pm 0.1\%$  and  $2.0 \pm 0.1\%$ , but protein content was  $22.4 \pm 0.5\%$  and  $21.8 \pm 0.5\%$ , respectively for SBM pig group and LSM pig group. Feed consumption for 1kg of live weight gain for SBM pig group was 3.9 kg and for LSM pig group 4.2 kg. Feed costs for the production of 1kg of live weight gain for LSM pig group was greater by 0.10 EUR than for SBM pig group.

In the conclusion it is possible to say that lupin seeds may be replaced by soybean meal in diets fed to fattening pigs in the second stage not affecting negatively pig performance, but in the first stage (growing period) the lupin seeds significantly lowered growth indices of pigs ( $p < 0.05$ ). Carcass indicators showed a tendency to accumulate more fat tissue in the pigs, which consumed lupin seed in the feed.

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## **VETERINARY MEDICINE**

# CONCEPTS AND CLINICAL APPLICATIONS FOR THERAPEUTIC PLASMA EXCHANGE AND PLASMAPHERESIS IN VETERINARY MEDICINE

**Marks Albovs**

Faculty of Veterinary Medicine, Latvia University of Life Sciences and Technologies,  
undergraduate student, Latvia

**Aija Ilgaža**

Latvia University of Life Sciences and Technologies, professor, Latvia

Therapeutic plasma exchange (TPE) is an extracorporeal hemocorrection used in both human and veterinary medicine which aims to change protein, water-electrolyte, enzyme and qualitative and quantitative gas capabilities in the case of some pathological syndromes, clinical disorders or exogenic intoxications.

Plasmapheresis falls is a subset of apheresis, which means, “to take away” in Greek. Apheresis is an extracorporeal therapy in which blood is removed from the patient’s circulation and separated into its various components. TPE means the plasma is separated and discarded from the patient in the extracorporeal circuit, then subsequently replaced with another solution such as donor plasma, crystalloid fluids, colloids, or human serum albumin. Plasmapheresis means the plasma is separated and discarded via an extracorporeal circuit without the use of a replacement solution. [1. 3.] For this reason, when creating a patient treatment plan using plasmapheresis, the goal is often to remove less than 15% of the patient’s total plasma volume. [2] In veterinary medicine, TPE is predominantly used, as the goal is often to remove a large percentage of the patient’s plasma which therefore needs to be replaced with another solution to maintain hemodynamic stability and oncotic pressure. Two distinctly different techniques can be used to perform TPE (centrifugal and membrane filtration). [1., 4.]

The objective of this research was to increase veterinary awareness of this type of extracorporeal therapy. In the future, this method of extracorporeal therapy could be adopted in Latvia.

In summary, this method is very popular in many advanced countries and Latvia should use it as well. Latvian doctors have already tried to adopt it, but have stopped due to reasons which must be ascertained.

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## MARE PREGNANCY DETERMINATION WITH ATRAUMATIC METHODS

**Amanda Astra**

Latvia University of Life Sciences and Technologies, Faculty of Veterinary Medicine, undergraduate,  
Latvia

**Aija Ilgaža**

Latvia University of Life Sciences and Technologies, Professor, Dr.med.vet., Latvia

An early and accurate diagnosis of pregnancy in mares plays a critical role in determining her reproductive efficiency during a given breeding season. Once diagnosed pregnant, the mare can be monitored for continued appropriate embryonic growth and development. Pregnancy can be diagnosed by a veterinarian performing cervical examination, rectal palpation or transrectal ultrasonography (further „manipulations”) [1]. Veterinarian has to physically involve in mares organism by performing these manipulations, that can cause stress and affect pregnancy. We cannot eliminate the fact, that these manipulations can traumatize not only mare, but also veterinarian. Hormonal diagnosis is alternative method to detect pregnancy after questionable manipulation results. It could be atraumatic method to determine if the mare is in foal, if hormones can be detected in body fluids.

Hormones are usually determined in plasma. However, blood sample collecting physically affects mare, can cause stress and negative affect pregnancy. All before mentioned methods are traumatic to mare. It is known that by the urine sample it is possible to acknowledge the physiological changes including pregnancy, because pregnancy hormones can enter urine, its presence can be found in sample. Human pregnancy tests are profitable and easily used, because test is based on atraumatic collected urine sample. By using these tests, it would be possible for owners to determine pregnancy „at home” without help of veterinarian and causing stress. In addition, it would be much more profitable than visit by veterinarian. Collecting urine can cause trouble, considering mares metabolic processes and unpredictability of urination. Progesterone (P4) is one of the hormones that helps maintain pregnancy [2]. In blood only 1 to 15% of P4 is in its unbound or biologically active form. The remaining P4 is bound to serum proteins. Unbound P4 can enter the saliva via intracellular mechanisms, and the majority of P4 in saliva is not protein-bound [3]. Correlations obtained between plasma and salivary levels measured in the same subjects have generally been quite high [4]. When P4 level increases in blood, it also increases in saliva, therefore it is allowed to claim that progesterone can be detected in saliva.

Use of pregnancy tests would be safer, more profitable and easier way to detect if the mare is in foal, it would not cause stress, which has a very significant affect on pregnancy.

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# MICROBIOLOGICAL CONTAMINATION OF DRINKING WATER FROM WELLS AND BOREHOLE IN VILLAGES

**Zane Baļuka**

Latvia University of Life Sciences and Technologies, Faculty of Veterinary Medicine, undergraduate student, Latvia

**Anda Valdovska**

Latvia University of Life Sciences and Technologies, Faculty of Veterinary Medicine, professor, Dr.med.vet, Latvia

European Union and Latvian legislation sets the minimum safety and quality requirements for drinking water, but does not provide for control of water obtained at separate extraction sites for use by less than 50 people. However, not all residents of Latvia use a centralized supply of drinking water. It is known that unpolluted water is a good guarantor of public health.

Therefore, the purpose of the study was to determine the microbiological contamination of drinking water used in villages and to determine the antibiotic resistance of isolated bacteria. For research, samples of drinking water were obtained in November and December 2017 in 23 different places in several villages in Latvia.

The presence of *Escherichia coli*, coliform and intestinal enterococci in drinking water was determined using the membrane filtration method in accordance with the requirements of LV EN ISO 9308-1: 2014, LV EN ISO 9308-2: 2014 and LV EN ISO 7899-2: 2006. Antibiotic resistance to isolated microorganisms was determined using the Kirby-Bauer disc diffusion method. Antimicrobial resistance to *E. coli* and coliforms was determined against ampicillin (AMP10), amoxicillin with clavulanic acid (AMC30), cefotaxime (CXT30), trimethoprim – sulfamethoxazole (SXT25), gentamicin (GEN10) and tetracycline (TET30), and enterococci – instead of tetracycline, against vancomycin (VAN30).

The study examined 27 water samples, of which only 22% (6/27) of the samples, in addition to the borehole (water), were generally required according to the mandatory microbiological requirements for drinking water. It is important that in 28% (6/21) of the samples there were discrepancies in all three parameters (*E.coli*, coliform and enterococci) tested, 28% (6/21) of the samples in *E.coli* and coliforms, but only 14% (3/21) in samples of coliforms and enterococci and 23% (5/21) in samples of coliforms. Sixty percent (9/15) of borehole water samples, as well as all 12 tested well water specimens, were not suitable for microbiological criteria.

Antimicrobial resistance results showed *E.coli* resistance in 100% of cases against AMP10, 88% against AMC30, and 50% against CTX30 and SXT25. Coliforms showed the highest resistance against AMP10 (62% of cases), while the gene CTX30 showed resistance against enterococci (88%) and GEN10 (38% of cases).

In conclusion, the presence of antibiotic-resistant microorganisms in drinking water used in the environment of the inhabitants of Latvia indicates serious environmental pollution, which may adversely affect the health of consumers.

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# EPIDEMIOLOGY OF OCULAR DISORDERS PRESUMED TO BE INHERITED IN EXAMINED PUREBRED DOGS IN LATVIA

**Marta Barbara Bergmane**

Latvia University of Life Sciences and Technologies, Faculty of Veterinary Medicine, undergraduate,  
Latvia

**Līga Kovaļčuka**

Latvia University of Life Sciences and Technologies, Asoc.prof., Dr.med.vet. Dipl. EESVO, Latvia

Ocular disorders, proven or presumed to be inherited in purebred dogs, have been a topic of interest by diplomates of the American and European Colleges of Veterinary Ophthalmologists for many years. [3] Hereditary eye diseases can significantly affect animal health, vision and welfare. Veterinary ophthalmologists and breeding clubs share an interest in standardized ophthalmic examination as a tool to evaluate prevalence and incidence of hereditary eye diseases and exclude non-treatable, painful or vision affecting diseases in animals used in breeding [2]. An ocular disorder is defined as "presumed to be inherited" values as suspected to be inherited, but does not represent potential compromise of vision ("breeder option") and diseases where evidence supports a potential compromise of vision: for example, cataract, glaucoma and retinal diseases (option – "No"). [1]

A routine eye certification includes slit lamp biomicroscopy, tonometry and indirect and direct ophthalmoscopy following pharmacological dilation of the pupils. Gonioscopy, Schirmer tear tests, electroretinography, ultrasonography and gene tests can be performed additionally. [3]

1180 eye certificates from 2013 to 2016 were processed and analysed. In 2013 there 431 breeding animals, 293 animals in 2014, 289 in 2015: and 167 in 2016. Eye certificates include information about the animal, owner and the results of the ophthalmologic examination were processed to obtain statistical data.

In 2013, breeds examined included Pomerians (39), Yorkshire terriers (34), and Chihuahuas (31). In 2014, Chihuahuas (40), Pomerians (35), Yorkshire terriers and Pugs (19) were examined. In 2015, Pomerians (31), Australian Shepherds and (19) Samoyeds (17) were examined. In 2016, Toy terriers (18), Chihuahuas (17), Pomerians (15) were examined. In a four-year period, the most frequent pathologies were: distichiasis (2013-55; 2014-39; 2015-31; 2016-15), cataract (2013-19; 2014-7; 2015-2; 2016-3), entropion (2013-10; 2014-10; 2015-3; 2016-0), and pigmentary keratitis (2013-9; 2014-6; 2015-3; 2016-0). The most frequent reasons for exclusion from the breeding process were: cataract; dry eye syndrome; pigmentary keratitis, and a mix of pathologies in one animal.

It was concluded that eye certification and exclusion of presumably sick animals significantly increases the breeding quality of pedigree dogs and prevents animals from suffering from non-treatable, painful and blindness-causing diseases. Still, there are many dog and cat breeds in Latvia that do not undergo eye certification and are not under genetic control. Eye certification and statistics of the results are important to improve breeding quality and to give a new breeding strategies for Kennel clubs.

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## MASTITIS HP3 PCR KIT SENSITIVITY

**Endija Maraka**

Latvia University of Life Science and Technologies, Faculty of Veterinary medicine, undergraduate student, Latvia

**Andris Balins,**

LLU Scientific Laboratory of Biotechnology, post-graduate, Latvia

**Anda Valdovska**

Latvia University of Life Science and Technologies, LLU Scientific Laboratory of Biotechnology; Latvia University of Life Science and Technologies, Faculty of Veterinary medicine, Institute of Food and Environmental Hygiene, Dr. med. vet., Professor, Latvia

Mastitis is inflammation of the mammary gland and udder tissue, and is a major endemic disease of dairy cattle. It usually occurs as an immune response to bacterial invasion of the teat canal by a variety of bacterial sources present on the farm, and can occur as a result of chemical, mechanical, or thermal injury to the cow's udder [1]. It is an important disease for milk farmers in Latvia. If cows have mastitis, then milk production can decrease by up to 7% [2].

In the research, 6 farms were studied in which dairy cows are between 51 and 700 and individual samples for cows which have clinical mastitis. In each of the farms bigger than 50 animals, samples were taken from 15 % of dairy cows. Samples were collected in plastic or glass sterile 10 mL tubes. All 155 samples were kept in a freezer at -18° C until investigation. Analyses were made using real time PCR and special new mastitis kit (bactotype Mastitis HP3 PCR kit) which is made by QIAGEN in Germany. 14 of the samples were tested with two methods: classical bacterial and real time PCR.

From all the samples 29 (18.70%) tested positive. The most common pathogenic bacteria was *Staphylococcus aureus*, found in 18 samples (11.61%). Some samples had 2 pathogenic bacteria *S. aureus* and *Streptococcus agalactiae* - 5 samples (3,22%). In 2 samples (1,29%) we found *Mycoplasma bovis* and 9 samples (5.80%) *St. agalactiae* was found. In large farms with more than 300 animals, invasion was 3.28%; but at some farms with under 100 animals, invasion was 2.32%.

In conclusion, Mastitis HP3 PCR kit is as sensitive in large farms as in small farms. The most common pathogenic bacteria in mastitis milk was *S. aureus*. Results of individual milk samples were similar regardless of the method of analysis.

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# PRINCIPLES OF WELFARE ASSESSMENT OF FARMED SALMONIDS IN LATVIA

**Anete Niemi**

Latvia University of Life Sciences and Technologies, Faculty of Veterinary medicine, undergraduate student, Latvia

**Ruta Medne**

Latvia University of Life Sciences and Technologies, Dr.med.vet., Latvia  
Institute of Food Safety, Animal Health and Environment "BIOR", Latvia

In recent years, welfare of farmed finfish has become an increased concern, because there is evidence that finfish can also feel pain, fear, distress, like other vertebrates [4]. The concept of animal welfare is based on five freedoms, which can be measured as direct and indirect welfare indicators [3]. The most important indirect indicators for finfish welfare are environmental conditions – oxygen level, temperature and stocking density [1]. High stocking density can cause feed competition, but very low stocking density can result in territoriality [3]. Direct indicators are fin erosion and operculum shortening [1]. Fin erosion is considered to be an important measurement of welfare of the finfish, but operculum function is to protect gills. Its shortening can lead to decreased oxygen intake and reduced life span [5].

In this research, environmental conditions were evaluated (oxygen level, temperature, stocking density) and two major disturbance factors of farmed salmonids were studied in particular: fin erosion and shortening of operculum. The first assessment in 5 salmonid farms in Latvia was made in March-April 2016 and was followed by reassessment in April-May 2017. In each visit, environmental conditions were evaluated. Oxygen levels were measured with oximeter and temperature with water thermometer. For individual evaluation, 100 Atlantic salmon (*Salmo salar*) or sea trout (*Salmo trutta*) parrs were weighed and measured and condition of fins was examined. Fin erosion was evaluated on a scale from 0 to 3, according to the severity of the damage [2]. Operculum was evaluated as healthy (fully covers gills) or shortened. The gained data was processed with *Microsoft Excel*.

Results show that oxygen levels (70...94%) and temperature (+0.1...+6.4°C) were normal in all fish farms, but stocking density was above the standard level (<22kg/m<sup>3</sup>) in 4 out of 5 fish farms in 2016 and 2017. In 2016, the most severely damaged was the dorsal fin. Scores ranged from 0.87 to 2.18. In a comparison, the anal fin was scored from 0 to 0.1. Operculum shortening was in a range from 4 to 44%. In 2017, the most damage was detected in the dorsal fin, where the range was from 0.57 to 2.65, but the anal fin was scored from 0 to 0.24. Operculum shortening range was from 1 to 55%.

In conclusion, environmental conditions – oxygen and temperature – were normal, but stocking density was above the standard level. In fish farms, where stocking density was higher than 22m<sup>3</sup>, fins were more damaged. High stocking density can have an impact on fish welfare. There was no correlation between stocking density and operculum shortening.

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# PROTOCOLS FOR SUCCESSFUL MULTIPLE OVULATION AND EMBRYO TRANSFER IN GENOFOND COW IN LATVIA

Guna Ringa-Karahona, Andris Grasbergs

Latvia University of Life Sciences and Technologies, Faculty of Veterinary Medicine, doctoral student, undergraduate, Latvia

Ilga Šematoviča

Latvia University of Life Sciences and Technologies, Faculty of Veterinary Medicine, Dr.med.vet., docent, Latvia

Multiple ovulation and embryo transfer (MO and ET) was developed to increase the amount of offspring from genetically valuable female animals (Mikkola, 2017). MOET allows for the multiplication of small fragmented populations of wild endangered species or domestic breeds (Comizzoli et al., 2000). There are many important factors which must be considered for successful MOET in cows (Mikkola, 2017; Marie, 1999).

In frame of the ERAF project Nr. 1.1.1.1/16/A/025 “Latvian Brown and Latvian Blue cow gene pool conservation using embryo transfer and related biotechnologies,” MOET should be done even in cows which are not candidates to become donors. Many gene fond (GF) cows in Latvia are in age, they are housed in small farms without calculated feeding rations, and these conditions may have an important role for reproductive inaccuracies. There is much useful advice and suggestions available regarding appropriate selection of donors and recipients of the MOET process.

The aim of this work was to create appropriate protocols to facilitate the MOET process in GF cows and thereby make suggestions for future work.

No one preparation of FSH for cattle is registered in Latvia. Therefore, PMSG was used, despite not being popular nowadays (Mikkola, 2017). PMSG protocols were found through consultations with professors from Estonia and Latvia who used them more than 30 years ago. Protocols were also used to evaluate cows' housing conditions (Liepa, Sematovica, 2017). Other protocols were created using data from our first visits in cowsheds. Health examinations were performed in donor cows and recipients were evaluated before the synchronisation: before the inducing of MO, in flushing and ET day. All the available protocols found in the literature were elaborated for routine work in MOET stations. Though they were found to not fit to the required conditions, they can be used for embryo evaluating, packing, freezing and thawing.

The conclusion of this review is that systematised protocols and questionnaires simplify the acquisition of data and help to organize and archive information of GF cow health and MOET results.

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## **FOOD SCIENCE**

## LYSOZYME ACTIVITY IN RIPENED CHEESE

Līga Baumane

Latvia University of Life Sciences and Technologies, Faculty of Food Technology, postgraduate student,  
Latvia

Inga Ciproviča

Latvia University of Life Sciences and Technologies, Faculty of Food Technology, Dr.sc.ing. Latvia

Egg white lysozyme is desirable as a food preservative mainly because of low toxicity, specific activity against *Clostridium tyrobutyricum*, which caused late blowing, especially in Swiss type cheeses, low effective usage level and low impact on cheese sensory qualities [2]. For the use as a food additive, it is produced from hen egg white, which contains the highest natural amounts of this enzyme (about 3.5% of the total protein content). However, lysozyme entails allergy risks representing one of the egg allergens besides the major hen egg white proteins ovalbumin, ovotransferrin and ovomucoid [3].

The aim of the work was to determine lysozyme activity during the production and ripening process. In the research Maasdam cheese with lysozyme addition was studied. Cheese was made using cow's milk, starter cultures (C352, PS-60, LH-B02 (Chr. Hansen)), coagulation agent Chy Max M (Chr. Hansen) and calcium chloride. Lysozyme was added before the starter in both cases. Cheese was ripened in 3 stages – 1 week at 12 °C, 3 weeks at 20 °C and 1 week at 12 °C, relative humidity 75–80%. Brine concentration was 20%, the duration of salting 1 hour.

Lysozyme was determined by turbidimetric method using UV/Vis spectrophotometer Jenway 6705 (wavelength 540nm).

The analyzed original cow's milk sample contains antibacterial protein lysozyme. Lysozyme content in cheese before salting ( $393.71 \pm 13.637 \mu\text{g}$ ) is higher than milk ( $121.57 \pm 7.071 \mu\text{g}$ ). This is due to the fact that lysozyme bonds with  $\alpha$ -casein, less with  $\beta$ -casein and not at all with  $\kappa$ -casein. Approximately 90% of lysozyme concentrates on cheese curd surface, that is why lysozyme is stable in all ripening process [1].

During the ripening process, the content is higher than at the beginning of the ripening process. After 4 weeks, lysozyme content increases about 7.5% ( $425.86 \pm 2.021 \mu\text{g}$ ). This is due to the fact that water evaporates out of cheese surface, and lysozyme becomes more concentrated.

Lysozyme content in cheese after salting ( $356.57 \pm 8.213$ ) is less than before ( $393.71 \pm 13.637 \mu\text{g}$ ). This is due to the fact that high salt concentration enhances the activity of lysozyme. Optimal content of salt concentration in cheese for successful lysozyme activity is 0.01–0.05 M [1].

The obtained results prove that during salting process part of lysozyme go through the cheese surface and are left in brine. Lysozyme concentration of brine before salting is less ( $14.42 \pm 1,010 \mu\text{g}$ ) than after ( $27.29 \pm 9.596 \mu\text{g}$ ). To avoid the allergy risk, cheese with and without lysozyme addition need to be salted in separate brines.

Sweet whey after curd processing contains lysozyme ( $20.57 \pm 4.041 \mu\text{g}$ ). This is the main reason why cheese producers in Latvia avoid using lysozyme in Swiss and Gouda type cheese production and search other alternatives against the influence of *Clostridium tyrobutyricum*.

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## USE OF MILLET FLOUR TO PREPARE BISCUIT DOUGH

**Tatjana Bazhenova**

St. Petersburg State Polytechnical University, post-graduate student of The Graduate School of Biotechnology and Food Technologies, Russian Federation

**Irina Bazhenova**

St. Petersburg State Polytechnical University, Ph. D. in Engineering sciences, associate professor, The Graduate School of Biotechnology and Food Technologies, Russian Federation

Presently, a lot of attention is paid to prevention of alimentary-dependent diseases, including coeliacia [1]. Therefore, the search for new gluten-free feedstock is essential. We have developed recipes and the technology of ground corn products based on millet flour.

technological and physical and chemical properties of millet and the derivative products allow to use this crop for cooking ground corn products. The composition of millet flour allows to use it as an alternative food source without the decrease of biological value of the final products. The proteins of millet are not capable of forming gluten, and it limits the use of millet flour. However, millet flour can be used for creation of gluten-free flour mixtures. In this research the testing of experimental recipes of biscuit products with partial or full replacement of wheat flour with alternative types was conducted.

Within the research, the analysis of viscosity of biscuit dough was conducted for six experimental samples. Rheologic characteristics of samples of biscuit dough, takes right after the finish of mixing, was determined with a rotary viscometer "Rheotest-2". The tangential stress  $\Theta$  was determined by a standard method depending on the constant values of sliding velocity  $\gamma$  with the temperature  $20 \pm 2$  °C. with the increase in content of millet flour the decrease of efficient viscosity was observed, which also influenced the quality of the final products. the particles of the disperse phase (air bubbles) extended more intensively at baking, which resulted in the increase of volume and porosity of the final product.

Organoleptic evaluation of the final products made of biscuit dough revealed the optimal variants of combining the flour to produce quality gluten-free products. According to the expert opinion, the combinations of millet flour with soy flour in the ratio 75:25, soy flour with rice flour in the ratio 75:25 and the sample produced with the use of millet flour only, were recognized as the best. High parameter values were also observed for the mixture of millet, rice and gram flour in the ratio 50:25:25.

The measurements of porosity, density, alkalinity and absorptivity of the baked products were conducted for each experimental sample. The data obtained allow to make a conclusion about the possibility to enlarge the assortment of products made of biscuit dough of all 6 variants presented.

Optimal doses of different flour types of gluten-free materials, allowing to enlarge the assortment of biscuit products of special purpose keeping the structural and mechanic and organoleptic quality values of traditional products, were theoretically grounded and confirmed by practice within the research.

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# EFFECT OF HIGH PRESSURE PROCESSING ON THE QUALITY OF STRAWBERRY

Lachinkhanim Huseynli

Latvia University of Life Sciences and Technologies, post-graduate, Azerbaijan

Jalpa Ratiya

Latvia University of Life Sciences and Technologies, post-graduate, India

Asnate Kirse and Ruta Galoburda

Latvia University of Life Sciences and Technologies, *Dr.sc.ing.*, Latvia

High hydrostatic pressure (HHP) offers an alternative potential non-thermal preservation method for pasteurization of food products [1].

The present study was undertaken to assess the effect of high-pressure treatment on physical sensory and microbiological properties of fresh strawberry.

Strawberries were processed at 600 MPa for 4, 8, and 12 min at ambient temperature and subjected to microbial testing, instrumental colour and texture analysis, and sensory analysis within 30 minutes of processing.

Preparation of test samples, initial suspension and decimal dilutions for microbiological examination was carried out according to ISO 6887-4:2017. 90 ml 0.85% saline was added to 10 g sample of fresh/processed strawberries in a stomacher bag; then the sample was homogenized with a stomacher BagMixer400 (Interscience, USA) for 30 seconds. After preparing serial decimal dilutions of the homogenate, total viable counts were determined on Nutrient Agar (Ref. 01-140, Scharlau, Spain) with incubation at  $30\pm 1$  °C for  $48\pm 3$  h. Colonies were counted using automated colony counter aCOLyte (Topac Inc., USA) as colony forming units (CFU). The colour of strawberries was measured using Color Tec PCM colorimeter (Accuracy Microsensors, USA). Strawberry firmness was determined with Texture Analyzer *TA.HD Plus* (Stable Microsystems, UK) using 5 mm diameter stainless steel flat end probe P/5. Pre-test speed -  $10\text{ mm s}^{-1}$ , test speed -  $0.2\text{ mm s}^{-1}$ , post-test speed -  $10\text{ mm s}^{-1}$ ; penetrating distance - 4 mm into the fruit, trigger force – 0.05 N. Sensory evaluation was conducted by 10 consumer panellists using line scale (ISO 4121:2003); such parameters as aroma, colour, and texture were tested.

The results showed that fresh strawberries contained  $2.94\times 10^3$  CFU  $\text{g}^{-1}$ , 4 min sample -  $6.9\times 10^1$  CFU  $\text{g}^{-1}$ ; 8 min sample -  $1.9\times 10^1$  CFU  $\text{g}^{-1}$  and 12 min sample -  $2.0\times 10^1$  CFU  $\text{g}^{-1}$  aerobic and facultative anaerobic, mesophilic bacteria. The results of instrumental analysis were examined in correspondence to sensory data. The panellists pointed out that only fresh strawberries had a typical light red colour, whereas all processed samples had a dark red colour. Colour analysis showed that  $L^*$  value of fresh strawberries was 37.3, but for processed samples it was  $25.9\pm 0.5$ , however there were not significant differences for  $a^*$  and  $b^*$  values. According to panellists, strawberries showed a reduced hardness as follows: fresh > 600 MPa 8 min > 600 MPa 12 min > 600 MPa 4 min. The results of the texture analysis showed that fresh strawberries were the firmest ( $2.01\pm 0.6$  N), whereas the softest sample was processed for 4 min ( $0.32\pm 0.2$  N). Only fresh strawberries had the typical fruity aroma, while processed strawberries were characterised by having a noticeable off-aroma.

The results of the study showed that HPP works very well on the reduction of microbial contamination in strawberry, as it was possible to obtain around 2 log reductions after processing. However, HPP had a negative effect on texture, aroma, colour of fresh strawberry, therefore this processing method should not be applied to fresh strawberry because of unsatisfactory quality after processing.

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# INFLUENCE OF TEMPERATURE ON CHEMICAL AND PHYSICAL PROPERTIES OF MEAT

Ingrida Jeruševičiūtė

Alytus College/University of Applied Sciences, the Faculty of Management and Engineering,  
undergraduate student, Lithuania

Dalia Šablevičienė

Alytus College/University of Applied Sciences, Dr.sc. ing, Lithuania

At low temperature, the preservation of foodstuffs is one of the best ways of their storage, and therefore this method is widely used in meat industry. Low temperature suppresses the activity of microorganisms and tissue ferments. Therefore the meat preserved by freezing keeps its initial properties for a long time, and there are only minimal changes of food value and taste.

Meat quality assessment is based on chemical and physical characteristics of the meat [1]. The physical characteristics of the meat are evaluated according to the following indices: coloring, L \* - brightness (48-58) a \* - pinkness (7.0-11.0) b \* - yellowness (6.0-9.0), acidity pH (5.5-5.9); water consistency, in percent (60-65); hardness of the meat (softness) kg/cm<sup>2</sup> (0.7-2.0); percentage loss of meat cooking (19-30); meat marble is evaluated visually (lean muscle fiber and fat content).

Meat chemical properties are evaluated according to the following parameters: dry matter content, protein content, fat content, and minerals content [2]. The proportion of pork fabrics is as follows: muscle 39-58 per cent, fat 15-45 per cent, connective tissue 6-8 per cent, bone and cartilage 10-18 per cent, blood 0.6-0.8 per cent. But it depends on the weight of the carcass and on the variety. The carbohydrate is the most nutritional part of the muscle. It is found in 72-80 per cent water, 16.5-20.9 per cent protein, 1.0-1.7 per cent nitrogen extracts, 0.7-1.4 per cent without azotone extracts, 2-3 per cent lipids, dry matter 22-28 per cent and 1-1.5 per cent minerals. From proteins that make up about 80 per cent of the dry matter of muscle tissue and belong to the biological value of the meat, the physical chemical parameters of the meat, and also the change in meat quality during the processing. The composition of muscle proteins in some way affects the consistency of the meat, the coherence of the water, and the colour of the meat [2].

The aim of the study was to investigate the changes of some physical and chemical properties of pork after freezing at -17 °C temperature. During the research, the following features of pork meat changes were compared: pH, cooking losses, dry matter, protein (protein), fat, ash content before and after cooling at -17 °C temperature for one month.

The obtained data showed that the pH of the unfrozen meat was almost unchanged after one month of freezing. The cooking losses of cooled meat after one month of refrigeration was lower, the amount of dry matter in the meat decreased, the amounts of fats, protein and ash remained almost unchanged and remained similar.

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# PERSPECTIVES OF USING OATS AND PRODUCTS OF THEIR RECYCLING FOR COOKING KISSELS

**Polina Kozlova**

St. Petersburg Polytechnic University of Peter the Great, Trade and Economic Institute, Master's degree student, Faculty of Technology of production and organization of public catering, Russia

**Anna Efimochkina**

St. Petersburg Polytechnic University of Peter the Great, Trade and Economic Institute  
Bachelor's degree student, Faculty of Biotechnology, Russia

**Irina Bazhenova**

St. Petersburg Polytechnic University of Peter the Great, Trade and Economic Institute,  
Candidate of Technical Sciences, Associate Professor, Russia

**Introduction:** Oats are a widespread cereal crop in many countries, including Russia. The homeland of oats is considered Mongolia and the Northeast of China. Oats are cultivated since the second millennium before Christ. People receive groats and flour from grains of oats [2].

Today a large number of recipes are known, in which this valuable cereal crop is used. People have known the advantages and medicinal properties of oats since ancient times. Mainly, they are used for decoctions and infusions. Products got from oats are used in dietary and therapeutic nutrition. When they are used, the mucous membrane of a stomach is not irritated, they contribute to the removal of harmful metabolic products and toxins, help to reduce cholesterol and improve functions of a liver and a pancreas [3]. In the Russian cuisine of different regions of Russia, there are oat kissels. They were cooked on water and milk, with or without sugar. Sometimes the crushed grain was fermented, and then kissel was made. At the present time many old recipes revive [1].

**Goals:** The purpose of the research is to analyze four types of raw materials from oats for further use in the production of kissels. Based on the results of the tests, two samples were selected for further use: oat flour and oat-flakes.

**Methods of researching:** The initial raw materials were fermented by self-kvass and rye bread and rye ferment for 2 days. The fermented flour or oat-flakes were wiped through a sieve, and kissel was made.

**Results and conclusions:** For the finished products, an organoleptic evaluation was carried out by a group of tasters, during which it was confirmed that the selected samples were most suitable for creating food products, with a pleasant taste. In the future, the development of recipes for thick and liquid kissels with the addition of prebiotics is planned. Also, it is planned to use bran, dried fruits and berries, etc.

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# USE OF MILLET FLOUR FOR MANUFACTURING OF PRODUCTS MADE OF CHOUX PASTRY

**Aleksandra Maslova**

Food Technology College, student, Russian Federation

**Tatjana Bazhenova**

St. Petersburg State Polytechnical University, senior lecturer of The Graduate School of Biotechnology and Food Technologies, Russian Federation

Ground corn confectionary and culinary products play an important role in the human nutrition. Due to the high content of carbohydrates, fats and proteins, these products are high-caloric and easily digested food products with a pleasant taste. The variety of ground corn confectionary and culinary products is very wide. Choux pastry is well-known for a long time and does not lose its popularity. The characteristic feature of items made of this type of dough is that in the baking process there is a cavity formed inside the item, which is then filled with cream. This semi-product is mainly used for making cakes. The dough is prepared without baking powders or sugar. The recipe requires the use of a large amount of eggs.

The purpose of this work is widening the assortment of gluten-free products due to creation of a new type of products – items made of choux pastry, based on millet flour.

Millet flour is a source of leucine (the high contents of which is related to prolamines), phosphorus, magnesium, silica, zinc, copper and bromine.

The replacement of wheat flour with alternative types is absolutely justified as it allows improving the nutritional value of the products and increasing the content of nutrition fiber, carotenoids, irreplaceable fatty acids, mineral elements and bioflavonoids.

To reach the set goal, testing of the recipe of the traditional choux pastry, which served as a control sample, and the recipe of the choux pastry with 100% replacement of wheat flour to millet flour, was conducted.

Based on the results of the test baking, conclusions on the improvement of structure of the final products were made, and the decision of necessity to use xanthum gum as the structure forming agent was taken; the necessary technology recommendations were given.

According to the organoleptic evaluation, the manufactured product made of choux pastry with 100% replacement of wheat flour with millet flour demonstrated excellent performance. The vivid cavity on the final product was noted, which testified the high quality of the product; the color inside the product was pleasant yellow, and it was brighter compared to the control sample made of wheat flour. The energy value of the new manufactured product (427 kcal) was lower than that of the control sample (435 kcal).

The conducted research demonstrated that the use of millet flour is promising for enriching the assortment of ground corn confectionary products for special purposes.

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# **SCHOOL SYSTEM INFLUENCE ON FRUIT AND VEGETABLE CONSUMPTION AMONG PUPILS**

**Madara Nevarževska**

Latvia University of Life Sciences and Technologies, Faculty of Food Technology, postgraduate student,  
Latvia

**Ilze Beitāne**

Latvia University of Life Sciences and Technologies, Faculty of Food Technology, Dr.sc.ing., Latvia

Nutrition plays an important role in growth of the whole body and mental development of children. Healthy nutrition in childhood reduces the risk of obesity and illness in the adult age, as well as makes the basis of healthy life habits for whole life. Fruits and vegetables are important components for healthy diet, because they are rich in vitamins, fibre, minerals and biologically active substances. A sufficient amount of fruits and vegetables daily performs preventive functions for human health, especially for most of chronic diseases, like cardiovascular and oncological. The recommendations of World Health Organisation indicate to 400 – 500 g of fruit and vegetables consumption per day. Unfortunately, the most world's population does not reach this amount. [1] Therefore the school could be an institution, which could change the current situation by educating pupils, teachers, parents etc. about healthy nutrition. [2] The aim of this study was to analyse the potential contribution of the school to raising the consumption of fruits and vegetables among children and to summarize the foreign experience.

Latvian recommendations for daily consumption of fruits and vegetables for young children are 500 g and more. Latvian schools participate in the EU program "School's Fruit" to provide pupils with a fruit or vegetable every day. In Latvia, pupils learn about nutrition in subjects: Social Sciences and Housekeeping Technologies. [3] Unfortunately, results of recent research about nutritional habits of Latvian pupils showed that only 21% of pupils eat a fruit and/or vegetable every day. [4] It is possible to conclude that Latvian schools are ready to take part in activities to increase the consumption of fruits and vegetables among pupils, but it is necessary to understand which approach could be more effective.

Foreign countries' experience to increase fruit and vegetable consumption is based on education about food preparing, fruit and vegetable origin, benefits and varieties, as well as on practical work in school gardens. Another approach is to change the catering guidelines in schools to provide 1/3 of lunch plate with fruits and vegetables (experience of Denmark) or to increase the amount of training in food preparing (experience of Ireland and Belgium). [5]

Different researches showed diverse results about the above mentioned experiences to increase the consumption of fruit and vegetables among pupils. An interesting approach was school gardens, which could be used by Latvian schools.

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# MICROFLORA OF PROBIOTIC DAIRY DRINKS MADE IN LATVIA

**Nargiza Raimberdieva**

Latvia University of Life Sciences and Technologies, post-graduate, Kazakhstan

**Abdusattar Akmalov**

Latvia University of Life Sciences and Technologies, post-graduate, Kazakhstan

**Beyza Nur Turhan**

Latvia University of Life Sciences and Technologies, undergraduate, Turkey

**Daina Kārklina and Asnate Kīrse**

Latvia University of Life Sciences and Technologies, *Dr.sc.ing.*, Latvia

Consumer interest in the relationship between diet and health has increased the demand for information about functional foods. Functional foods deliver additional or enhanced benefits over and above their basic nutritional value [1]. Most of the probiotic food products are categorized as functional foods and represent a significant part of it, therefore yoghurt drinks with probiotic bacteria produced in Latvia can be attributed to such functional products. Probiotic foods are able to provide several health benefits, including maintaining a good balance and composition of intestinal flora, and increase the resistance against invasion of pathogens [2]. For probiotic products it is very important that the probiotic bacteria are in sufficient quantity and alive [3].

The purpose of this study was to analyse the microflora of three probiotic dairy drinks: fermented dairy drink 'Lakto' (Food Union Ltd.), probiotic yogurt drink with strawberry 'Saulespiens' (distributor MAXIMA Latvia Ltd.), yogurt drink with strawberry 'Balance' (Tukumapiens Ltd.). In addition to yogurt cultures, 'Lakto' contains *Lactobacillus acidophilus* LA-5, *Bifidobacterium lactis* BB-12 and inulin, 'Saulespiens' and 'Balance' – *Bifidobacterium lactis* BB-12, *Lactobacillus paracasei* CRL-431, *Lactobacillus acidophilus* LA-5.

The total plate count of mesophilic aerobic, facultative anaerobic microorganisms (MAFAM) was determined on Plate Count agar with skim milk (30 °C for 48 h), lactic acid bacteria on MRS agar (37°C for 48 h) and presence of *Escherichia coli* was tested on Endo agar (37°C for 24 h). Colony forming units (CFU) were enumerated using automated colony counter aCOLyte (Topac Inc., USA). All products were evaluated organoleptically.

The results showed that levels of MAFAM in all products was below  $10^6$  CFU ml<sup>-1</sup>. Probiotic drink 'Lakto' contained  $1.41 \times 10^7$  CFU ml<sup>-1</sup>, 'Balance' -  $1.15 \times 10^7$  CFU ml<sup>-1</sup> and 'Saulespiens' contained  $>10^7$  CFU ml<sup>-1</sup> lactic acid bacteria. The presence of *Escherichia coli* not confirmed in either of the products.

Organoleptic testing (overall appearance, colour, flavour, acidity and sweetness) showed that students enjoyed probiotic yogurt drink with strawberry 'Saulespiens' the most.

All three products contained high levels of viable lactic acid bacteria and are suggested for consumption; however, consumers have to test all available products in the market to find out the flavour they like the best.

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# **STUDY OF QUALITY OF KAMUT FLOUR AND VARIOUS TYPES OF DOUGH. ORGANOLEPTIC EVALUATION OF BAKED PRODUCTS USING KAMUT FLOUR**

**Katrine Ryzhkova, Taisiya Lashkova**

Peter the Great St. Petersburg Polytechnic University/Graduate School of Biotechnology and Food Science, Faculty of Public Catering Services, undergraduate, Russia

**Irina Bazhenova**

Peter the Great St. Petersburg Polytechnic University/Graduate School of Biotechnology and Food Science, PhD in Technical Sciences, Russia

The aim of the article is to study a new and interesting kind of flour that would exceed the wheat flour by its nutritional and biological value. It was interesting to check what we can use for the flour of the kamut. In the work we used a lot of research methods of studying the physical-chemical qualities of flour. We compared 3 kinds of flour (wheat, spelt, kamut). A comparison was made of the physical-chemical qualities (moisture, ash content, acidity, extensibility, the amount of dry and wet gluten) and the organoleptic characteristics of the flour varieties under study. To conduct research, we used the methods recommended by the Russian State Standards. In the end, an experimental baking of pancakes, shortbread cookies, biscuit and yeast buns was conducted, with an assessment of their organoleptic indicators.

As to the physical characteristics of kamut, the moisture and extensibility showed lower results. For all other indicators (ash content, acidity, the amount of dry and wet gluten). As to the organoleptic characteristics, the flour of the kamut has a mild taste with a sweetish nutty flavor, an oily odor, an amber color, and it is coarse-grained in granularity. Our study showed that the wheat flour has normal acidity, and the spelt and the kamut have much more acidity. The content of minerals in all types of flour is approximately the same. Shortbread cookies surpass other products in terms of energy value.

Based on the studies conducted, it is possible to recommend flours for making dough types that do not require strong gluten. It cannot be used as a complete substitute for wheat flour. It is not suitable for yeast dough and can be used for biscuits and pancake. To form a texture, you need to create mixtures of flour from different types of cereals and legumes.

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## MICROFLORA OF PROBIOTIC DAIRY DRINK 'ACTIMEL'

**Symbat Zhaksybay**

Latvia University of Life Sciences and Technologies, undergraduate, Kazakhstan

**Zhansaya Bairamova**

Latvia University of Life Sciences and Technologies, post-graduate, Kazakhstan

**Asnate Kırse**

Latvia University of Life Sciences and Technologies, *Dr.sc.ing.*, Latvia

Actimel<sup>®</sup> is a probiotic dairy yogurt-type drink produced by the French company Danone Ltd. The main claimed benefit of Actimel is the strengthening of the body's natural defences through the use of patented bacterial culture called *Lactobacillus paracasei* ssp. *paracasei* CNCM I-1518 or *L. casei* Danone<sup>®</sup> [1]. Each bottle is claimed to contain 10 billion of these bacteria. In addition, each Actimel contains the traditional yogurt cultures *Lactobacillus delbrueckii* subsp. *bulgaricus* and *Streptococcus salivarius* subsp. *thermophilus*, and B<sub>6</sub> and D vitamins.

Probiotics are defined as “live microorganisms which, when administered in adequate amounts, confer a health benefit on the host”. This term refers to specific strains of bacteria; typical probiotics include lactic acid bacteria such as *Lactobacillus* and *Bifidobacterium* [2].

Probiotics have a positive effect on human digestive health, decrease in antibiotic resistance and inflammation, and an additional or supplementary therapy that may have potential for preventing wide scope of immunity-related diseases [3].

Two types of dairy drinks enriched with probiotics were selected for the research: yoghurt drink Actimel (Danone Ltd.) and yoghurt drink Actimel with pomegranate (Danone Ltd.).

For the microbiological analysis, initial suspension was made by mixing 10 g of yoghurt drink and 90 ml 0.85% sterile saline. After preparing serial decimal dilutions of the homogenate, total viable counts were determined on Plate Count agar with skim milk (incubation at 30 °C for 48 h), lactic acid bacteria on MRS agar (incubation at 37°C for 48 h) and presence of *Escherichia coli* was tested on Endo agar (incubation at 37°C for 24 h). Colony forming units (CFU) were enumerated using automated colony counter aCOLyte (Topac Inc., USA). Lactic acid bacteria were identified by Gram stain, catalase reaction, and colony morphology.

The results showed that the total viable count of microorganisms in both Actimel drinks was below  $9.4 \times 10^6$  CFU ml<sup>-1</sup>. The dairy yogurt drink Actimel contained  $3.78 \times 10^8$  CFU ml<sup>-1</sup> and Actimel with pomegranate contained  $3.41 \times 10^8$  CFU ml<sup>-1</sup> lactic acid bacteria. The count of probiotic bacteria in both Actimel drinks exceeded their label claim (at least  $10^8$  CFU ml<sup>-1</sup>). The addition of pomegranate in Actimel drink did not have a significant effect on the probiotic bacteria count compared to Actimel without flavour. The presence of *Escherichia coli* was not confirmed in either of the products. Actimel<sup>®</sup> drinks are available in a wide range of tasty flavours, including four delicious fat free varieties and a specific range for kids. The dairy drink Actimel is recommended to consumers because of the high level of probiotic bacteria, however, based on the high sugar content (therefore, extra calories from simple sugars) it is not suitable for people with low physical activity levels for everyday consumption.

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## **ENGINEERING**

# EFFECT OF THROTTLE BODY DESIGN ON VOLUME FLOW RATE PROGRESSION IN INTERNAL COMBUSTION ENGINES

**Kārlis Banis**

Latvia University of Life Sciences and Technologies, Faculty of Engineering, doctoral student, Latvia

**Dainis Berjoza**

Latvia University of Life Sciences and Technologies, Dr.sc.ing., Latvia

The majority of internal combustion gasoline engines is equipped with a throttle body - device responsible for regulating the amount of air fed into the cylinders. Throttle body design with respect to the type of throttle valve has very early been recognized as a potential flaw due to its restrictive and non-linear nature [1]. Nowadays, the most common throttle valve is butterfly type – a disc rotating on a cross-shaft. Several attempts [2, 3] over history have been made to improve the design and/or performance with little success in real-life application and ease of production leading to a general usage of butterfly type throttle valves in production and purpose-built vehicles alike. Several methods have been deployed to improve the butterfly valve performance such as actuator mechanisms or types [4, 5]. The aim of this study is to determine the criteria describing throttle valve performance and compare them across three different designs including an experimental design proposed and patented by the author. In general, the goal of a throttle valve is to ensure predictable throttle control while minimizing the flow resistance in fully open position for maximum performance. It is also important to prevent flow reversion in partial openings that can disturb the air-fuel ratio.

The experiment was carried out in SolidWorks Flow Simulation environment using steady state analysis at constant pressure differential – 6.98 kPa. The analysis was repeated across throttle actuator positions ranging from 0% to 100% of rotational travel with an incline of 10%. Three different designs were tested – butterfly type valve, offset axis drum valve [4], and experimental valve (patent application of Latvia P-17-90) with all other parameters being equal. Testing criteria were selected as volume flow rate progression coefficient of linearity, volume flow rate at fully open position and anti-reversion at mid-throttle position.

The results show a notable variation in volume flow rate progression curve with respect to angular position of the actuator wheel. The greatest coefficient of linearity is produced by the experimental (P-17-90) throttle valve – 0.93, followed by butterfly valve – 0.92 and offset axis drum valve - 0.89. The greatest volume flow rate in fully open position was indicated by the experimental (P-17-90) throttle valve – 3.07% higher than butterfly type and 1.67% higher than offset axis drum type [4]. The greatest anti-reversion characteristics - 20.5% were also provided by the experimental (P-17-90) throttle valve as opposed to butterfly valve - 3.9% and offset axis drum valve – negative 8.36%, meaning that the flow resistance is decreased in reverse direction.

In conclusion, the experimental type throttle valve (P-17-90) surpassed other designs in every criterion tested indicating a potential advantage in throttle control and engine performance.

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# INFLUENCE OF ELECTROMOBILE TECHNOLOGIES ON ALYTUS TOWN

**Karolis Baranauskas ATE II<sup>nl</sup> course**

ALYTAUS KOLEGIJA/University of Applied Sciences, FACULTY OF ENGINEERING AND BIOMEDICINE, undergraduate student, Lithuania

**Birutė Rakauskienė**

lecturer, Master of Radiophysics

**Povilas Šaulys**

docent, Master of Transport Engineering and Doctor of Mechanical Engineering

Vehicles powered by electricity are gradually becoming popular in developed countries; these ecologic automobiles are taking the first steps also in Lithuania. But our country's people are still inconveniently looking at these silent vehicles.

The reasons why people in Lithuania anxiously are looking at perspective to drive electromobles, can be divided into few parts: financial, habits and fast charging system absence in the country.

For electric vehicles at this moment are not granted any discount. – the only advantages is an opportunity to go on bus bar and free parking in town. But these opportunities may care also for Vilnius and Kaunas citizens.

Counting in cash, electromobile in Lithuania costs about twice more expensive than analogic but just powered by gasoline. This difference is one of biggest in Europe because in many other countries there exist special pollution taxes for automobiles. Electric vehicle don't emit not a single gram of harmful gas, so electromobles are relieved from taxes, which cost hundreds or thousands euros every year.

If we talk about opportunity to charge electromobile, in October 2017, the Council of Alytus approved 3 electromobile fast charging stations installation in Alytus town. 5 years after this project ending will be warranted intercourse of this project and during this period electromobile charging service will be provided for free. Charging stops are planned to instal near Sport and recreation centre of Alytus, in parking near cinema „Dainava“ and in parking on Jotvingių st. 5 near former bus station.

Installing of charging stops will cost 83.2 thousand euros: 70.7 thousand – from European Union, 12.5 thousand – from Municipality Council of Alytus town budget. Charging stops will be installed during several two years. This way city is going to promote using of electromobles and reducing negative effect of transport for environment.

In this report is examined an effect of eletromobles for environment, their pluses and minuses and the benefits, damages of growing electromobile population for Alytus town.

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# TECHNOLOGICAL SOLUTIONS FOR IGNITION SYSTEMS IN THE ENGINES OF THE NEWEST AUTOMOBILES

**Rimantas Giedraitis**

undergraduate student, ALYTAUS KOLEGIJA/University of Applied Sciences, Faculty of Engineering and Biomedical, undergraduate student, Lithuania

**Birutė Rakauskienė**

lecturer, Master of Radiophysics

**Mindaugas Valaitis**

assistant,

**Rozalija Radlinskaitė**

lecturer, MBA

Ignition systems of the newest automobile models are analysed in this report. This system is one of the major parts in automobile engine because no internal combustion engine in automobiles can work without this system. Both in older and newer automobiles, the basic element is the same – to spin the cylinder out and ignite fuel / air mixture. Undoubtedly, the system is more compact and more reliable in newer automobiles than the old ignition systems.

Ignition system generates ignition voltage which is needed for spark ignition in all engine operating modes, as well as supplies ignition voltage to ignition spark plug at the right moment. Only when this process is performed qualitatively, all the energy accumulated in fuel, is efficiently used to get the automobile moving.

The newest ignition systems can be of the following types: classical battery (contact) and contactless, magnetic, electronic battery, capacitance discharge, transistorized, microprocessor. Physical bases of ignition systems and their technical parameters as well as advantages and disadvantages of realization of ignition systems in the newest automobile models are analysed in the report.

During October 2017, the commission consisting of 10 members of Lithuanian Journalists' Auto Club, were testing the newest automobile models. The verdict was announced in the event "Lithuanian Automobile of the Year 2018" held at "Litexpo", Lithuanian Exhibition and Congress Centre, on 2 December 2017. "Mazda CX-5" was awarded the first place, "BMW 5" took the second place and the third one was awarded to "Hyundai i30". The ignition systems used by automobile producers in the above-mentioned automobiles are analysed in more detail in this report.

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# **HANDPRINT TECHNOLOGY IN OUR LIVES: PROBLEMS AND PERSPECTIVES**

**Nomeda Kruopytė, Eglė Rimkienė**

Klaipėda State University of Applied Sciences, Faculties of Technologies, Environmental and Construction Engineering Department, undergraduate students, Lithuania

**Raimonda Sūdžiuvienė, Vida Gerikienė**

Klaipėda State University of Applied Sciences, Faculties of Technologies, Environmental and Construction Engineering Department, Lecturer, Master

Along with the increasing automatization of our everyday life, we have increased safety requirements. Every day the questions are asked: „Does this person have permission to access this security system?“, „Does this person have sufficient system privileges to carry out a specific task?“. By asking these questions we try to solve the same security problem – how to correctly identify people. Right now we have a few popular approaches to resolving this issue [1]. One of them is related to „something that we have“ - that could be cards, security keys, etc. Another one depends on „what we know“ - that's passwords, various access codes and similar information. Both of these solutions provide authorization to specific objects – be that access cards or passwords but not to the person himself. If a person receives specific access information, he gets authorization. Otherwise, he doesn't have it. When applying this type of security policy, people need to carry various cards or have to remember dozens of passwords. The loss of the card or failure to remember the password could cause user substantial problems [2]. Researchers attempt to solve this problem by employing various means, but the use of the biometrics is the most promising. Biometry should be a technology that makes use of unique human physical or behavioral traits, distinguishes one from another, or correctly identifies them. Biometry is based on „what we are“, providing us with particular authorization to access specific systems, thus naturally distinguishing authorized persons from imposters [1]. This is why the goal of our work is after analyzing biometric traits and principals, to discover possibilities and perspectives of its use, and to find out how much people are knowledgeable about this field. To base our thoughts, in March of 2018, we did a survey of 40 random respondents aging from 19 to 50 years old. Our aim was to find out how many people are using this technology in their everyday life, the problems that emerge from it. After concluding our survey we found out that 93% of respondents don't know what dermatoglyphics means. One fifth (about 20%) of respondents stated, that they use handprints technology. Based on the given answers, we have determined that in everyday life people mostly use mobile phones (around 30%), 3 % use computers that have a fingerprint recognition system installed, 2 % of respondents said that they use safes at home, and 5% of the people stated that they utilize employee identification system. From the results of the survey, it is shown that 25 % respondents think that it is possible to determine sex, residence and character from the handprints. From the results of the research, we could make a conclusion that biometric systems of today allow fast and accurate distinction of one person from another by unique physical, physiological traits or behavioral patterns. In the last twelve years, active employment of biometric systems for various aims in private and public sector has increased, and base goal of these systems is to ensure the safety of society and maintain public order. Most popular person identification methods that are used in biometric systems, are recognition by finger papillary ridges and recognition by unique facial traits.

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# MODERN TECHNOLOGIES OF HARDENING OF MACHINE PARTS

**Sergei Sakhanko**

Baranovich State University, Faculty of Engineering, doctoral, Belarus

**Mikhail Niaroda**

Baranovich State University, Faculty of Engineering, Head of the department, Ph.D, Belarus

In the laboratory "High-energy methods of hardening" at the engineering faculty of the educational institution "Baranovich State University" there is a unique installation that allows to realize the process of ion-plasma nitriding of machine parts.

The essence of the method of ion-plasma nitriding lies in the fact that an anomalous glow discharge is generated between the cathode on which the machined parts are located and the anode, the role of which is performed by the walls of the vacuum chamber, in the discharged vacuum nitrogen-containing gaseous medium, which forms the active medium (ions, atoms excited molecule).

This ensures the formation of a nitrided layer on the surface of the product, consisting of an external - nitride zone with a diffusion layer located below it.

The nitrided layer obtained by this method has a high hardness and wear resistance. The wear resistance of nitrided steel is 1.5 ... 4 times higher than the wear resistance of hardened high-carbon steels which had the process of cyanidation, carburization and nitrocarburization.

Nitriding reduces the viscosity of steel, increases its strength, reduces the influence of stress concentrators on the reduction of the endurance limit of steel and significantly increases the endurance limit, in particular that of thin parts and parts that work in some corrosive environments.

The main advantage of the method is stable quality of processing with minimal dispersion of physical and mechanical properties of the part. In comparison with the widely used methods of hardening the chemical-thermal treatment of steel parts, such as carburizing, nitrocarburizing, cyanidation, gas nitriding, the ion-plasma nitriding method has the following main advantages: higher surface hardness of nitrided parts; no deformation of parts after processing; increase of the endurance limit with increasing wear resistance of machined parts; lower process temperature, due to which the processed parts have no structural changes;

the ability to process blind and through holes; preservation of hardness of the nitrided layer after heating up to 600 - 650 ° C; the possibility of obtaining layers of a given composition; the possibility of processing products of unlimited sizes of any shape; absence of environmental pollution; improving the culture of production; reduction of the cost of processing.

The method of ion-plasma nitriding is promising for hardening machine parts that work under friction wear conditions. The hardness of the surfaces of machine parts is increased by 2 ... 2.5 times. Besides the method is environmentally friendly (clean).

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# DIETHYL ETHER/VEGETABLE OIL BLENDS FOR THE USE IN DIESEL ENGINE

**Artūrs Zaķis**

Latvia University of Life Sciences and Technologies, Faculty of Engineering, undergraduate student,  
Latvia

**Ruslans Šmigins**

Latvia University of Life Sciences and Technologies, Dr.sc.ing, Associate Professor, Latvia

During the last years the use of different alternative fuels as fuel additives to conventional fuels became more popular. One of such, not so widely applied fuels is also diethyl ether (DEE), which is an organic compound and historically used as an anaesthetic agent. Due to a DEE explosive flammability and other physico-chemical characteristics (higher cetane number, oxygen content, lower auto-ignition temperature, prolonged flammability, as also improved miscibility [1]), it can be used for the improvement of diesel engine performance, as also emissions. Only few works exist on the experience of the use of DEE in blends with diesel, biodiesel or vegetable oil. One of the most promising fuels for blending is exactly vegetable oil, which could be easily produced by farmers and is available in any market. It is possible to use this fuel in diesel engines, if its main disadvantage – too high viscosity – would be solved. Due to high viscosity vegetable oil could promote poor fuel atomization, and as a consequence result in to poor combustion, injector cooking and fuel pump failure. Problem could be solved by heating the oil, but in that case there is necessity for the modification of fuel equipment of existing vehicle and it is connected with additional investments.

Previous researches have shown that DEE can be used as a perfect additive for the reduction of viscosity of vegetable oils besides the other it advantages, like improvement of emissions. Gorski & Smigins searched selected physicochemical properties (kinematic viscosity, density, lower heating value, cold filter plugging point, miscibility, flash point, coefficient of friction, lubricity, surface tension, and copper strip corrosion) of diethyl ether/rapeseed oil blends of 10, 20, 30, and 40% by volume [2]. They observed that DEE has significant influence on the rapeseed oil viscosity, miscibility of all blends in a wide range of temperature regimes, as also that all tested blends do not promote the corrosion processes [2]. Based on these findings they suggested usage of such blends in diesel engines in winter season.

Other researchers [3] have made investigations in dual fuel diesel engine on the feasibility of blending karanja oil with DEE, which used as an oxygenated additive in proportions of 5, 10, 15, 20, and 25% by volume. They observed that main advantage of DEE addition is its ability to significantly reduce NO<sub>x</sub> emissions [3]. Researchers concluded that such fuel combination can be used as a commercial fuel with further advancements in the processing techniques and preparation of the fuel [3].

The authors think that DEE could be promising alternative for farmers who produce vegetable oil by themselves and would like to use them as a fuel in different seasons without any problems in such way also improving ecological situation.

Further investigations in Alternative Fuels Research laboratory of LUA will be realized to clarify impact of DEE/rapeseed oil blends on engine performance and emissions.

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## **INFORMATION TECHNOLOGIES**

# **ADVANCED E-LEARNING SYSTEM**

**Jose Augustine**

Latvia University of Life Sciences and Technologies,  
Faculty of Information Technologies, post-graduate student, Latvia

**Ivars Mozga**

Latvia University of Life Sciences and Technologies, Dr.sc.ing., Latvia

The goal of the advanced e-learning system is to deliver a computer based web system which can be used in real interactive teaching, learning and training situations. E-learning and online education have moved from a knowledge transfer model to a highly intellectual, swift and interactive proposition capable of advanced decision-making abilities. Two challenges have been observed during the exploration of recent development in e-learning. Firstly, to incorporate e-learning systems effectively in the evolving semantic web environment, and secondly, to realize adaptive personalization according to the learner's changing behaviour.

An ontology-driven system has proposed to implement the Felder- Silverman learning style model in addition to learning contents, to validate its integration with the semantic web environment [1]. Interactive video lectures are increasingly being adopted in digital learning contexts for increasing interactivity [2]. Interactive video lectures can provide learners opportunities to obtain timely constructive support to produce effective learning outcomes. The learner's learning style and their modifications are made within the proposed e-learning system.

Cloud storage is used as the primary back-end in order to maintain the ontology, databases and other required server resources and ASP.NET is used for front-end development [3].

This study proposes a personalized and interactive e-learning system which contains interactive video lectures that can continuously monitoring the learner and content is provided in accordance to the learners level of knowledge and the way of learning style.

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# DEVELOPMENT OF A HYBRID MOBILE APPLICATION

**Viesturs Bērziņš**

Latvia University of Life Sciences and Technologies, Faculty of Information Technologies,  
undergraduate student, Latvia

**Armands Kviēsis**

Latvia University of Life Sciences and Technologies, Mg.sc.ing., Latvia

Mobile application development is increasing rapidly as demand for mobile experience grows. From operating system-specific mobile development to cross-platform mobile development, and now hybrid mobile application development, technologies have evolved.

As with native applications, hybrid mobile applications are installed on a user's device and can access native features. While native applications are built using platform-specific development tools, hybrid applications are built using same technologies that are used for web page development – HTML, CSS and JavaScript. Hybrid applications are built as mobile web sites that are wrapped in full-screen web browser called web-view [1]. This means that same application can run on different platforms and still access native features of each platform.

For building hybrid applications, there are several open source frameworks available. Each framework provides different options and methods for building, testing, compiling and maintaining hybrid mobile applications.

Ionic framework is open source and is built on top of the Angular web application framework [2]. While the framework's functionality is based on Angular, Ionic focuses on user interface components. Ionic command line interface provides helpful commands and comes with a built-in development server.

Onsen UI, same as Ionic is open source. Onsen UI is a large set of user interface components which can be used together with popular web application frameworks such as Angular, React, Vue.js and others [3].

The most popular hybrid development tools were examined [4] and compared. Several criteria were set for comparison: development options, user interface components, official documentation and size of community.

The aim of this research was to explore hybrid application frameworks, choose the best option based on comparison results –and to build a hybrid mobile application as an extension for the existing food ordering system.

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# **DEVELOPMENT OF TOOLS FOR CELLULAR DATA NETWORK SIMULATION**

**Mārtiņš Brūns**

Latvia University of Life Sciences and Technologies, Faculty of Information Technologies, post-graduate, Latvia

**Ivars Mozga**

Latvia University of Life Sciences and Technologies, Dr.sc.ing., Latvia

The master's thesis is based on research of cellular data networking and existing cellular data network simulation tools. Necessary hardware and software for development of simulation tools were also researched. The aim of the research was to develop cellular data network simulation tools for mobile app developers. Cellular data network simulation tools, depending on their sophistication, can be useful to mobile app developers all around the globe by reducing development costs and complexity of app development.

By researching cellular data networking and existing cellular data network simulation tools, useful specifications and network parameters for simulation were determined, such as bandwidth, latency and others. After developing simulation tools, their usability is tested by adjusting network parameters and comparing behaviour of simulated cellular data network and actual cellular data network. Qualcomm presentation gives idea about network parameters. [1] The description of the simulation tool developed by the group "Polidea" presents an idea of how simulation tools can work and some idea of their specifications. [2]

Research shows that developing cellular data network simulation tools is an achievable goal. By concluding the research and achieving the aim of the research, working cellular data network simulation tools have been developed and tested.

The developed cellular data network simulation tools can be used in mobile app testing, making it less expensive and practical when cellular data is necessary. The developed simulation tools can be more useful and accurate if more research is conducted and the tools update accordingly.

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# UTILISING MOBILE TECHNOLOGY FOR LEARNING VET ANATOMY

**Sajan Chiramel Dominic**

University of Life Sciences and Technologies (LLU), Faculty of Information Technology, post-graduate,  
Latvia

**Ivars Mozga**

Latvian University of Life Sciences and Technologies (LLU), Docent, Dr. Sc.ing, Latvia

Learning is often associated with two conditions; 1) location; and 2) time. Based on these two conditions, a number of important problems have been raised; namely, difficulty of access to relevant references from the laboratory or library due to limited opening hours, and limited physical materials, such as framing materials to borrow for revision. This could be a barrier to long-lasting understanding of the subject matter. However, these problems could be solved by introducing alternative learning resources such as mobile learning tools. Mobile learning is especially significant to the user. With mobile devices, information is always with the user because he/she has easy access to information through a mobile device. While, a traditional learning material, for instance using a textbook, has limited access and lack of visual understanding of the subject matter. This is especially so in learning anatomy. Hence, the mobile learning facility provides the benefit of mobility, and enhances the learning environment. Mobile learning is known as ubiquitous learning, and the term ubiquitous refers to providing learning using handheld devices such as mobile phones and tablets as the assistive learning tools.[1]

Vet Reckoner either two or three dimensional computer generated imagery (CGI), objects and/or information, and allows users to interact with them. Vet Reckoner on mobile devices are evolving and offer a great deal of potential in terms of learning and training. This research discusses the development process of a mobile prototype learning environment that utilises mobile technologies. The prototype is called the Vet Reckoner, and the selected learning topic is the anatomy of the Domestic animals. The main objective of Vet Reckoner is to aid students and it could potentially enhance their learning process. There has been a report stating that there is a decline in retaining and generating long lasting information longer when learning the above mentioned topic. This paper intended to the development of prototype Vet Reckoner. [2, 3]

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# DEVELOPMENT OF SECURE SMART HOME IOT SYSTEM USING TELEMETRY PROTOCOL AND SINGLE BOARD COMPUTERS

**Edvards Gustaitis**

Latvia University of Life Sciences and Technologies, Faculty of Information Technologies,  
undergraduate, Latvia

**Vitalijs Komašilovs**

Latvia University of Life Sciences and Technologies, Dr.sc.ing, Latvia

Smart homes offer sustainable and efficient use of resources, convenience and comfort. However, as the Internet of Things (IoT) continues to integrate and play bigger role in our everyday lives [1], security is becoming the biggest concern [2]. Any system that uses sensitive and personal information, especially one that affects our environment and lives, should prioritize security and IoT in smart homes is no exception.

The aim of this research was the creation of a secure smart home IoT system prototype, based on assessment and analysis of the existing security issues and challenges, comparison of most widely used technologies – communication protocols and standards, architectural patterns and evaluation of the usage of single board computers in IoT systems.

This research consisted of two interconnected phases. The first phase regarded information gathering and analysis of the overarching issues and challenges of IoT systems – the key aspects that make IoT systems vulnerable and insecure, and which requirements must be met in order to avoid them. The second phase dealt focused on the creation of a secure smart home IoT system prototype based on the gathered and analyzed information from the first phase. The underlying technologies used in this research were – Message Queuing Telemetry Transport (MQTT) protocol [3] and Raspberry Pi single board computers.

The findings in this research deduce that the security must be the forefront and the most important key aspect when designing any IoT system architecture – from the selection of optimal communication protocol and device to the frontend device management software. Security and data privacy in smart home systems must be the utmost priority, and in order for it for it to be achieved, the right technologies and design patterns must be used. MQTT protocol and its wide range of tools offer features that that allow the developer to mitigate the biggest concerns of smart home systems. The highly scalable and configurable MQTT protocol message broker it utilizes offers key functionalities to secure smart home devices via various settings and security options.

The conducted research concludes that the key aspects of secure smart home IoT system are; device authorization, authentication, updates and management, data integrity, privacy and consistency. MQTT communication protocol and its specifications [3] allows it to be implemented on a wide array of devices, from low power and performance embedded to high performance devices, and its open source nature offers highly configurable and extensible development environment.

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# TRADITIONAL WEATHER FORECASTING COMPARISON AND ASSESSMENT WITH REAL WEATHER CONDITIONS

**Ivars Ikarts**

Latvia University of Life Sciences and Technologies, Faculty of Information Technologies, post-graduate, Latvia

**Ivars Mozga**

Latvia University of Life Sciences and Technologies, Dr. sc. ing., Assistant professor, Latvia

The precision of weather forecasts is important for economies, especially for the agriculture sector [1]. In the 21st century, weather forecasting takes place with expensive and sophisticated hardware, but until to the 1990s [2] the weather was predicted by the observation of nature signs. At present, digital signatures by nature signs for weather forecasting are not collected, so it is not possible to effectively determine the accuracy of observation of natural signs in relation to real weather conditions.

In the master's thesis, the development of weather forecasting has been studied and described, and weather conditions have been aggregated and nature signs classified by type of observation and groups influencing the weather conditions. Nature signs are translated from sentences to numerical information. The significance and influence of weather conditions has been described by area, and comparison of time observation with real weather conditions studied in the territory of Latvia from 2017 by 2018 quarterly and over the last 50 years based on the testimony of people.

As a result of the master's thesis, the "Dabas Laiks" online information system has been developed, which consists of the collection of nature signs logs, observations of nature signs, reporting tool and database to store obtained weather forecasts. The probable forecast for the next quarter in the territory of Latvia has been obtained.

The "Dabas laiks" information system is intended as a support system for forecasting weather conditions in order to improve the accuracy of weather forecasts and as educational material for Latvian cultural history, obtaining observations of different nature signs and their significance in certain parts of Latvia.

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# THE CHANGE OF GDB10LT (GEOREFERENTIAL) DATA DURING THE PERIOD OF TIME FROM 2008 TO 2016

Vaida Jakubauskaitė

Aleksandras Stulginskis University, Faculty of Water and Land Management, student, Lithuania

Vilma Šalkauskienė

Aleksandras Stulginskis University, Faculty of Water and Land Management, lecturer, Lithuania

Land cover objects are reflected by georeferential data. Georeferential data are the geo-data of universal use on the most important topographic, engineering and geodetic objects [5]. Georeferential data are updated throughout the world. Georeferential data are not only used for mapping but are also becoming an important basis for integrating. These trends are supported by the INSPIRE Directive, which is based on the fact that spatial data shall be created once and used at various levels, and their accuracy and reliability shall be strictly regulated [2]. Orthophotographic maps are most commonly employed to update georeferential data. It is also important to note that the processing of geographic data includes the interactive revision of data, therefore the responsibility is borne by the operator himself/herself [3]. Taking into account the fact that GIS is applied in more and more research areas including not only land management but also soil science [4]. It is essential to process and provide any spatial data so that they would result in effective analysis and adoption of correct planning solutions [1]. The research aimed to update the georeferential data in the selected area. To achieve the aim, the following tasks were set: To update the data of built-up areas, areas overgrown with trees and bushes, dams, pools, lakes, ponds and roads in the selected area; to perform the analysis of changes in the data under investigation. The object of the research includes layers of built-up areas (pu0), roads, dams, pools (hd4), lakes, ponds (hd3), areas overgrown with trees and bushes (ms0) in a part of Igliauka elderate, situated in Marijampole municipality. Updating the layer of built-up area, it was determined that its total area increased by more than 1%, i.e. 23763 m<sup>2</sup>. According to the revised data, the built-up area occupied 25% of the total area, out of which newly detected built-up area comprised 12%, while defunct built-up area comprised 4% of the total area under investigation. The number of objects overgrown with trees and bushes increased by 125 units. Large forest areas expanded, the territory overgrown with forest increased by small areas. In comparison with the year 2008, in 2016 the total forest area increased by 12470 a. Forest section lines and clearings have not changed over 8 years. The existing roads changed slightly. Comparing the data of 2008 and 2016, it was determined that only 6% of the total number of roads changed. No changes were observed in hydrographic linear objects (rivers, drainage ditches) were observed within the period from 2008 to 2016. Comparing the total area of dams and pools in 2008–2016, their total area in the territory increased by 51997 m<sup>2</sup>, and the number of objects grew by 125.

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# DEEP LEARNING APPLIED TO REAL-TIME TRANSCRIPTION

**Vladimir Koptikov, Vladislav Ivanov, Anastasia Schegoleva**

Peter the Great St. Petersburg Polytechnic University, Institute of Computer Science and Technology,  
undergraduate student, Russia

**Tatiana Panycheva**

Institute of Humanities, Specialist, Russia

Machine learning and its subset deep learning in the last decades have changed the human approach to issues in various fields, such as speech recognition and music transcription.

Though there exist a large amount of research regarding the well-marketed field of speech recognition, music/audio transcription is not as well-developed. In recent literature, there are no examples of such a system that could determine the nature of different sounds and classify them. This could be very important in recognizing animals or birds by their voices. For example, it can help with monitoring of range shifts of animal species due to climate change, biodiversity assessment and inventorying of an area. We aim to develop an application that could be used in modern devices which target to classify different sounds via the neural network. Since classification of sounds is such a broad topic we chose to focus on music transcription in our work.

Useful methods of pre-processing audio data were described by Cheveigne and Kawahara, including a fundamental frequency estimator for speech and music [1], which is a method for extracting numeric features from audio, such as time frequency time-series.

After pre-processing, we received data ready to be fed into our network, based on architecture described in “An End-to-End Neural Network for Polyphonic Piano Music Transcription” [2].

Our approach is supported by the detailed description of different neural networks architectures and discussion of their pros and cons.

Since neural networks on the low level are just simple multiplications and additions, first we needed to transform our audio data into a numeric format. Our next step is to create suitable Neural Network, which can process our dataset. In our research, we came to a conclusion that the convolutional neural network would suit us best and so we implemented it and in the end, built a robust system called “Marsic” capable of transcribing polyphonic piano sounds in real-time.

Ever since academic music was created, musicians have faced the same problem: the necessity of turning music sheets while playing the musical instrument. Our goal is to bring the end to this trouble: with the state-of-the art technologies such as deep learning we aim to develop a program that could detect the notes played by the musician and follow the pace of the musician. It will be an android application for smart phones and tablets. It allows user to load necessary musical composition, let them check and edit music sheets and finally help to keep track of notes needed to play next. The program is a further step to sound processing and tracking in various areas.

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# **THE GEOGRAPHICAL INFORMATIKON (TOP50\_LT) UPDATE FOR THE CITY OF SAKIAI AND SUBMISSION TO THE USER**

**Artur Novikov**

Aleksandras Stulginskis University, Water and Land Management Faculty, Real Estate Cadastre, Student, Lithuania

**Daiva Gudritiene**

Aleksandras Stulginskis University, Water and Land Management Faculty, Geomatics and Land Management Institute, Lecturer, Lithuania

The updating and presentation of recently georeferenced cartographic data is very important, as it serves as a basis for planning, designing and analysing the processes of land cover change. (Gudritiene, 2016). The law of geodesy and cartography in the Republic of Lithuania determines the management of cartographic works, principles and peculiarities of the compilation of geographic information system data sets (Lietuvos..., 2001). Spatial data is a digital representation of the data describing the geographical location, form, interconnections and uniqueness of the analysed object. (Papisiene, 2014).

The research object was the year 2013 TOP50\_LT data collection of the Sakiai district.

The purpose of this research was to perform the year 2013 Sakiai district TOP50\_LT spatial database update while referring to the year 2016 ORT10LT map data interpretation.

The following tasks for this research were to perform an overview of the existing Lithuanian territory spatial data, to perform the year 2013 Sakiai district TOP50\_LT spatial database update while referring to 2016 ORT10LT map data interpretation and to perform the spatial data range analysis of the Sakiai district during the years 2013 - 2016.

In terms of research methods, this paper analyses regulation documents as well as various scientific, specialised and foreign literature sources. The paper also analyses the cartographic history and Lithuanian (as well as foreign) spatial data and its possible uses and looks at the legislations governing this area. ArcMap 10.2.2 software and computer databases were used to aid the completion of this paper, while topographical and orthophoto maps were also analysed. While researching the geographical map data, scientific methods such as comparison, modelling, summation and graphical visualisation were used. In the process of updating the topographical map, various cartographic material was referred to as well as methodological advice and orthophotographs. The comparison analysis of the received data is complete.

Results – Linear, areal and point layers of spatial data of the years 2013 - 2016 were updated and analysed for the Sakiai district. Major changes were identified in the forest areas as well as the linear road layers. Based on this information, it can be assumed that nature and our environment is constantly changing and therefore it is extremely important to keep updating the digital spatial data.

It was established that out of all areas, the plot area of forest changed the most. It increased by 840.74 hectares. Out of all layers, the largest changes were found in the layer of roads. The number of road lengths has increased from 1324.25 to 1412.42 kilometers. 335 new point objects were created, of which 134 are point objects of plants, 87 homesteads, 85 buildings, 18 towers and 11 other objects. The total number of these point objects from 2013 to 2016 increased from 2196 to 2531 units. The increase of almost all objects took place at the expense of the cultivated land, therefore the area of it significantly decreased.

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# QUERY PERFORMANCE TUNING USING MS SQL AND ORACLE DB SERVERS

**Dmitrijs Ozerskis**

Latvia University of Life Sciences and Technologies, Faculty of Information Technologies,  
undergraduate student, Latvia

**Gatis Vītols**

Latvia University of Life Sciences and Technologies, Dr.sc.ing, Latvia

Modern information system performance bottlenecks could be a reason behind slow application performance. Up to 44% are problems with data management (databases) [1]. There exist various vendors of databases, but principle problems are same for each. Information system vendors choose the most suitable platform for their software to reach the most balanced price to productivity. But developers usually have only basic skills working with specific database and do not use benefits of the platform; as a result, there are problems with DB performance.

The research method implies discovery of MS SQL and ORACLE DB distinct functions that can improve DB performance and comparing them. Additionally, to improve overall DB performance the DB performance tuning model is being recommended by IT specialists, which is a guideline on how to best optimize the complex performance's improvement [2].

To trace performance changes, metrics were gathered before and compared with the result, after implementing each model's step using a real database. Based on that, it was concluded that summary performance can grow more than 100 times. Additionally, it is clear that the best offer for a client is the one with the most suitable DB platform for his information system.

The qualitative analysis covers comparison of DB platforms, improvements of each model's step and a comparison of the final model implementation and improvement.

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# DEVELOPMENT OF SMART PARKING SOLUTIONS USING DEEP LEARNING AND COMPUTER VISION

**Viktors Roze**

Latvia University of Life Sciences and Technologies, Faculty of Information Technologies, student,  
Latvia

**Aleksejs Zacepins**

Dr.sc.ing. Aleksejs Zacepins, Latvia University of Life Sciences and Technologies

In many countries, including Latvia, there is a rise in the number of vehicles on the road, which is one of the major issues smart city solutions try to solve. According to the Road Traffic Safety Directorate and the European Automobile Manufacturers Association, in Latvia during the last ten years, the number of vehicles has increased consistently. According to the latest publicly available data from the European Automobile Manufacturers Association in Latvia, in 2015, 676592 vehicles [1] were used. This is 3.6% more than in the previous year, one of the fastest growing rates across Europe. The increasing number of vehicles in densely populated areas will exacerbate various vehicle-related problems. One of these problems is the lack of parking lots in the cities. As a result, drivers spend more time looking for free parking, which increases road traffic and the amount of carbon dioxide emissions in the air. One way to alleviate such a problem would be to more efficiently use parking spaces, and informing drivers of nearby free-standing parking places would help to reduce the number of transport-related problems. Solutions of this kind are called smart city solutions, which elevate city's prestige and improve the everyday life of the population in the urban environment using information technology.

One smart city solution is the smart parking, which can use a variety of sensors or cameras to identify the situation in individual parking places or car parks. Smart parking is a parking space that uses information technology to perform and improve its functions. Our research looks at computer vision and the use of deep learning in creating smart parking spaces and describes the benefits of these technologies. In this research, a smart parking prototype is being created from a publicly available parking live video stream that is processed using the TensorFlow deep learning framework and OpenCV computer vision library. For drivers to obtain data on car parks, it would be visualized on the website and in the mobile application. Also, in this research optimal CCTV camera settings are searched for optimal results in low light situations and streaming quality.

It has been found that smart parking solutions that use computer vision and deep learning are potentially more precise and more cost-effective than sensor solutions, and that centralized intelligent parking solution with the Tensorflow framework has many benefits over decentralized solutions, where image classification and other computationally expensive tasks accrue at every camera or parking space. A centralized solution, where all video streams meet in one server, allow the smart parking solution to be easily manageable with less human resources. Choosing a centralized solution requires multi GPU servers where the choice of Tensorflow framework come handy with its better scalability than its closest rivals [2]. In this research, it is proposed that training multiple deep neural networks which each focus more situationally specific image recognition can yield better results. To test this proposition, two separate neural networks were trained – one for daytime and one for night time. Such an approach to deploying deep neural networks yielded a significantly better result at night time for the same computational power.

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# DEVELOPMENT OF STUDENTS REGISTRATION SYSTEM FOR THE CONSULTATION VISIT

**Eric Shishko**

Latvia University of Life Sciences and Technologies, Faculty of Information Technologies, Master student, Latvia

**Svetlana Atslega**

Latvia University of Life Sciences and Technologies, Prof. Dr.math., Latvia

University life is always loaded for both students and lecturers. Given the diverse workload, it will be important for students to know when they will be able to discuss their course or thesis work, or simply consult. The current e-learning system do not provide registration possibility for the consultation. When the student want to visit consultation, he must agree on time with the lector by phone, email or personally. Which is not convenient, lectors need to control of this procedure by themselves. Optimization of this process is very important. [1]

The aim of the research was to find the way to minimize the effort and time required for organization of consultations visit. This can be done by using registration system for the consultation visit. The developed system was web-based application, so every student and lecturer with internet connection can use it. It is planned to use current Latvia University of Life Sciences and Technologies e-learning capabilities. Making authorization of application based on current e-learning system, will save users and administrators of additional steps, as registration.

As the result users productivity should be increased, misunderstanding between lecturers and students will be minimized. Also can create statistics based on this data, as some information.

The developed system will be used in Latvia University of Life Sciences and Technologies, however, it can be adapt for another areas. The same problem is hiding in business every day they lose a few customers. Some of them simply could not get in touch by phone. Someone does not have time for phone calls. Automated online booking system will help not to miss any requests. [2]

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## **E-WASTE MANAGEMENT AND POLICIES IN LATVIA**

**Ilva Siliniece**

Latvia University of Life Sciences and Technologies, Faculty of Information Technology undergraduate,  
Latvia

**Gatis Vitols**

Latvia University of Life Sciences and Technologies, Faculty of Information Technology Dr.sc.ing,  
Latvia

The general problem of Information Technology and related fields is that it is developing so rapidly throughout the years, that a lot of hardware and software related technologies become outdated. When it comes to software, it's easy to follow up with the changes. But outdated hardware management issue is more complex.

Electronic waste (e-waste) is fastest growing waste stream in the EU, with some 9 million tonnes generated in 2005, and expected to grow to more than 12 million tonnes by 2020.

If looking at the amount of people living in the world right now and the amount of demand for household appliances, gadgets and other similar technology, it can be seen that demand for devices is increasing. One middle aged person carries around 1-2 gadgets with him during a day, for example – a phone, tablet or a small personal computer, smart watch or a smart bracelet to track steps. [1] However, the amount of appliances that are recycled is still, in comparison, small. In the EU and Latvia, there are directives that are required to follow, for a proper waste disposal [2]. Even if a foreign company that ships its gadgets and electronics, by the Waste Management Law of Latvia, it makes it clear that not all manufactures care about small countries. [3] In most times the individual or a legal person is not aware of these directives. There are options in Latvia for legal person and individuals, that don't want to spend time manual sorting their e-waste, and option is waste management unions that take care for this process and guarantees its proper – legal and environmentally safe disposal. [4]

Society trends show that people buy more and more electronic items they don't need in a daily basis. In some countries as soon as a new, for example, phone arrives in the market people are ready to wait in lines for days just to buy it thus cluttering their surroundings with electronics. By constant demand for new electronic devices we encourage the demand for precious metals, gasses, minerals etc. hence creating an even bigger demand to continue to mine earth to get more rare elements.

There is a need to create more in-depth organizational policies that follow EU Directive on waste electrical and electronic equipment (WEEE Directive) and the Directive on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS Directive). Later being orientated more towards local producers of devices. At the moment active directive Directive 2012/19/EU being only partially followed as companies still does not properly manage all e-waste streams, for example, battery and old printer cartridges are disposed improperly

More intensive recycle can promote implementation of is circular economical model that such philosophies as Zero Waste followers aim for the future of EU, there for Latvia too.

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# EXPLORING THE POSSIBILITY OF CREATING A TRAFFIC LIGHT BASED ON MACHINE LEARNING

<sup>1</sup>Anton Sliusarev, <sup>2</sup>Olga Boichenko

<sup>1,2</sup>Peter the Great Saint Petersburg Polytechnic University, Institute of Computer Science and Technology, undergraduate students, Russia

**Elena Boitsova**

Peter the Great St-Petersburg Polytechnic University, Russia

Large cities have been suffering from the problem of traffic jams for a long time. Traffic jams are caused by various reasons. The delays at traffic lights can be a starting point of the roads congestion. Traffic jams make the drivers waste a lot of time; they hamper social and economic activities; harm the environment and worsen the quality of the citizens' lives. There are various ways to solve this problem. For example, there exist centralized traffic lights management systems, but they require a serious improvement of the infrastructure and, therefore, their cost is quite high [1].

The following article is aimed at presenting the way of improving the operation of the traffic light system based on modern algorithms of machine learning [2]. The authors of the article are the students engaged with programming specialties. They have developed the program allowing to provide each traffic light with an independent self-learning system enabling to automatically adjust the traffic lights to the rapidly changing traffic flow conditions. The beneficial advantages of the program include reliability, the speed of the action and the economy of applying.

The program developed is directed to the estimation of the amount of transport ready to cross the road at the street intersection. The estimation is performed by means of image recognition technologies and video cameras. The operation of the smart traffic light is based on determining the time required for the transport to cross the road.

The combination of the smart traffic lights into the road network will provide the arrangement of the optimal transport decisions in a large area: diverting the flow of cars from a busy area; hastening the traffic between different objects of destination; introducing a new algorithm of traffic congestion reduction in the whole city.

The program has been designed to be gaining an advantage from its previous experience. With the help of the "reward" (a numerical score that shows how optimal the program decision has been) received from the traffic light environment the system constructs the action-value function  $Q$ , which subsequently gives the system an opportunity to choose the strategy of behavior [3]. The following strategy takes into account the experience of the previous interaction with the environment choosing the most reasonable ways of behavior, but not the random ones.

The reference of the program discussed to the artificial intelligence issues gives the opportunity to look at common things differently, and it can lead to increasing their productivity. The application of the algorithms of machine learning will help to improve the problem of road regulation in the nearest future.

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# COMPARATIVE STUDY OF ENTRY THRESHOLD IN NEWEST PROGRAMMING LANGUAGES

**Anastasia Turygina**

St. Petersburg Polytech University, 1st year student, Russia

**Tatiana Panycheva**

Institute of Humanities, Senior Lecturer, Russia

Nowadays one can observe a rather sad situation when the IT industry is still using out-of-date, obsolete technologies, and IT ‘professionals’ are specializing in narrow areas and are reluctant to study new developments. In our study we want to show how the innovations in the IT world can help in the developments and simplify them.

Having a year work experience in a well-established American IT company (Junior IT Engineer at EPAM, Russia), engaged in software development, as well as research in the field of bioinformatics and blockchain technologies, I noticed that there exist different samples of program developments with striking differences. So, we were curious to find out why it seems so difficult for some people to begin to use new and newest programming languages and how to overcome this situation. This paper aims to make an attempt to describe the entry threshold into new and newest programming and also compare the basic tools that are used in them.

The tools used in the research are the following:

1. Giving open classes for students and graduates of St. Petersburg Physics & Mathematics Lyceum # 30 (completely new to programming);
2. My personal experience in learning new languages and comparing them with those languages that I know;
3. My colleagues at work survey and their experience (20 respondents);
4. New programming languages Official documentation and description;
5. Other resources in open access;
6. Comparison of newest programming languages with existing ones based on their syntax (such as Java[1]), code structuring, integration with other languages, and basic tasks.

The survey was conducted according to Google Forms which was created especially for the purpose of this study. 120 young people of different ages participated in the survey. They are 30 students from Math Lyceum No 30 (15-18 years old) and different people from IT companies and University students related to IT (20 – 30 years old).

Thanks to the results it is possible to suggest how easy it is to understand new programs for different age groups and for people with different skills in programming. The results demonstrate the difference in programs acquisition for different age groups and for people with different skills in programming. We also conducted a comparative analysis of some new languages and existing ones in order to evaluate the effectiveness of creating new languages to achieve more convenient solutions to existing problems in development.

This study resulted in confirmation of the initial assumptions. The newest technologies make it much easier to cope with any tasks, however, in mastering these technologies, number of difficulties may arise, which can be described as follows: unintuitive syntax, long assembly of large-scale projects and lack of easy tools for faster work.

Programming today has become much more convenient to study. This is no longer ancient languages that were causing headache, but new tools that help programmers to implement their tasks easier and faster. New frameworks such as React, Redux, Next[2] and languages like Kotlin[3], Reason and Crystal[4] has become a real blessing for IT World.

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# DEVELOPMENT OF VEHICLE COUNTING SYSTEM'S PROTOTYPE

**Normunds Vētra**

Latvia University of Life Sciences and Technologies, Faculty of Information Technologies,  
undergraduate student, Latvia

**Armands Kviēsis**

Latvia University of Life Sciences and Technologies, Mg.sc.ing., Latvia

Nowadays, people are trying to follow several processes and actions by making statistics about them, such as how people spend their money, how many children are born, traveling routes and several more. With the help of these statistics, we can find crucial information about any given idea and create improvements or create some supports for these ideas. This research is related to vehicle counting on the road and can be considered as a part of the "smart-city concept"[1] that in its meaning relates to innovations to improve city efficiency and sustainability[2]. Usually different automation procedures are involved, to relieve people from manual work, so that the information wouldn't be influenced by human error. For example in Jelgava city, there are few places where vehicle counting systems are being used, e.g., video and sensory based systems are placed on the main road that goes through Jelgava so the traffic information in this city is limited. There are three kinds of vehicle counting methods, where two of them are automated and one is done physically:

- Video based counting[3] - this method is based on approach that uses real-time video footage, where the vehicles are identified by size and counted accordingly.
- Sensory based counting[4] - the idea of this method is the usage of any types of sensory gadgets, such as pressure, light or movement sensors to identify vehicles.
- Human based counting - this method is based on manual vehicle counting. Where people observe vehicles passing by a specific point on the road. Such method does not involve any automated systems and has the potential to introduce human errors.

The aim of this study is to examine and compare various vehicle counting methods and to develop an automated vehicle counting system's prototype, based on Arduino electronic platform and pressure based sensors. Such system is necessary to provide traffic flow related statistics including information about the vehicles speed, direction and count, during a period of time. This allows not only to track the traffic flow and usage of any certain road, but also follow up with the speed at which people are driving at.

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# ON DISCRETE UNIVERSALITY OF THE RIEMANN ZETA-FUNCTION

Giedrė Vitkevičienė

Šiauliai University, Department of Computer Science, post-graduate student, Lithuania  
Supervisor

Renata Macaitienė

Šiauliai University, Dr., Professor, Lithuania

The Riemann zeta-function  $\zeta(s) = \sum_{m=1}^{\infty} \frac{1}{m^s}$ ,  $s = \sigma + it \in \mathbb{C}$ , has an interesting universality property, which, roughly speaking means that a wide class of analytic functions is approximated by shifts  $\zeta(s + i\tau)$ ,  $\tau \in \mathbb{R}$ . That property was discovered by S. M. Voronin in 1975. Now the modern version of the Voronin theorem states that if  $K$  is the class of compact subsets of the strip  $\{s \in \mathbb{C} : \frac{1}{2} < \sigma < 1\}$  with connected complement, and  $f(s)$  is a continuous non-vanishing function on  $K$  which is analytic in the interior of  $K$ , then, for every  $\varepsilon < 0$ ,  $\liminf_{T \rightarrow \infty} \frac{1}{T} \text{meas} \{ \tau \in [0, T] : \sup_{s \in K} |\zeta(s + i\tau) - f(s)| < \varepsilon \} > 0$  (where  $\text{meas}\{A\}$  denotes the Lebesgue measure of a measurable set  $A \subset \mathbb{R}$ ). Thus, the set of shifts  $\zeta(s + i\tau)$  approximating a given analytic function  $f(s)$  is infinite, and even has a positive lower density. The proof of the statement can be found in [3].

Voronin's result turned out to be interesting for number theorists. Reich, Gonek, Bagchi, Good and others proposed new methods for proving of universality, improved Voronin's theorem and extended the universality property for other zeta and  $L$ -functions.

We will focus on the discrete universality of  $\zeta(s)$ , when  $\tau$  takes values from a certain discrete set. The simplest discrete result was given by Bagchi [1] for the set  $\{kh : k \in \mathbb{N}_0\}$ ,  $\mathbb{N}_0 = \mathbb{N} \cup \{0\}$ , where  $h > 0$  is a fixed number. His result has been extended by Dubickas and Laurinčikas in [2] for the sequence  $\{k^\alpha h : k \in \mathbb{N}_0\}$  with a fixed  $\alpha$ ,  $0 < \alpha < 1$ . For this, the uniform distribution modulo 1 of the sequence  $\{k^\alpha : k \in \mathbb{N}_0\}$  was applied. The properties of the sequence  $\{k^\alpha\}$ ,  $0 < \alpha < 1$ , were also applied, for example, in [4], where a joint discrete universality theorem for Dirichlet  $L$ -functions  $L(s, \chi)$  was obtained. The aim of this research is to present the discrete universality of  $\zeta(s)$  for the class  $\mathfrak{X}$  of sequences  $\{x_k : k \in \mathbb{N}\} \subset \mathbb{R}$  satisfying the following hypotheses: 1)  $\{ax_k\}$  is uniformly distributed modulo 1 for all real  $a \neq 0$ ; 2)  $1 \leq x_k \leq k$  for all  $k \in \mathbb{N}$ ; 3) for  $1 \leq k, m \leq N$ ,  $k \neq m$ , the inequality  $|x^k - x^m| \geq \frac{1}{y_N}$  holds with  $y_N > 0$  satisfying  $y_N x_N \ll N$ .

**Theorem [5].** *Suppose that the sequence  $\{x_k : k \in \mathbb{N}\} \in \mathfrak{X}$ . Let  $K \subset \{s \in \mathbb{C} : \frac{1}{2} < \sigma < 1\}$  be a compact subset with connected complement, and let  $f(s)$  be a continuous non-vanishing function on  $K$  which is analytic in the interior of  $K$ . Then, for every  $\varepsilon > 0$ ,*

$$\liminf_{N \rightarrow \infty} \frac{1}{N} \# \{1 \leq k \leq N : \sup_{s \in K} |\zeta(s + ix_k h) - f(s)| < \varepsilon\} > 0.$$

We observe that the sequence  $\{k^\alpha\}$ ,  $0 < \alpha < 1$  (that was analyzed in [2] for approximation of given analytic functions by shifts  $\zeta(s + ik^\alpha h)$  with  $h > 0$ ), is an element of the class  $\mathfrak{X}$ .

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**RURAL ENGINEERING AND ENVIRONMENT**  
***CIVIL ENGINEERING AND LANDSCAPE***

# BUILDING INFORMATION MODELLING (BIM) IN LATVIA

**Jānis Freimanis**

Latvia University of Life Sciences and Technologies, Faculty of Environment and Civil Engineering,  
post-graduate student, Latvia

**Sandra Gusta**

Latvia University of Life Sciences and Technologies, Associate professor, Dr.oec., Latvia

Latvian Construction industry is facing digitalization with consequent changes in existing project delivery approaches. It brings several benefits related to project process optimization, cost and time savings (especially for project owners in a full building life-cycle) as well as risk reduction, which all are now especially needed for Latvian industry, considering that the public funding for construction projects in Latvia is expected to decrease after 2020. To facilitate the development, improve the productivity and competitiveness of the industry there is a need for identification of limiting factors and prerequisites to successfully adopt the new technological opportunities.

Latvian construction industry has declared BIM development as one of its strategic goals that has to be achieved until year 2022 [1]. Criteria for use of BIM processes have been worked within Guidelines for the economically most feasible offer determination in public procurements [2]. Other countries are taking a step forward beyond that and developing BIM information management standards and setting a mandate for those when delivering large projects [3].

The aim of the research is to identify prerequisites and constraints for the development of BIM within Latvian construction industry as well as provide recommendations for involved parties to facilitate BIM development within the industry.

Semi-structured interviews have been chosen as the primary information source to investigate the existing situation in the construction industry from several different key stakeholder organisations' viewpoint and to identify specific questions to be analysed quantitatively.

The interviews are followed by a secondary method which is a survey, covering private sector companies which operate within project delivery chains. Survey provides data which is processed to create quantitative information that can be used for evaluation of BIM development influencing factors and respective decision making regarding importance of the mentioned factors.

The research including both methods is being carried out in the first two quarters of 2018.

Findings show that there is a lack of strong well developed strategy regarding construction industry digitalization as well as lack of organized activities. The initiatives within the industry are fragmented. Educational institutions have undertaken initiatives for BIM inclusion or integration within study programs that prepare specialists for construction industry. Recommendations for non-governmental organizations and educational institutions to facilitate the Latvian construction industry digitalization have been worked out on the basis of the research results.

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# **ANALYSIS OF A+ ENERGY EFFICIENCY CLASS REQUIREMENTS FOR SPORTS BUILDINGS**

**Dovydas Janušas, Aurimas Einikis**

Klaipeda State University of Applied Sciences, Faculty of Technology, undergraduate students, Lithuania

**Vida Ovaltaitė**

Klaipeda State University of Applied Sciences, Faculty of technology, Lecturer, Lithuania

The energy efficiency of buildings and heat consumption began to be concerned about in 1973, when the energy crisis arose. Then the first building energy efficiency audits were carried out. Global warming and rapid climate change prompted energy-saving movement. According to the new European Union directive, from 2014, the owner will have to provide data on the actual energy consumption of the object when selling or renting a house or apartment. Nowadays, real estate owners are already obliged to do so, but this obligation is not functioning effectively.

This problem is particularly important for large buildings, because they consume extremely high amount of energy. In Lithuania, a lot of attention has been paid recently to the construction of multifunctional sports buildings. During events those buildings use the most energy. Therefore, it is particularly important for the designers of sports facilities to pay more attention to its energy efficiency class, so when no events are taking place, less money is allocated for maintenance of the building. In accordance with the legislation in force in the Republic of Lithuania from 2018 1 January All newly built buildings must meet the requirements for A + energy efficiency.

The report analyses structural, architectural, engineering solutions that ensure sports buildings A + energy efficiency class compliance with legislation. Differences between A + and A ++ (the highest energy efficiency class as defined by the applicable legislation in Lithuania) energy efficiency classes. An overview of the influence of the building's purpose on the energy efficiency class.

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# **BUILDING DEFORMATION DETERMINATION WITH TERRESTRIAL 3D LASER SCANNER**

**Raimonds Katkovskis**

Latvia University of Life Sciences and Technologies, Faculty of Environment and Civil Engineering,  
undergraduate student, Latvia

**Armands Celms**

Latvia University of Life Sciences and Technologies, Dr.sc.ing., Latvia

Measuring building deformations makes a significant part in the work of engineering geodesy. The main reason for making these measurements is to understand how severe is the deformation, and to understand how quickly the problem must be solved to keep building in normal use in future. Many essential building sites can't be imaginable without the survey of deformations [2]. Nowadays, more and more is used laser 3D scanning, also in surveying deformations of buildings.

In geodesy practice term of deformation usually means changes of building in spatial state. Deformations of buildings are classified in: horizontal (shift), vertical (sinking), spatial (leaning) [1]. To determine most of building's deformations, usually uses a geometric leveling, trigonometric leveling, hydrostatic leveling, micro leveling and photogrammetry [2].

Determination of building's sinking and movement has always been and still is one of the most important tasks in engineer building. A special interest is made by a possibility to use a terrestrial laser scanner to determine deformations of buildings and safety of structural elements. Using laser scanning technology in these spheres is helping not only to decrease labor costs but also it's a possibility to acquire information about large amounts of points in one physical moment by using non destructive method, which is very important in measuring the dynamic buildings deformations.

Advantages of terrestrial 3D laser scanner are: high degree of automation, 3D visualization in real time, high precision of measurements, provides high level of safety in scanning objects that are hard to reach and in dangerous environments, highly efficient. These facts makes laser scanning most economically advantageous amongst other methods. Also with laser scanner it's possible work in poor lighting, it has high level of detail and multifunctional use [3]. By summing up all the facts, it's possible to determine that laser scanning is very precise and fast, it can replace all previous methods of surveying structural deformation also it means that laser scanner can replace all previous hardware.

Observation and survey of building deformation has been done in Palace of Jelgava, north-east wing with 3D laser scanner "Trimble" FX3. Before beginning of laser scanning there was made support points, to enable measured material to be inserted in system of coordinates.

This part of the palace was scanned two times in large time span so that it would be possible to compare scanned material (clouds of points) and to determine that there is or is not happening structural deformation.

Research allowed to learn how to operate terrestrial 3D laser scanner, understand process of scanning, understand differences in types of building deformations and how they are exposed in practice. This research will be very useful in future professional growth.

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# LEVELNESS OF CONCRETE INDUSTRIAL GROUND FLOORS IN LATVIA

Mareks Pavārs

Latvia University of Life Sciences and Technologies, post-graduate student, Latvia

Sandra Gusta

Latvia University of Life Sciences and Technologies, associate professor, Dr. oec., Latvia

## Introduction

This research explores what makes industrial concrete floors different from ordinary concrete floors and what are the main requirements and their indicators for the quality of floors in individual countries. The quality flooring is based on a complete understanding of the requirements of use and necessity. In this research key attention is paid to the regularity of the surface of industrial concrete floors in accordance with requirements and quality control. Each country has its own standards for determining the floor quality [1].

## Research methodology choice.

In this study, mostly used the empirical research method, which is an experiment (active research). Experiment is a type of research that, by means of special methods, instruments and equipment, actively affects the subject or phenomenon under investigation, creating conditions which correspond to the purpose of the research, and the artificial induction of the phenomenon being investigated. The main purpose search experiments is to collect information necessary for clarifying any hypothesis or choice in a short time with a small amount of funds. Measuring a physical size means comparing it with another same nature size, which accepted as a unit [2].

## Results of surface quality measurements

According to the British technical report, a measurement grid is designed to measure the floor surface in steps of 3.0m \* 3.0m and measurements at intersection points of the network axis [3]. For measurement of surface flatness, the measurement value is 1/10 of the total area of the floor. In our case, the required level of flatness of the floor surface is  $2458.0 / 10 = 245.8$  t/m. Using a surface levelness measurement network, the number of measurements is sufficient if we use each second measurement network in each direction, it is every ~ 6.0m, which collects 360.0 t /m. To measure the levelness we used 3.0m long aluminum lata [3] and Wurth electronic caliper, as well as pencil and paper for recording. The results of the experiment, the surface levelness, the obtained data graphically depicted in Figures. The curves shown in Figures clearly show us the maximum and minimum values obtained as a result of the calculation, which is within  $\pm 15$ mm. By eliminating the data obtained in the largest calculations up to a 95% limit [3], it is obtained that the maximum surface irregularity in both the longitudinal and transverse directions is within an acceptable range of 9.0mm.

## Conclusions

1. With the concrete leveling technology used in this facility, it is not possible to obtain a standard floor surface maturity, while the surface plain is at a critical boundary reaching the maximum values specified in the Standard.
2. For Latvian businessmen engaged in the construction of concrete floors, think about the use of advanced technologies in their operation, such as „Laserscreed” installation equipment.
3. Responsible designers should, in the design process, include standard requirements for the floor use and in Latvia it would be necessary, at the national level to develop appropriate standards for determining the quality of surfaces of industrial concrete floors.

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# THERMAL ENERGY MANAGEMENT

Vilnis Sēlis

Latvia University of Life Sciences and Technologies, undergraduate, Latvia

Irina Orlova

Latvia University of Life Sciences and Technologies, Mg.philol., Latvia

In order to make proper living conditions, humans have been managing thermal energy since the beginning of humanity. Thermal energy is managed to keep optimal temperature of environment, to prepare and store food, for production and building processes, etc. Every building has its system to meet its required temperatures in various applications. With the price of energy rising and the global climate changes, a lot more attention is paid to cost-effective environment-friendly energy use.

Almost every building has a heating system, hot water heating, air circulation system and cooling system. It depends on the use of the building and how advanced each of these systems is. As usually, each of these systems works separately, thus, a lot of energy is wasted. First, energy is used to heat things up, like radiators, cooker, hot water boiler, etc. If there is steam, gases or smells generated in the process it is ventilated outside. If there is too much heat buildings are cooled down with air conditioners. Most of the air ventilated outside has higher temperature than average room temperature. A lot of hot water going in to drainage is hotter than incoming water supply. Air conditioners conduct absorbed heat from building in to atmosphere. In a simple apartment this energy waste is relatively small, but in commercial buildings this is a huge amount of energy wasted. There for there is a need for thermal energy management.

To provide a sample of wasted energy, a measurement took place in a cafe/bar/fast food restaurant opened 12h a day 7 days a week, with an average of 500 customers a day. Average electricity usage 3540kWh/month (590Eur), natural gas 1240m<sup>3</sup>/month (495Eur), central heating 300Eur/month, water supply 120m<sup>3</sup>/month (255Eur).

Main equipment and average energy(that can be recycled or saved) usages: natural gas continuous flow water heater Junkers WR 11-2P (7-19kw)(natural gas 300m<sup>3</sup>/month generates 90m<sup>3</sup> of 40C water, 80m<sup>3</sup> going in to drainage), electrical boiler 10l 1.5kw, 3,5kw motor for ventilation (1500m<sup>3</sup>/hour of 36C air 360 hours of runtime monthly), 6 central heating radiators, 8 refrigerators (10.6kwh/24h), 8 freezers (12kwh/24h). It is planed to add air conditioning in storage and kitchen. Although most of the equipment is gas powered, therefor more cost-effective than electrical devices, still a lot of energy is wasted.

Most efficient energy recycling would be from ventilation. Absorbing heat from ventilation and directing it in to customers area would be enough to replace central heating. Simple drainage heat recovery would pre heat incoming water supply, recovering 25% of used energy, more complex systems would recover up to 50%. Placing refrigerator and freezer conductors in more cool place or making central cooling system would decrees energy usage, and it can be directed to area where heating is needed. In hot season (when heating is not needed) recovered thermal energy can be directed to a specific water heating system consisting of sections of water storages with different temperatures required by heat source groups. Groups would consist of ventilation heat exchanger, drainage water recovery, air conditioners (planned to install this year), freezers, and refrigerators. Then, preheated water would be distributed to utilization points.

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# MULTIFUNCTIONALITY OF GREEN INFRASTRUCTURE

**Aiga Spāģe**

Latvia University of Life Sciences and Technologies, Faculty of Environment and Civil Engineering,  
undergraduate student, Latvia

**Daiga Zigmunde**

Latvia University of Life Sciences and Technologies, Dr. arch., Latvia

The European landscape has faced the loss of habitats and fragmentation to a greater extent than other regions. This is why Europe is paying more attention to the implementation of green infrastructure. In Latvia is a new concept, therefore, it is necessary to study the multifunctionality and potential benefits of green infrastructure.

The main objective of the study is to understand the strategy of green infrastructure – the structure, multifunctionality and existing planning examples. In order to achieve the objective of the study it is necessary to analyze the content of green infrastructure and the preconditions for sustainable development, focusing on the basic system consisting of elements of hubs and connections, which, as a result of interaction, ensures the sustainable existence of green infrastructure [1]. In the context of European integration, green networks are becoming increasingly important from both social and ecological point of view. Since the beginning of 1990, the public and scientific cooperation has been focused on nature conservation strategy [2]. The green structure nowadays is not only an ecological and sustainable process, but it also includes economic and social benefits. Attractive green areas make a great contribution to the strengthening of the identity of the surrounding area and reinforce its cultural and historical features, providing a wide range of uses both for peaceful recreation in nature and for games in informal playgrounds. Connected green elements encourage a healthier way of life, walking and cycling in a well-maintained and safe environment that at the same time provides the protection of biodiversity [3]. Currently, there are no such strategies in Latvia, and there are only a few cities that have drawn attention to the planning of the plantings in the city. The study examines how Latvian legislation currently supports and regulates the implementation of green infrastructure [4]. To carry out the research the author used the practical research method – comparative method, theoretical research method – source analysis, monographic or descriptive method, information gathering and analysis methods.

The study reveals the accordance of green infrastructure with all the preconditions for sustainable development planning. The green infrastructure strategy provides not only ecological and aesthetic quality but also social and economic benefits. The study allows one to draw conclusions about the legislation in Latvia and the awareness of the necessary improvements so that the green infrastructure strategy can be fully implemented throughout the country.

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## **SOLARWALL**

**Evaldas Šalaševičius**

Alytaus Kolegija University of Applied Sciences, Faculty of Engineering and Biomedicine,  
undergraduate student, Lithuania

**Sigita Alavočienė**, lecturer, MBA

Recently, much attention has been paid to the use of renewable energy in buildings. When assessing renewable energy sources, the sun has the highest potential for energy, therefore, today intensive efforts are being made to transform this energy into heat or electricity. Active solar and passive solar collectors are most commonly used in solar thermal energy technology solutions.

The solar wall (Unglazed transpired solar collector) system is simple: the southern facade of the building is fitted with a perforated dark metal coating, which is distanced a certain distance from the outer wall of the building.

The solar wall is connected to the ventilation device, which creates an artificial air traction. The air is pumped through the entire area of the solar wall, through thousands of small holes. The air is then warmed up, then it enters the ventilation device and is distributed in the building.

Typically, when using a solar collector, it is used in winter and during a transition period when heat is needed to heat the premises. In the summer, this collector is not used - the air is delivered to the premises through the rush valve. The question is what happens if the solar collector is not used, because in summer there is a high solar radiation and high environment temperature. The manufacturer of unglazed solar-powered solar collectors says that the solar collector protects the external barrier against direct sunlight-reduces the room's cooling demand.

However, the manufacturer does not indicate how much cooling demand is reduced. It is clear that the solar wall works in the partition's thermal regime and in the winter, because there is warm air in the sun's wall, this effect should be positive. Again, it is unclear how much heat loss can be reduced through the outer partition in the winter, when it is equipped with a sun wall.

Assessing the scope of today's research, it is possible to distinguish between two countries with a particularly high scientific contribution to the study of unglazed solar collectors. This is currently USA and Canada. The basics of the field under study are based on US scientists. They developed the theory of collector heat exchange, carried out experimental research, developed numerical models, simulated the heat exchangers in the collector, assessed the influence of wind on collector efficiency, and carried out economic assessments.

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***LAND MANAGEMENT AND GEODESY***

# LOCAL GEODETIC NETWORK DEVELOPMENT TENDENCIES IN RIGA

**Jānis Akmentiņš**

Latvia University of Life Sciences and Technologies, Faculty of Environmental and Civil Engineering,  
undergraduate, Latvia

**Armands Celms**

Latvia University of Life Sciences and Technologies, Dr. sc. ing., Latvia

The local geodetic network plays an important role in the development of the city's territory. Based on the local geodetic network, cadastral and topographical surveying, geodetic engineering works, and execution measurements of newly built buildings, structures, and engineering networks are carried out.

In the territory of Riga, the first triangulation network was established during the period from 1880 to 1882. On its basis, a polygonometric network was created. As the city developed and expanded, it became necessary to establish new polygonometric networks [1]. Until 1990, it is possible to distinguish six main projects where polygonometric networks were established in Riga territory. The data obtained as a result of these polygonometric network projects do not correspond to the demands of the 21st century [2].

The aim of the research is to identify the differences between the coordinates of the local geodetic network points determined at different time periods, to determine their coordinates using modern technologies, and to analyze the effect of the differences observed on cadastral surveying, topographic surveying, and execution measurements.

For the study, 50 polygonometric points were selected with coordinates calculated in 1963 in the coordinate system of 1942 and in 1989 in the local coordinate system of Riga. During the study, measurements were made using the GNSS receiver Leica GS 14 with a real-time correction to determine the coordinates and height of these polygonometric points. Measurements were made in accordance with the recommendations of the Latvian Geospatial Information Agency, fulfilling the minimum conditions for the real-time correction signal capture measurements to achieve 2-centimeter accuracy in RTK mode. The coordinates and heights of the polygonometric points selected were determined using three GNSS base station networks: LatPos, EUPOS-RIGA, and Trimble. The coordinates of the points determined in 1942 and in Riga local coordinate systems on the LKS 92TM system were transformed using a coordinate transformation program developed from 1996-98 by the National Survey Center of the State Land Service [3].

The research shows that there are significant differences between the coordinates of the local geodetic network points calculated in 1963 and 1989 and the coordinates determined using modern technologies. Therefore, the main conclusion is that local geodetic network points in Riga should not be used for any kind of surveying until the local network is upgraded and meets the accuracy requirements determined by the legal regulations.

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# THE ANALYSIS OF APPLICATION OF GEO-REFERENCED TECHNOLOGIES IN CADASTRAL MEASUREMENTS

**Benas Beniušis**

Aleksandras Stulginskis University/Institute of Land Management and Geomatics, Faculty of Water and  
Land Management, post-graduate student, Lithuania

**Daiva Tiškutė-Memgaidienė**

Aleksandras Stulginskis University/Institute of Land Management and Geomatics, lecturer, doctor of  
agricultural sciences, Lithuania

The cadastral measurements of land plots are performed according to the documents of territory planning, the resolutions of Government of the Republic of Lithuania that regulate the data collection of Government Real Property Cadastre of the Republic of Lithuania. However, not always measured land plot borders match defined borders indicated in the documents of territory planning and factual land usage [1]. In the developing countries the advanced technologies for land measurements are used more and more often in order to optimize expenditures and assure the precision of land measurements. Therefore, innovative attitude towards land measurements and application of advanced technologies become relevant. The application of innovations in land measurements ensures the decrease in the expenditures and consumed time as well as the increase in the efficiency of activities [2]. The primary data has a great impact on cadastral measurements. Geo-data that is necessary for land planning ought to be reliable, accurate enough and detailed as well as constantly renewable and available.

The aim of this study is to analyse and evaluate the application of geo-referenced technologies in cadastral measurements in Lithuania.

The method of expert questionnaire and descriptive statistical analysis using MS EXCEL programme package have been used to collect and evaluate the data of this research. The set of questionnaire for this research is 50 respondents. The specialists of their own spheres that took part in this research were the land-surveyors of Kaunas region.

The research has revealed that the land-surveyors prepare about 10 cadastral files in a month on the average. About 50-80 percent of all prepared cadastral files are delivered from the very first time. Universal instruments and software are used while compounding topographical land pictures. Usually GPS devices “Trimble” and software package “GeopMap 2017” are used for making drawings of cadastral measurements. The most important factor for purchasing new geodesic devices and software is the price. According to the respondents, the level of geo-referenced technologies in the country is adequate and innovations in the sphere of cadastral measurement should be financially promoted from the State budget.

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## FARM SIZE AND CHARACTERISTICS INDICATORS

**Elēna Blumbaha**

Latvia University of Life Sciences and Technologies, Faculty of Environment and Civil Engineering,  
Master student, Latvia

**Anda Jankava**

Latvia University of Life Sciences and Technologies, Dr.oec., professor, Latvia

Land is the most important thing in the national economic sector, which is the base for agriculture and for food. One of the most important factors to use land economically is a rational size of farm.

The rational size of farm provides for the farm's production force, for example, land, labour force, buildings, productive animals and the amount of machinery. Production force in specific conditions gives a chance to get maximum production quantity from land with minimal work and consumption of funds. Because of agriculture material technical base developments and production force improvements the rational size of farm is changing [1].

Several indicators are used to characterize farm size: production per year, land area, amount for fixed assets, number of livestock and others. In the European Union agricultural holdings are divided into economic size groups. Groups are broken down per standard output values. Standard output is value expressed in EUR of the corresponding region. Standard output value is a production of agricultural crops acquired per hectare during the year expressed in monetary terms [2]. There are three economic size groups for agricultural holdings: small farm holding (up to EUR 14.9 thsd), medium-sized farm holding (from EUR 15.0 – EUR 99.9 thsd), and large farm holding (over EUR 100 thsd.) [3]. But very often land area is used as indicator for farm size characterizing. The size of a holding can be applied to compare equally specialized farms. When the land area size is used as an indicator, it would be better called as the rational size of the agricultural holding's territory.

For successful agricultural management J. Zusevics believes that the size of the farm should be grouped by land area and that it needs a landlord. Professor advocates to group land area size into five groups: farms with an area of up to 5 hectares, from 5 to 10 hectares, from 10 to 20 hectares, from 20 to 50 hectares and farms with an area over 50 hectares, defining different management form for each group [4]. Such farm size guidelines complies with Latvia's economic conditions. Of course, the guidelines may vary, because farms differ with production specialization and location.

Analysing Latvian farms by economic size, it has been established that in the last years the number of large farms in 2016 has increased by 600, compared to 2013. By 2016, the medium-size farms, compared to 2013, has increased by 1.6 thsd. But the number of small farms has decreased by 14.1 thsd.

Over three years (from 2013 to 2016) the number of farms has decreased by 11.9 thsd, but the area of agricultural land has increased by 53.1 thsd. hectares [3].

To sum up, the number of small farms is decreasing at the expense of large farms.

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# EVALUATION ON THE CHANGE OF URBANIZATION OF RURAL TERRITORIES IN ŠAKIAI DISTRICT MUNICIPALITY

**Gabija Dikavičienė**

Aleksandras Stulginskis University/Land Management and Geomatics Institute, Faculty of Water and Land Management, master student, Lithuania

**Virginija Gurskienė**

Aleksandras Stulginskis University/Land Management and Geomatics Institute, docent, doctor of technological sciences, Lithuania

The aim of this research is to analyse the change in depopulation of rural territories in Šakiai district municipality. The Šakiai district municipality territory planning documentation solutions, statistical data, scientific works, normative and other documents have been analyzed. Methods of information seeking, systematization, analysis and synthesis were used to achieve the purpose of the research.

Growing cities have a great influence on the villages nearby, as neighboring villages grow along with cities, while remote villages disappear [1]. After the fulfilment of an overview of the documents on territory planning (including land use planning) it can be stated that a number of plans have been developed throughout the municipality, the main purpose of which is to create conditions for a permanent, motivated growth of quality of life.

The master plan of Šakiai district municipality has been analyzed. This master plan seeks to concentrate the rural inhabitants of the district in 7 residential areas (construction of new residential houses) while developing the engineering infrastructure and public services [3]. It has been established that detailed plans and rural development land use planning projects do not have significant impact on the change of urbanized territories.

In Šakiai district municipality, 12 villages were eliminated from the Register of Addresses (507 in 2009 and 495 villages in 2017) during the period between the years 2009 and 2017. In Šakiai district, as in the whole of Lithuania, changes in demographic processes occur in a disadvantaged way – the population is decreasing, the society is aging, mortality is increasing. The analysis on the distribution of the population in Šakiai district during the period between the years 2011 and 2015 shows that in rural areas the number of inhabitants decreased by 1774 during four years, i.e. 8% of the total rural population. According to the data of the population census, after analyzing the population change in the cities and larger villages, it has been established that during the period between the years 1989 and 2011, in the eight small towns it decreased by 1091 inhabitants, i.e. almost 20%, and in 57 villages – 1915 inhabitants or 15%, of which four villages have fallen by more than 100 inhabitants [2]. A significant proportion of younger people go to bigger cities or travel abroad. The built-up area in Šakiai district is increasing marginally. This increase is much lower than in the municipality of the county center – the city of Marijampolė or in the neighboring municipalities of Kaunas County.

The Šakiai district municipality's current master plan envisages concentrating the inhabitants of the district in 7 areas, providing for the construction of new residential houses, and developing infrastructure. Urbanization of territories is much more active near larger cities – Vilnius, Klaipėda, Kaunas, in part – Marijampolė, rather than in the analyzed municipality center – Šakiai city.

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# PERSPECTIVES OF RURAL TOURISM IN THE MIDDLE LITHUANIA REGION

**Rita Valentina Golcova**

Aleksandras Stulginskis University, Institute of Land Management and Geomatics, Faculty of Water and Land Management, master student, Lithuania

**Audrius Aleknavičius**

Aleksandras Stulginskis University, Institute of Land Management and Geomatics, Prof.dr., Lithuania

Favorable conditions have emerged for the changes of rural development policy and promotion of new approaches after accession of Lithuania to the European Union. One of the areas supported by the Rural development program is the development of rural tourism. Research object is Middle Lithuania region. It was chosen due to nice landscape, good natural conditions for rural tourism development and authentic ethnic environment.

The development of rural tourism homesteads are determined by various factors: both natural (forests, water bodies, diversity of nature) [1,2], and human created factors (quality of services, sports and entertainment offer, ethnic environment) [3].

There were 661 rural tourism homesteads in Lithuania in 2016 and since 2013 this number gradually increased by 41 (6.6%). There were 149 rural tourism homesteads in the Middle Lithuania region in 2016 which is 22.5 % from the total number in Lithuania. The goal of the research is to analyze the current state of rural tourism and its development opportunities in the Middle Lithuania region.

Accomplishing this task the analysis of rural tourism homesteads located in Kaunas, Kėdainiai and Raseiniai municipalities was carried using the cartographic material and general plans of these territories. In total, 46 rural tourism homesteads were analyzed and the following factors affecting the distribution of homesteads were investigated: protected areas, natural and landscape objects, settlements and transport infrastructure.

According to the analysis data, 7 rural tourism homesteads are located within the boundaries of protected territories and 9 more are not more than 0.1 – 0.5 km away from the boundaries. It is assumed that small number of homesteads in protected areas can be a result of more strict requirements and land use regulations for economic activities and constructions.

Natural elements of the landscape, such as rivers, lakes and ponds, are also very important for rural tourism. 26 farmsteads are located near all large water bodies (from 0.1 to 1.3 km). Artificial water bodies like ponds are created in homesteads, which are not close to the rivers or lakes.

The demand for rural tourism and the density of homesteads depend on the need determined by the population concentration. The number of farmsteads in Kaunas municipality (which has a largest population) is 2-3 times higher than in Kėdainiai and Raseiniai municipalities.

The study also found out that good access roads are of great importance for the location and successful economic activity of the rural tourism homestead. The average distance from the highway is 2.0 km in all 46 farmsteads.

After accomplished analysis we can conclude that choosing optimal location for rural tourism homesteads the distance from the main roads should not exceed 3 km and there should be a water body for recreation (up to 1 km) is a water body for recreation. Such requirements are met by 19 (41.3%) of analyzed rural tourism homesteads.

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# ANALYSIS OF EROSION AND ACCUMULATION PROCESS ON THE BALTIC SEA COAST FROM NORTHERN PIER UP TO DUTCH HAT

Samanta Greferytė, Iveta Paliokaitė, Raimonds Rimkus

Klaipėda State University of Applied Sciences, Faculties of Technologies, Environmental and Construction Engineering Department, undergraduate students, Lithuania

Birutė Garnienė, Indrius Kuklys

Klaipėda State University of Applied Sciences, Faculties of Technologies, Environmental and Construction Engineering Department, Lecturer, Master

Baltic sea is a part of Atlantic ocean, deeply entangled into Northern Europe. Lithuania has the shortest coastline – only about 90 kilometers, which have sandy beaches and accumulation dunes. Global climate changes, frequent hurricane storms, rise of sea level, lack of sand resources promotes coastline erosion. Also huge influence has maritime industry development. To detect changes, each two years after serious storms geodetic measurements are carried out. Coastal measurements from the north pier to the Dutch Hat were made to find out erosion and accumulation changes.



1 image. Baltic sea shore section from north pier to Dutch Hat

The coast was divided into 8 sectors with a distance of 1 km. The study was conducted in 2010-2017. Summary of changes in the shores of the Baltic Sea (from the northern pier to the Dutch Hat). The study identified specific areas of the Baltic Sea coast exposed by erosion and accumulation processes. During the period of 2010 – 2017, the Baltic Sea coast (from the north pier to the Dutch Hat) had a rapid erosion throughout the territory, and especially in the first ( $25052 m^2$ ), fifth ( $10792 m^2$ ), sixth ( $10727 m^2$ ) and eighth ( $10667 m^2$ ) sectors. The rapid accumulation took place in almost the entire territory, except in the first, seventh and eighth sectors. The reason for the changes in the first sector is the nearby northern pier, where the coast is volatile and constantly changing. The 7-8 coastal sectors on the Dutch Hat every year, especially after the storms of the cold season, suffer from increasing erosion. This area of the Baltic Sea beach is currently on the line of extinction. The greatest impact on coastline variations is due to the waves, the prevailing winds, extreme climatic phenomena, and the movement of underwater currents. To save the coast from the north pier to the Dutch Hat, it is necessary to replenish the sand, strengthen the clusters, and upgrade the quays.

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# **MODERNITY OF GEODETIC DEVICE DESIGNS: PROBLEM OF USE AND PERSPECTIVE ON THE CONSTRUCTION SITE**

**Indrė Jonušonytė**

Klaipėda State University of Applied Sciences, Faculties of Technologies, Environmental and Construction Engineering Department, undergraduate student, Lithuania

**Raimonda Sūdžiuvienė, Indrius Kuklys**

Klaipėda State University of Applied Sciences, Faculties of Technologies, Environmental and Construction Engineering Department, Lecturers, M.Sc.

Precision of geodetic measurements is relevant for solving various geodetic problems, i.e. measuring horizontal and vertical angles between directions, determining the length of sections, the position of individual points on the earth's surface in certain coordinate systems, designing structures for various uses, examining structural deformations, etc. Construction requires highly precise geodetic measurements. However, the measurement conditions are often complicated. Measurements feature large tilts of geodesic instrument alignment beam angles, alignment beams are not always perpendicular to the plane in which they are stamped and approved. Complexity of measurement conditions can affect the measurement errors. However, the impact of measuring conditions on structures is not the same for all devices. Recently, automatic electronic rangefinders and total stations have been widely applied for surveying, construction, controlled-slowed-images, structures and determining of building deformations. Since most of the measurements are carried out outdoors, it is inevitable that various additional external factor (trigger) distort measurements. So that is why the purpose of our report is to examine the principle of operation of the total station and the benefits of measurements on the construction site. To achieve this objective, we raise the tasks such as: 1) analysis of components of the total station; 2) overview of the operating principle of the total station; 3) it is also important to consider how the environmental factors affect high-precision measurements. Distorted and non-linear surfaces, inappropriate colour, prevailing rainfall or interrupted flow of light yields false or distorted data, the inaccuracy and inconsistency whereof to reality negatively affect measurements quality. By performing the measurements of the construction site in different ways, accurate measurements obtained with tachymeter are characteristic to this area and to subsequent construction activities. In the conclusion using automatic tachometers and rangefinders at the construction site, it is not compatible to perform their control measurements are during the construction and installation work with the devices, the measurement of which it requires the reflector prisms because not all was these prisms can be installed on the measured point. It is therefore most convenient to use devices without prisms. Even more convenient is to work with devices with a visible laser beam. Rangefinders mounted to theodolites are widely used in construction. But in order to ensure high quality work with such device, one has to understand the principles of operation of devices, their measurement capability, etc. Only this way we can avoid measurement errors.

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# ACCURACY ASSESSMENT OF DIGITAL SURFACE MODEL MADE BY PHOTOGRAMMETRIC METHODS

**Gytis Juozapavičius**

Aleksandras Stulginskis University/ Institute of Land Management and Geomatics, Faculty of Water and Land Management, master student, Lithuania

**Donatas Jonikavičius**

Aleksandras Stulginskis University/Land Management and Geomatics Institute, associate professor, doctor of technological sciences, Lithuania

Aerial mapping is one of the most advanced tool for obtaining information on objects on the Earth's surface, their position and purpose using photographic images. The main tasks solved by photogrammetric methods are the determination of the position and purpose of various objects of the Earth's surface in photographic images. The annual falling cost of the system and the improvement of the quality of digital images and the automated process of data processing make the field of science very relevant. Photogrammetry of unmanned aerial vehicles systems (UAVs) opens up new opportunities for aerial photography and terrestrial photogrammetry. This is a new, remote-sensing application and a cheap alternative to classic aeronautical photogrammetry.

The purpose of this study is to evaluate accuracy and quality of DSM made by small format aerophotos, as well as to get clear answers about the possibilities of lawfully using them in specific fields. For this research, about 200 hectares of the territory of the Republic of Lithuania were selected in the Kaunas District Municipality, Ringaudai subdistrict. The use of small-format aerial photographs taken by the BEKAS Ch32 ultra-lightweight aircraft with a Nikon D800E CIR camera (focal length of 28 mm) is a digital surface model and its accuracy is estimated. Accuracy is estimated by calculating the mean square error of the verification points. The Agisoft PhotoScan software is used to generate the DSM.

The measurements using the Trimble R8 GNSS receiver and the Trimble 5500 series electronic tacheometer were used as a basis for assessing the accuracy of the model. In the study area, 100 points were measured (hills, ditches, slopes, roof corners of buildings, engineering wells, etc.). Points to measure with an accuracy of 0.02m cm. The obtained results were also compared with the surface model obtained using LIDAR data (2007).

It was determined that the mean square error in the comparison of ground measurements with the digital surface model obtained by photogrammetric data is 0.17 m. An analogous comparison of ground measurements with data from the digital surface model using LIDAR data is 0.14 m. It is concluded that the precision of photogrammetric surface models is very high. The precision of the right is slightly different from that of a very precise surface model obtained using LIDAR data.

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# ASPECTS OF SOUTHERN LITHUANIAN ETHNOGRAPHIC VILLAGES

**Gintarė Jurčiukonytė**

Aleksandras Stulginskis University/ Institute of Land Management and Geomatics, Faculty of Water and Land Management, master student, Lithuania

**Virginija Gurskienė**

Aleksandras Stulginskis University/Land Management and Geomatics Institute, docent, doctor of technological sciences, Lithuania

The aim of this research is to examine the aspects of the change of ethnographic villages in southern Lithuania. The research was carried out by analyzing scientific literature, cartographic material, the legal basis of the country. The GIS information system was used to create the planned substance. As the subject of the research three ethnographic villages in Southern Lithuania were selected: Darguziai, Musteika and Zervynos located in Varena district.

The problem of ethnographic rural change is not extensively investigated not only in Lithuania but also in other EU countries, therefore the real estate objects data were collected and analyzed their use in the research. The ethnographic village in Lithuania differs from other villages in the following ways: land use or land plot, the regional peculiarities of residential areas and individual homesteads, landscaping and adaptation to the environment, etc. In order to preserve the buildings of ethnographic villages as long as possible, it is necessary to take a look to the subtleties of the historically developed landscape and architecture of the area, the architecture of the buildings should not be distinguished in the rural natural and urbanized environment. Construction, reconstruction, repair, etc. in the ethnographic villages is more strictly regulated than in other villages. The oldest built building is in Darguziai village in 1856. Most of the buildings were built in Darguziai in 1988 – 14 buildings, in Musteika and Zervynos villages the largest number of buildings was built in 1940, in Musteika – 6, in Zervynos – 44 buildings. From 2011 to 2017 in the analyzed villages written approvals for the reconstruction or repair of buildings were made: in Darguziai village – 9, in Zervynos village – 4, in Musteika village – 8. The construction of new buildings also distinguishes Darguziai village, from 2011 6 new buildings were built, while in Zervynos only 1. The lower number of permits construction and conversion of new buildings in Musteika and Zervynos villages shows that villages situated in Dzūkija National Park have got stricter building construction and conversion conditions. Most of the buildings in ethnographic villages are from timber. In Darguziai village timbered buildings represent 44%, carcass – 35%, brick – 8%. In Musteika village 100% of buildings are timbered, in Zervynos village 74% of building are timbered, 15% of the carcass. It is due to the preservation of old traditions.

Most of the analyzed villages territory is formed by forests, and they occupy more than 50% of all villages. By analyzing the use of land restored during the land reform, citizens who have land plots in the protected part of the ethnographic village were randomly selected and it was determined how the other plots of the same citizen were located. It was observed that in all the villages analyzed citizens have one plot of land, one plot of land cultivated (averaged 150-200 meters from the house), one plot of land used for agricultural activities (about 650 meters from the house) and another one usually a forestry plot on average (about 1800 m from the house). Such a division of grave villages into parcels (one of the analyzed villages had features of Valakai land reform carried out in the 16th century) is rather inconvenient to the citizens.

In order to maintain the valuable features of ethnographic villages for a long time, it is necessary to promote and support local people, communities, search for sources of funding for restoring and preserving buildings and preserving old tradition.

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# PREVALENCE OF INVASIVE SPECIES SOSNOWSKI HAWTHORN IN JELGAVA DISTRICT

**Viktorija Korotkēviča**

Latvia University of Life Sciences and Technologies, Faculty of Environment and Civil Engineering,  
Master student, Latvia

**Anda Jankava**

Latvia University of Life Sciences and Technologies, Faculty of Environment and Civil Engineering,  
Dr.oec., professor, Latvia

Land is the main resource which are used by humans to survive. It can be used in agriculture, for building, but sometimes land is not used for its aim or it can be abandoned because of many reasons which can cause land degradation. Main causes which can cause land degradation are primitive use of pasture, primitive agrotechnics which are used inappropriate for relevant land requirements, too intensive land use (land cannot rest), thoughtless deforestation and abandonment of land [1]. Degraded territories are territories with a destroyed or damaged upper layer of ground or abandoned territories of construction, extraction of mineral resources, economic or military activities [2].

At the moment there is not defined specific division of degraded territories in Latvia, but in many laws and normative acts degraded territories are defined, how to limit them and reduce areas which are degraded. One of the sort of degraded territories are invasive species. Invasive species are unusual species of Latvian nature which endanger native species, make economical loss, harm to humans health and environment [3]. That's why it is necessary to find out prevalence of invasive species, areas which are occupied with them. It can help to fight with this problem therefore in this research has been made an analysis of the distribution of invasive plant species Sosnowski hawthorn prevalence. In the State Plant Protection Service has been defined that Sosnowski hawthorn is a plant whose flower looks like a dill, leaves are like rhubarb, it makes a smell like Anise or fennel and burns [4].

The aim of this research was to make an analysis of the distribution of invasive plant species Sosnowski hawthorn prevalence in Jelgava district. The following tasks were set to achieve the aim: 1) to explore literature sources about degraded territories, paying attention on invasive species, 2) to characterize Jelgava district, 3) to define areas with invasive species, 4) to make conclusions.

Jelgava district is about 131,700 ha big, in this research units of land with 2,197 ha total area where Sosnowski hawthorns grow were analysed. In Jelgava district about 4% or 79 ha land area is invaded. Also 1111.10 ha of land belongs to natural persons, 58.50ha or 5.3% are invaded territories, legal persons have 205.09ha of lands, 2.8% or 5.72ha are invaded, Jelgava municipality has 181.57ha of lands, 9.26ha or 5.1% are invaded, the country has 690.16ha of land, 5.51ha or 0.8% are invaded, and one foreigner has 9.24ha of land, 0.01ha or 0.1% are invaded.

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# ANALYSIS OF URBAN DEVELOPMENT IN SUBURBAN AREAS OF KAUNAS CITY

**Remigijus Listauskas**

Aleksandras Stulginskis University / Institute of Land Management and Geomatics, Faculty of Water and Land Management, master student, Lithuania

**Jolanta Valčiukienė**

Aleksandras Stulginskis University / Institute of Land Management and Geomatics, Faculty of Water and Land Management / Associate professor, doctor of technological sciences, Lithuania

The number of inhabitants grows in most of the countries, cities' suburban areas becoming more and more attractive places to live because of the cities industrialization. In the case of Lithuania, suburban areas are the part of 10 counties which are formed due to bipolar system where the capital city is dominating. Kaunas city is the second largest city of Lithuania, which borders with the 10 elderships (suburban areas): Domeikava, Karmėlava, Neveronys, Samylai, Rokai, Garliava, Alsėnai, Ringaudai, Raudondvaris and Užliedžiai. As a temporary capital, Kaunas has been turning into an attractive area for different industries to expand. Due to the fact, the suburban areas of Kaunas are being developed for potential investments in land use [1] [2].

The aim of the research is to analyse the development of suburban areas of Kaunas city in 2007 – 2017. The statistical data shows that population of Kaunas city over a decade (2007-2017) has declined by 19.1%, while in Kaunas suburban areas, the population has increased by 4.5%. Furthermore, the change of Kaunas population are closely related with land use and growing area built up territories. The suburban built up areas of Kaunas city, has grown 44.9%. Permits to build a new residential house has been issued to 9.274 applicants. Thus, the change of suburban built up areas of Kaunas is directly related with an increased number of population, on the assumption that suburban areas became built up areas because of the population growth [1] [3].

According to the research data conducted from 2007 to 2017, in suburban areas of Kaunas there are 5,500 ha urbanized territories of which more than 90.9% are living spaces. As a consequence, suburban areas which was densely built up, functions as living territories. The efficiency number of land use has increased during the analyzed decade. Therefore, in order to ensure social, engineering and communicational infrastructure, the new urbanistic development is possible only with full urbanization implementation of suburban areas.

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# REMOTE SENSING OPPORTUNITIES' EVALUATION FOR SCANNING PROCESS IN THE CASTLE ISLAND IN JELGAVA

**Jolanta Luksa**

Latvia University of Life Sciences and Technologies, Faculty of Environment and Civil Engineering,  
undergraduate student, Latvia

**Armands Celms**

Latvia University of Life Sciences and Technologies, Dr.sc.ing., Latvia

Photogrammetry and remote sensing are art, science and technology for obtaining reliable information on the Earth, its environment and other physical objects and processes, by obtaining data with contactless imaging and other sensory systems and their measurement, analysis and representation [1]. Remote exploration is a tool by which, not only the land surveyor, but also other related industry specialists, can conduct a feasibility study of the object, thus helping to make the most accurate and precise decision on the application of survey methods. The purpose of this study is to identify the application of remote sensing methods and to perform a preliminary study on the Castle Island scanning process.

Laser scanning results is a dense point cloud, where each point has specific X, Y, Z coordinates. The resulting data is based on the point cloud, which processes the digital terrain model, the digital surface pattern and defined contours, land uses, and intensity images that are often used to determine the horizontal accuracy of LIDAR data. The main task of LiDAR systems is to obtain three-dimensional points for the development of digital surface models, digital height models [2].

Depending on the purpose of the application, a wide variety of laser scanners are produced. An essential component of a laser scanner is a laser distance meter that rejects laser beams and, based on its reflection, determines the distance to the object. Three types of laser scanning can be distinguished: Terrestrial laser scanning; Mobile Laser Scanning; Aerial laser scanning - this is often the case with the term LIDAR (from the words Light and Radar) [3].

The next practical study related to the development of a diploma project will be related to the creation of 3D surface relief model in Jelgava, the southern part of Castle Island, both with photogrammetry and laser scanning. Also, to analyze the results of these created models and evaluate the application. Since the object is quite large (65 hectare) (see Figure 1), it has been decided to do with aerial laser scanning with drone. Depending on the options of the chosen drone, laser scanning, as well as taking photos of photos, will last for several days.

The theoretical study has helped to understand the operating principles of the process and to choose the most suitable laser scanning and photogrammetry method in order to achieve the goals set forth in the subsequent research.



Fig.1. The object of practical research (Jelgava, the southern part of Castle Island).

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# STRATEGIC STATE PROJECTS AND LAND CONSOLIDATION: CASE OF RAIL BALTICA PROJECT

Laura Mockutė

Aleksandras Stulginskis University/Institute of Land Management and Geomatics, Faculty of Water and Land Management, post-graduate student, Lithuania

Giedrius Pašakarnis

Aleksandras Stulginskis University/Institute of Land Management and Geomatics, lecturer, doctor of technological sciences, Lithuania

In many European countries land consolidation has been under way for more than a century in order to improve the use and cultivation of agricultural land and living conditions in the countryside. It is a special process of land management, when complex land plots are being restructured, the formation of rational farmland use, the improvement of their structure and the development of the necessary rural infrastructure [1]. Land fragmentation is not only a consequence of land reform or division of land. Linear infrastructure projects also can divide land into several plots and reduce land by the compulsory acquisition for the public's needs. Currently, Rail Baltica, an important railway project for all three Baltic states, requiring an acquisition of 1,300 private and public land plots (Lithuania), is ongoing [2]. This will determine the partitioning of land parcels into smaller plots and their arrangement on both sides of the infrastructure, which will result in economically inefficient farming.

The aim of this study is to analyze the impact on the strategic national significance project Rail Baltica on land holdings and to look at the alternative redevelopment of the affected areas through the implementation of land consolidation projects.

Objectives of the study: 1) to review the experience of foreign countries applying land consolidation in major infrastructure projects; 2) to review the land consolidation projects carried out in Lithuania near road infrastructure objects; 3) to analyze the impact of the Rail Baltica project on the structure of land use; 4) to determine possible changes in the land use structure after the Rail Baltica project by carrying out consolidation projects.

The research was conducted by applying these methods: analysis of literature, comparison, abstraction and interviewing.

The results of the study revealed that there will be long-term benefits provided for the state's economy, but the project will affect rational land use. The railway will have a direct and indirect impact on land parcels. For land plots divided into two sections, access roads were designed (Picture 1), but long-distance rides for farmers are not worthwhile.



Picture 1. Rail Baltica project's impact on land structure [2]

It was noticed that land abandonment is threatened on such land. Rail Baltica project should follow land consolidation project instead of acquiring land for public needs, or land consolidation should start right after Rail Baltica project will be finished.

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# ACCURACY ASSESSMENT OF 3D MODELS USING CLOSE-RANGE PHOTOGRAMMETRY METHODS

**Deividas Narūnas**

Aleksandras Stulginskis University/ Institute of Land Management and Geomatics, Faculty of Water and Land Management, master student, Lithuania

**Donatas Jonikavičius**

Aleksandras Stulginskis University/Land Management and Geomatics Institute, associate professor, doctor of technological sciences, Lithuania

UAVs have become a common tool in buildings research as they provide higher resolution images compared with satellite imagery. Research indicates that unmanned aerial vehicles (UAVs) can be used for low-altitude imaging and remote sensing of geospatial information. UAVs are being used for surveying buildings due to their affordability, reliability and ease-of -use. Recent developments in photogrammetry technology provide a simple and cost-effective method of generating relatively accurate 3D models from 2D images .

The integrated use of different spatial data sources is essential for this project. Ground Control Points (GCP) were also acquired by topographic measurements, allowing the connection of different modelled features in the model, as well as the absolute positioning of the site. A total station and handheld GNSS receiver were used for these measurements.

In the study, the DJI Phantom 4 Pro drone with a 1-inch 20-megapixel camera on-board was used to take images of the Balbieriskis St. Holy Virgin Mary Church. The drone was used due to its maneuverability to take images above and around the church. Over 400 images were taken within 1 hour. Agisoft PhotoScan photogrammetry software was used to conduct the image processing. For the alignment of the 3D model 10 GCPs of structure were measured using tacheometric measurements.

The image alignment or reconstruction of the image acquisition starts with the automatic detection of characteristic points or feature points on each image. Thereafter, a feature matching is performed in order to relate each point with its counterpart in other images. The focal length and image size of each image are slightly adjusted during a maximum likelihood adjustment, which allows an iterative bundle adjustment and the estimation of a sparse point cloud. In this phase, the GCPs are assigned to each image and the scene will be aligned in an absolute 3D coordinate system. All clear images with sufficient overlap were included in the processing in order to generate a dense point cloud of the church. GCPs were applied to correct the scale and georeference the model.

The final step in the 3D reconstruction process is the projection of a texture map for each model. This texture map allows the photorealistic appearance of the model and it is calculated by projecting original images on the geometric framework of the model. Each pixel in the texture map is the result of a weight distance function of the colour values from different images.

The construction of 3D models of the Balbieriskis St. Holy Virgin Mary Church was discussed in this paper. A large number of images were taken. The images were processed in Agisoft PhotoScan software workflow and ground control points were measured with a total station. This resulted in mean absolute errors between 0.01 and 0.02 m.

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# ACCURACY OF FRAME TYPE HYPERSPECTRAL IMAGE AEROTRIANGULATION

Inga Naturjeva

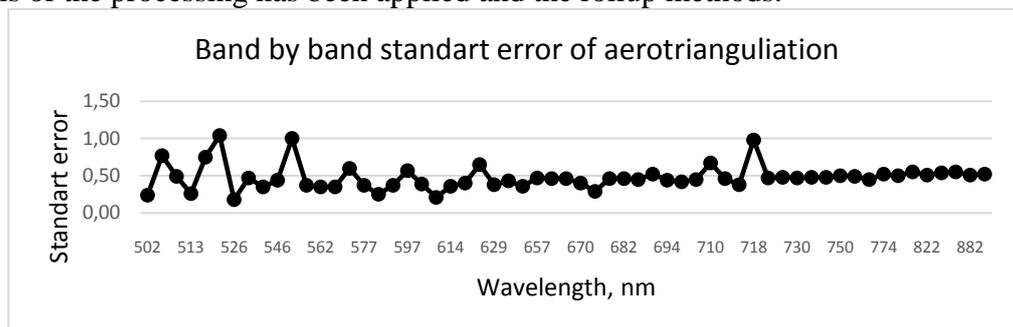
Aleksandras Stulginskis university/ Institute of Land Management and Geomatics, Faculty of Water and Land Management, master student, Lithuania

Donatas Jonikavičius

Aleksandras Stulginskis university/ Institute of Forest Management and Wood Science, Faculty of Forest Sciences and Ecology/ associate professor, doctor, Lithuania

More and more hyperspectral images are used in the various areas worldwide. Hyperspectral images are commonly used to monitor various objects. The main objective was to assess the accuracy of the production of aerotriangulation using different spectral bands of the images. The study was conducted in about 1000 ha of Ringaudai village near Kaunas city located in the middle of Lithuania. In the research area there are different types of land cover: forests, agricultural land and urban area. The remotely sensed data were collected on 2016.09.11. Oblique aerial photographs were taken by a RIKOLA hyperspectral camera (58 spectral bands from 502 nm every 4th band to 903 nm with spectral resolution of 8-12 nm) from ultra-light airplane X32 BEKAS flying altitude 1000 m above sea level and with 65% of side and 75% forward overlaps. Resolution of aerial photographs 0.5 m. Coordinates of every frame of image center were collected by GPS integrated in aerophotography system with accuracy ~2m.

First of all, the received images were calibrated. Aerotriangulation (AT) were done with each band of the spectrum. During AT tie points (connection points between the images) were placed in images automatically and the square error calculated. Standard error was estimated for all 58 image bands separately. All image processing and calculations were done by Rikola hyperspectral image software, Rikola Ltd coregistering, EnsoMOSAIC Rikola coregistering applications, Microsoft Excel. The results of the analysis of the processing has been applied and the rollup methods.



Best accuracy of aerotriangulation is obtained using the 526 spectral band, standard error is 0.18 pixel, so best accuracy we can achieve if we use 526 spectral band to create hyperspectral orthophoto.

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# DISAPPEARING AND ALREADY GONE VILLAGES OF JONAVA DISTRICT

Giedrė Plukienė

Aleksandras Stulginskis University/Land Management and Geomatics Institute, Faculty of Water and Land Management, master student, Lithuania

Virginija Gurskienė

Aleksandras Stulginskis University/Land Management and Geomatics Institute, docent, doctor of technological sciences, Lithuania

The aim of this research is to analyze the disappearing and already gone villages of Jonava district and to determine the causes of their disappearance. In the course of the research, literature sources, statistical data, legal acts and other documents were analyzed. For the fulfilment of the research Rural Plans M 1:10 000 of the Jonava district for the end of the 20th century were used. Analytical, statistical grouping and comparison methods were used as well.

This topic is relevant in many countries. Since the middle of the 20th century in both Lithuania and other countries, the processes of urbanization have intensified. For economic and social reasons, many rural residents went to cities. These processes also touched Jonava district situated near Kaunas. There are 8 rural subdistricts in this district. At present, there are 259 villages. From 1979 to 2017 the number of villages has decreased by 25%. In 1979, there were 344 place names of villages in Jonava district, in 1989 – 274, in 2001 – 269, and in 2017 – 259.

During this period, the Žeimiai subdistrict lost 24 villages, Bukonys lost 17 village names, Dumsiai – Šveicarija lost 16 village names, and other subdistricts – fewer village names. Most of the place names disappeared during the period between the years 1979 and 1989 [2; 3]. In the same period the names of the dwellings were eliminated – Gorunuvka, Pediškės. Three dwellings have acquired village status. According to the decree of 2015, 10 place names were eliminated, of which 4 had the title "Railway station": Žeimiai, Dumsiai, Kalnėnai, Gaižiūnai railway stations. The disappearance of the villages resulted from the works of land reclamation and demolish of individual farm-steads during the existence of collective farms; as well as intensive farming was developed, the transfer of population from single villages to larger settlements took place; the economic and social situation of the population, as most of the population went to cities, and after Lithuania's accession to the European Union, a large proportion of the population went to work and live abroad. During the period between the years 1979 and 2017 the number of inhabitants in rural areas decreased by 18%. In 1979, the number of inhabitants was about 18.000 in Jonava district villages, and in 2017 – 14757. The largest decrease in population took place during the period between the years 2001 and 2017 (decreased by 2,795 inhabitants, i.e. 15%).

During the period between the years 1979 and 2017, 25% of the villages were abolished in Jonava district municipality, most of the village names were abolished in Žeimiai subdistrict (45% of all the place names of the subdistrict). The largest abolition of the place names of villages took place during the period between the years 1979-1989, 20% of the district's villages were abolished at that time. There has been a steady decline in the number of inhabitants in rural areas of Jonava district, mainly (16%) decreased in 2001-2017.

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# **ANALYSIS OF THE EXPECTATIONS AND THE RESULTS OF THE PARTICIPANTS OF THE LAND CONSOLIDATION PROJECT OF TAUJĖNAI AND VIŠKONIAI CADASTRAL AREAS**

**Erika Rasakevičiūtė**

Aleksandras Stulginskis University/Land Management and Geomatics Institute, Faculty of Water and Land Management, master student, Lithuania

**Giedrius Pašakarnis**

Aleksandras Stulginskis University/Land Management and Geomatics Institute, lecturer, doctor of technological sciences, Lithuania

According to the approved land consolidation strategy, it is planned to continuously analyze the prepared projects and improve land consolidation procedures [1]. *“It was not expected such a result which was obtained after the implementation of the land consolidation project”*, more and more often said the land consolidation project participants. What did the persons who participated in the land consolidation project want to say by this statement? What was wrong that after the implementation of the land consolidation project, the expectations raised by the participants in the beginning of the project differed from the obtained results after the implementation of the project?

The project of land consolidation of Taujėnai and Viškoniai cadastral areas in Ukmergės municipality implemented within the framework of the 2007-2013 Rural Development Program was selected as the subject of the research. The aim of this research was to distinguish the expectations and the reasons for failure to implement them in the land consolidation project distinguishing the expectations raised by the participants in the beginning of the project and the obtained results after the implementation of the project. The Master's thesis was prepared on the basis of the existing material of the implemented project, using scientific literature, and valid legislation for the preparation of the land consolidation. The research was carried out by applying empirical and theoretical research methods: comparative analysis, mathematical statistical analysis and questionnaire survey method (by e-mail and telephone interview according to the questionnaire).

Most of the persons involved in the project wanted to restructure the boundaries of the land plots, to combine their land parcels, thus reducing the distances between the land parcels owned by land ownership, and to increase the land holdings, thus improving their brevity. Also, high expectations were raised to arrange and improve the access roads to the land plots and to handle inoperative land reclamation. The final number of land plots of the implemented project decreased by 67 units (10.58%), and the total area, by contrast, increased by 17.68 ha (1.17%). The changes in plots and area were influenced by the solutions in which the land plots were reduced or combined into a single array. The current legislation and certain circumstances of the current situation cause the result which is contrary to the objectives of the land consolidation. The land plots get smaller and lose part of the area (the formation and transformation of the boundaries of the land plot must be combined with the natural boundary and the arrangement of structures and equipment), therefore, it is not possible to combine certain plots of land into one array.

During the survey respondents were honest to express their dissatisfaction with the results of the project. According to the participants, only the cadastral measurements of the land plots, the purchase and sale of the land plots were mainly carried out. The participants expected that the condition of the roads would be rearranged and the land reclamation would be organized in those places where it is inactive. There was also such a respondent's answer that named the financing as the reason for all this. The argument was that in the beginning of the project was stated that funding would certainly be enough to meet all the goals set, but in the course, it turned out that it would only be enough for the cadastral measurements. Indeed, many have praised the good idea of managing the countryside, but after the project, many were disappointed because the project didn't meet their expectations.

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# MEASURING GEODETIC NETWORK POINTS USING GNSS TECHNOLOGIES, MULTIPLE BASE STATION SYSTEMS

**Rinalds Riekstiņš**

Latvia University of Life Sciences and Technologies, Faculty of Environment and Civil Engineering,  
undergraduate student, Latvia

**Armands Celms**

Latvia University of Life Sciences and Technologies, Dr.sc.ing., Latvia

Geodesy is science branch which explores planet Earth's form and size, it is fields of gravity and makes practical measurements on earth's surface, representation of it is surface on plans and maps, data gathering for solving different tasks. [1]

Geodetic network is support point cluster on Earth's surface, which is supported with multiple different constructions, whose coordinates and heights are connected on constant united system. [2] Till last century's middle making of the network was done using traditional surveying methods, such as triangulation and trilateral survey. Due to advancement of artificial Earth's orbiter systems and their use in geodesy development of geodetic network has become faster, more precise and more globalised. [3]

Main foundation for all survey data is geodetic network of the state. Geodetic network of the state is made of horizontal and vertical network support points. Networks are classified in multiple classes, depending on their accuracy. The aim of this work is to process and analyze data which are acquired using GNSS technologies and to compare it to geodetic database of the state data.

Global Navigation Satellite System is based on satellite one directional distance survey positioning system. GNSS satellites are sending a signal that allows fast and precise calculations of satellite's location in space. [3] In region of Latvia it is possible to use two GNSS base station networks – LatPos and Trimble WRS Now. In Latvia more common use is made of LatPos network which is connected with geodetic network of the state.

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# GEODETIC RESEARCH IN DOVILAI MOUND TERRITORY

Raimonds Rimkus, Aurelija Šiuškaitė, Domantas Norkus

Klaipeda State University of Applied Sciences, Faculty of Technologies, students, Lithuania

Lina Kukliene, Dainora Jankauskiene

Klaipeda State University of Applied Sciences, Faculty of Technologies, lecturers, Lithuania

Minija is a river in the western Lithuania. Its length is 201.8 km, the basin occupies 2942.1 km<sup>2</sup>. Fortifications of a defence tract (coordinates from 55°40'04.7" north and 21°21'12.8" east to 55°39'52.8" north and 21°20'27.9" east) of the surveyed part of the Minija shore, belonging to the Western Samogitian Plain are made up of the obstacles of natural origin and man-made buildings of field soil and natural elements of relief adapted to defence.

Slope gradient in the surveyed Minija shore is approximately 45°, however a 2-3m wide terrace can be noticed at the middle of the slope. The terrace couldn't have formed during the natural processes. When surveying the location it was determined that the Minija slope was formed artificially by the German soldiers during World War II.



Pict.1 The beginning of the slope terrace



Pict.2 Artificial terrace

The aim of the research is to carry out geodetic surveys in the territory of the Dovelai mound and to draft a plan of the layout of the Mound forest, trenches and Koch bunkers.

Coordinates of the surveyed objects were determined using a GPNS receiver "Geomax Zenith 25 Pro" and electronic tacheometer "Geomax Zoom 80". Planimetric approach method was used to coordinate nine Koch bunkers, one trench, laying across the precipice, and four trenches laying vertically to the shore of the Minija. Geodetic surveys also determined spatial coordinates of trees damaged by barbed wires. During World War II oak-trees, tall pines and fir-trees were encircled by a barbed wire in order to defend the territory of trenches. The bigger part of damaged trees was found on the top of the artificial slope and around the longitudinal trench. All coordinated spatial objects of the Dovelai Mound were depicted in a topographic plan with a scale M 1: 500.

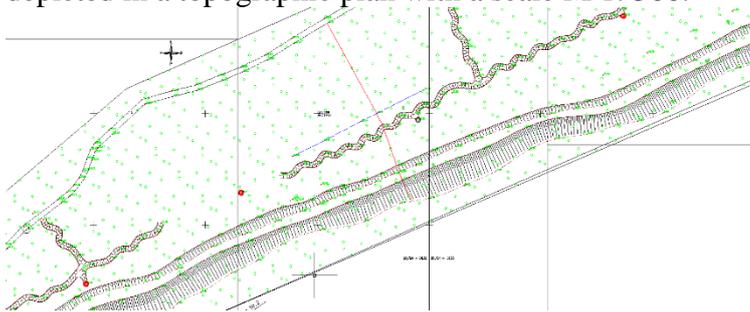


Fig. 3. Topographic plan of an artificial defence slope



Fig. 4. Artificial defence slope

When surveying the trenches of the Minija slope it was found that part of them is extinct and leveled to the leaf litter and the remaining part makes only some 5 percent of all the trenches made during the war.

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# ASSESSING THE GEOMETRIC ACCURACY OF SMALL-FORMAT AERIAL PHOTOGRAPHS BASED ON ORTHOPHOTOS IN URBAN TERRITORIES

**Ina Rudenko**

Aleksandras Stulginskis university/ Institute of Land Management and Geomatics, Faculty of Water and Land Management, master student, Lithuania

**Donatas Jonikavičius**

Aleksandras Stulginskis university/ Institute of Forest Management and Wood Science, Faculty of Forest Sciences and Ecology/ associate professor, doctor, Lithuania

With the changing technologies, information that is easily accessible to everybody by remote methods is increasingly being used. This information is obtained using various UAV or ultra light flyers. As the amount of such information increases, it is necessary to assess the accuracy and appropriateness of this information for solving land-use problems.

The main goal of the work is to evaluate the photometric properties of orthophoto made using small-format photographs in urbanized areas. The aim of the work was to raise the following tasks: to analyze and evaluate the process of orthophoto creation; to determine the geometrical accuracy of orthophoto in separate urbanized areas.

Study was conducted in about 1200 ha of Kaunas city located in the middle of Lithuania. In this area are different types of urban areas, such as old town, industrial area, living area.

**Field data collection.** In the area, using a GPS device Trimble R10 GNSS, reference points were measured. In the built-up area (option 1), 80 points were measured, and in the open area (option 2), 50 points were measured. The accuracy of the GPS receiver location was 1-1.5 cm.

**Remotely sensed data.** The remotely sensed data were collected on 2016 09 11. Oblique aerial photographs had been taken by a NIKON D800E camera with modified lens (3 band (NIR, RED, Green) from ultra-light airplane X32 BEKAS flying altitude 1000 m above sea level. Overlap of images were: side – 75%, forward – 85%. From images generated orthophoto with 0.2 m resolution. In the study, for the estimation of the geometric accuracy of the orthophoto map, points measured in the area were used. Well-seen objects are identified on an orthophoto map, and the position of those points in the area with respect to the measured points is determined as well as the mean square error of the points is calculated. The objects used for the research are the intersection of the road and the corners of the pavement.

Root mean square error			
Type of area	X	Y	Average
<b>Option 1</b>	1.36	1.04	<b>1.2</b>
<b>Option 2</b>	0.12	0.76	<b>0.44</b>

In the area of the clearly visible objects, the square error of the ortho-photographic map from the ultra-light aircraft, in relation to the photographed in the built-up area, is 1.2 meters, while the error of orthophotographic photos in the open area reaches only 0.44 meters. In open areas geometrical accuracy of orthophotos made using small format areal images is 36,6 % higher than in built-up areas. Higher building in urban areas have influence for geometric accuracy of orthophotos

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# ANALYSIS OF ABANDONED BUILDINGS IN PLUNGĖ DISTRICT MUNICIPALITY

Giedrė Vaitkutė

Aleksandras Stulginskis University/ Institute of Land Management and Geomatics, Faculty of Water and Land Management/ master student, Lithuania

Jolanta Valčiukienė

Aleksandras Stulginskis University/ Institute of Land Management and Geomatics, Faculty of Water and Land Management/ assoc. prof., doctor of technological sciences, Lithuania

Recently, both in Lithuania and in other countries of the world, the activity of construction works is observed, and many new buildings complying with quality standards are being built. However, the buildings of old construction, which are currently unused and abandoned and which do not meet the requirements of today and the public needs of the modern construction, remain excessive. In Lithuania, care is also taken to abandoned and unused buildings that cause significant damage: they disfigure landscape, reduce the attractiveness of the area, endanger human security and cause material damage [1; 2]. In order to avoid this, research is needed in order to enable effective solutions for the management and use of abandoned buildings. The aim of this research is to analyse abandoned buildings in Plungė district municipality, which forms a significant part (25.4%) of Telšiai County's territory.

According to the data of the Real Estate Register, in 2017, over 58 thousand of abandoned buildings were in Lithuania, of which almost 57% (33 thousand) were residential buildings. According to the Plungė district municipality council list, currently, there are 26 abandoned, unused buildings in Plungė district municipality, of which to 23 buildings are formed parcels for their intended purpose. All of these buildings have owners (mostly natural persons), which are inadequately supervised and technically disorganized. The distribution of abandoned buildings in the municipality is uneven. Most of these objects are located in Plateliai subdistrict (7), and least of them are in Kuliai and Alsėdžiai subdistricts (by 1). Such kind of the distribution of abandoned buildings in the subdistricts was determined by the decrease in population in settlements, when nobody takes care of these buildings after the deaths of their owners. The visual inspection of abandoned buildings in the field study revealed that most of these buildings are in poor condition: damaged, rotten structures, windows and doors have disappeared, areas not covered or otherwise protected from human access, asbestos slate roof coverings, abandoned environment (Fig. 1).

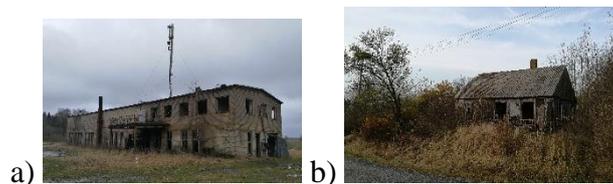


Fig. 1. Abandoned buildings in Plungė district municipality: a – mechanical workshop, b – dwelling house

To summarize, it can be stated that in the analyzed Plungė district municipality, the majority of the existing 26 abandoned buildings are owned by natural persons, of which 16 are residential buildings, and the remaining 10 are non-residential. The distribution of abandoned buildings in the municipality is uneven, the majority of these buildings are located in Plateliai subdistrict. After a visual inspection of these buildings, it can be argued that most of them have been ruined or physically damaged, they are in an emergency condition and posing a threat to the environment and people.

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# USE OF ULTRALIGHT AIRCRAFTS FOR CREATING PHOTOPLANS IN LAND-USE PLANNING

Agnė Vaitonytė

Aleksandras Stulginskis University/ Institute of Land Management and Geomatics, Faculty of Water and Land Management, master student, Lithuania

Giedrius Pašakarnis

Aleksandras Stulginskis University/Land Management and Geomatics Institute, lecturer, doctor of technological sciences, Lithuania

Although at the moment the orthophotoplans prepared for forest inventory are with high geometrical quality and characterises high resolution, their preparation process is very long (it takes mostly about one year and more from the adoption of decision to carry out the works till presentation of the product) and complicated [1]. Today the unmanned aerial vehicles, commonly known as a drones, are becoming more popular. At first this device was used for military purposes, but now the use of drone is very wide. The unmanned aerial vehicles helps to get an information about land cover and its characteristics, it is theory important for many diverse areas: in land-use planning, hidrotechnic, forestry, for the control of forest health, wetlands management, climate change [2].

The aim of analysis is to evaluate the geometrical accuracy of photoplans, which are made using ultralight aircrafts and to analyse the adaptation in land-use planning.

Objectives of the study:

1. to review the theoretical precenditions about photoplans use in land-use planning.
2. to evaluate the accuracy of photoplan of Kirmėliai village, Anykščiai district.
3. to identify the applicability of photoplans in land-use planning.

For the analysis were used literary sources, spatial analysis, statistical and comparative analysis of data, methods of data aggregations and graphical representation. The data for analyses were collected performing field measurements in Kirmėliai village, Anykščiai district (picture 1.). The processing of captured points, photoplans and ORT10LT was made using ArcGIS Desktop and Excel programmes.



Picture 1. Kirmėliai village., Anykščiai district., captured points

In order to determine whether the accuracy of photoplan or ORT10LT is better for land use plaining in the area were 80 points captured and verified. It was determined that the average geometrical exactness of photoplan 1,10 m.. ORT10LT average geometrical exactness 0,54 m..

The accuracy of photoplans made by ultralight aircrafts in such conditions allows surveyors to identify characteristic elements (roads, streets, railways, centra lines and outlines of water bodies, building boundaries, forest properties and landed properties boundaries, geodetic base points). It confirms that the photoplans can be used for the preparation of land-use planning projects, for forest inventory, for means of restrictions, for land planning and for decision making before giving the permissions.

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# ANALYSIS OF URBAN DEVELOPMENT IN THE CITY OF MARIJAMPOLĖ

**Dalia Vasiliauskaitė**

Aleksandras Stulginskis university/Institute of Land Management and Geomatics, Faculty of Water and Land Management, master student, Lithuania

**Jolanta Valčiukienė**

Aleksandras Stulginskis university/Institute of Land Management and Geomatics, Faculty of Water and Land Management, assoc. professor, doctor of technological sciences, Lithuania

The urban general plans provide for relatively large areas for newly urbanized territories, which proves that urban development in cities, especially in larger ones, is taking place quite intensively. The main factors influencing such urban development are economic, social, demographic, and territorial. Another important enough factor proving the relevance of this topic is the attention of mass media when it comes to urban development issues, great dissatisfaction with irrational land use, chaotic development of suburban areas, and so on. The aim of this work is to perform analysis of urban development in the city of Marijampolė. The city of Marijampolė is the seventh largest city in Lithuania, which, according to the data of the Land Fund of January 1, 2017, occupy 16.90% of Marijampolė County and 1.15% of the Republic of Lithuania area. In the decisions of the general plan of the Republic of Lithuania, the city of Marijampolė is assigned to the second level - the regional center category A. This city needs the maintenance and renovation of the existing social and economic potential.

During the last five years (2012 - 2017), the built-up territories in the city of Marijampolė have increased by 121.96 ha, i.e. as much as 10.57%. The area of the built-up territories was most often increased at the expense of another land. In the last five years (in 2012 - 2017) another land in Marijampolė has decreased by 650 ha, i.e. as much as 81.23%. [1]. The city of Marijampolė is expanding in the north-east direction, developing industrial and storage areas, developing a low-rise residential area in the north-west direction. The city of Marijampolė also has a well-developed network of roads. The city is surrounded by two main roads, international road – “Via Baltica” and “Rail Baltic” railroad. Good communication helps to attract local and foreign investment, create new jobs, and improve the social and economic environment in the city. In the analysis of the current condition of the general plan of Marijampolė, approved on 27-08-2012, the part of the built-up territory amounted to 47.79% and the population density per hectare was 16.39 inhabitants / ha. Today's population density is 14.93 inhabitants / ha, i.e. a downward trend is observed. According to the data of the Department of Statistics from 2010 by 2017 the population in Marijampolė has decreased by as much as 27.15%, while, as already mentioned, the area occupied by urban territories has increased [2]. Today, the built-up territories in the city of Marijampolė account for 53%, agricultural land – 26%, roads – 7%, other land – 6%, water bodies – 6%, forest land – 2% of the city area.

Urban development in the city of Marijampolė goes to suburban areas, and the area of the built-up territories is increasing in the area of other land uses, i.e. at the expense of trees, shrubbery, wetlands, damaged land, non-used land. The well-developed road network in and around the city has led to a large dependence of the population on cars. As a result, there was a problem of pollution, lack of parking places, degradation of public transport. Growing city needs to develop infrastructure, adapting it to people's needs.

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# FACTORS AND PROBLEMS INFLUENCING SOLUTIONS OF LAND CONSOLIDATION PROJECTS

Ovidijus Vekrikas

Aleksandras Stulginskis University, Institute of Land Management and Geomatics, Faculty of Water and Land Management, master student, Lithuania

Audrius Aleknavičius

Aleksandras Stulginskis University, Institute of Land Management and Geomatics, Prof.dr., Lithuania

Land consolidation is a special land management process, in which land parcels are redistributed in a certain area. This specific process is not applied on a daily basis; therefore individual projects are important for the development of Lithuanian agriculture [1]. The main tasks of land consolidation project are: the complex redevelopment of land plots; formation of rational size and shape of land plots; increasing landholding and reducing distances between land parcels on farms [2]. However, real implementation of land consolidation projects is faced with a variety of problems that has a negative impact on project solutions [3].

The aim of the article is to identify problematic factors influencing land consolidation project solutions. To achieve the goal, two land consolidation projects in Kelmė and Biržai districts were analyzed. A comparative analysis for identifying problematic factors in the consolidation projects has been carried out.

The total area of land consolidation project in Kelmė district is 1049 ha, with 91 land owners and 196 land plots participated. The area of analyzed project in Biržai district was 569 ha, with 38 participants and 98 land plots. Changes of land plots owners after land consolidation project were analyzed in this survey (table 1).

Table 1. The main changes affecting the benefits of the land consolidation project

Project	Changes of land plots allocation for owners % from total number		Changes of plots configuration for owners % from total number	
	Yes	No	Yes	No
Kelmė district	29.5	70.5	45	55
Biržai district	10.5	81.5	53	37

As we can see from the table, the situation after the project changed very little. Plots were not formed closer to the owners (only from 10.5% to 29.5%). Their configuration was mainly due to the fact that the neighboring plots of the same owner were connected. This indicates that the land management specialists who made these projects were not able to achieve the desired improvement of land plots allocation. In addition, in the Kelmė project, 51% of owners had only one plot, in the Biržai project there were 40 percent of such owners. These figures indicate that a large part of the project participants only wanted to make free cadastral measurements without other additional profits from land consolidation projects.

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***WATER MANAGEMENT***

# **ESTIMATION OF AMMONIA SOIL FLUX MEASUREMENT TIME USING PICARRO G2508**

**Janis Atelbauers**

Latvia University of Life Sciences and Technologies, Faculty of Environment and Civil Engineering,  
undergraduate, Latvia

**Inga Grinfelde**

Latvia University of Life Sciences and Technologies / Researcher of Scientific Laboratory of Forest and  
Water Resources, Mg.sc.env., Latvia

The ammonia emission is one of most important air pollution gas from agricultural sector. In Latvia 83% of total ammonia emissions is from agricultural sector. The one of key source is application of organic and mineral fertilisers. The field measurements of ammonia emissions is one of tools to evaluate efficiency of ammonia emissions mitigation measures [2].

The cavity ring down spectroscopy device (CRDS) Picarro G2508 can be used in laboratory and field experiments for soil flux measurements of five gases nitrous oxide (N<sub>2</sub>O), methane (CH<sub>4</sub>), carbon dioxide (CO<sub>2</sub>), ammonia (NH<sub>3</sub>) and water vapour (H<sub>2</sub>O) simultaneously. Since CRDS device Picarro G2508 is relatively new equipment there is need to develop methodology for measurements of ammonia emissions using static chambers.[1]

The transparent chambers with volume 3litres and area covered 415 cm<sup>2</sup>. The connection of chamber with CRDS is made with 9m long teflon tube. The 56 measurement sessions with chamber closure time 1400 seconds were made in different agricultural lands. The concentration data of ammonia and Ideal Gas Law were used to calculate ammonia emissions from soil.[3]

The results show that ammonia emissions are not stable during measurements, and depends on water vapour and ammonia emissions intensity. Each experiment the chamber closure time for ammonia emissions measurements have to be calibrated by control measurement on fields. The ammonia concentrations have to be controlled to be under 2000 PPB during measurement sessions. [2]

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# THE POTENTIAL OF RECLAIMED WATER FOR SEAWATER INTRUSION CONTROL IN COASTAL AQUIFERS OF TURKEY

Said Ali Sina Azarm

Selcuk University, Department of Environmental Engineering, MSc Student, Turkey

Selim Dogan

Selcuk University, Department of Environmental Engineering, PhD, Asst.Prof., Turkey

Seawater intrusion (SWI) is one of the most wide-spread environmental problems along the coastal areas where the fresh groundwater is surrounded and could be easily penetrated by seawater. SWI threatens water resources and makes unsuitable for human, industrial and irrigation usage. Therefore, efficient methods should be applied in coastal areas to protect aquifers which are under the risk of SWI.

In this study the potential of reclaimed water has been investigated in order to prevent SWI in coastal aquifers of Turkey. Besides, this study also assesses the application possibilities of injecting reclaimed water into injection wells for making hydraulic barriers.

SWI is generally caused by human activities due to the over-pumping of groundwater which creates unbalanced condition hydraulically. This problem has been reported in many countries all over the world such as USA [1], Greece [2], Syria [3] and Turkey [4]. Control of SWI in coastal areas by reclaimed water injection barriers is an environmentally friendly method for both disposal of wastewater and protecting groundwater resources. The barrier projects have been successfully applied for conservation of fresh water aquifers in the Central and West Coast Basin of California for 50 years in the USA [1]. A positive hydraulic barrier has been built in the coastal area of Barcelona in Spain to stop the advance of the SWI and this barrier works by injecting reclaimed water in 14 wells [5].

In this study, 15 provinces from Marmara, Aegean and Mediterranean regions (northwest, west and south coasts of the country) of Turkey are selected which are under the threat of SWI. 75 wastewater treatment plants with large capacity have been considered with an average distance of 5 km to coastline in order to investigate reclaimed water potential which might be injected into wells. A potential of 4.6 Mm<sup>3</sup>/day reclaimed water have been estimated that could be used by injection wells in order to build a hydraulic barrier to help preventing SWI in coastal regions.

## Acknowledge

This study is derived from the first author's MSc Thesis.

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# THE IMPACT OF ROAD SALT ON GROUND WATER QUALITY

Oskars Eiduks

Latvia University of Life Sciences and Technologies, Faculty of Environment and Civil Engineering,  
undergraduate, Latvia

Inga Grīnfelde, Olga Frolova

Latvia University of Life Sciences and Technologies / Scientific Laboratory of Forest and Water  
Resources, researcher, Mg.sc.env., Latvia

Every year, when the air temperature drops below zero, there is an icing on roads that makes it difficult and dangerous for people and vehicles to move. In order to ensure safe transport and pedestrian movement in Latvia, for a long time salt-sand mixture has been used on streets, roads and footpaths, which is an economically effective and proven anti-icing tool. However, this mixture has a negative impact on the surrounding ecosystem. Urban elements, such as home basements, concrete structures, green areas etc., suffer from salt impact. The object of the research is to evaluate salt movement in ground waters at urban areas [1; 2].

The Dome Cathedral is one of the most powerful cultural and architectural monuments in Latvia, but its construction elements are subjected to negative effects of the urban environment, including high salt concentration in groundwater, that accumulates on the sidewalks and the anti-ice protection measures of the Dome Square. Three data loggers CTD-DIVER were installed in Dome Cathedral with different distances from Dome square. [2]

The influence of salts on the foundations of the Dome Cathedral is analyzed in the research. Following the electrical conductivity, the amount of grounded salts in the groundwater is determined - whether it has increased with the start of street maintenance works and scattering a salt-sand mixture. The obtained data is valid for the period from October 24, 2016 until June 2, 2017.

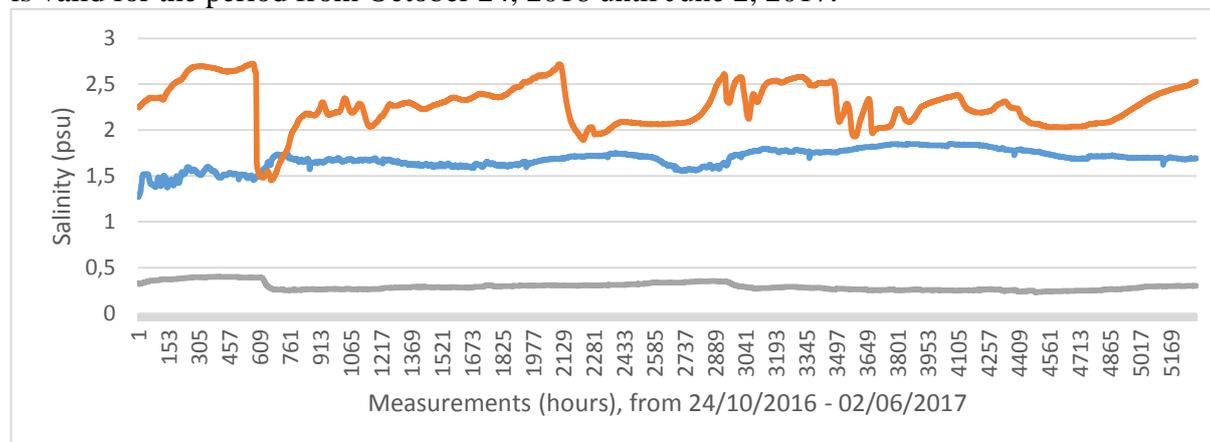


Figure 1: Salinity amount in three different monitoring points.

(Orange – the closest to Dome square, gray – the furthest from Dome square)

The distance to Dome square has impact on salinity concentration amplitude (see figure 1.)

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# INTEGRATED NITROGEN MANAGEMENT IN LATVIA'S AGRICULTURAL SECTOR IN THE FRAMEWORK OF CLIMATE AND ENVIRONMENTAL POLICIES

Paula Eihe

Latvia University of Life Sciences and Technologies/ Faculty of Environment and Civil Engineering,  
undergraduate student, Latvia

Inga Grīnfelde, Laima Bērziņa, Jovita Pilecka, Olga Frolova

Latvia University of Life Sciences and Technologies, Laboratory of Forest and Water Resources, Latvia  
University of Life Sciences and Technologies/ Faculty of Information Technologies, Latvia

The development of the agricultural sector is closely linked to the introduction of new technologies that not only increase productivity, but also reduce the environmental impact of the agricultural sector. The activities of the agricultural sector are governed by the guidelines of the world's, the European Union's and Latvian climate and environmental policy, in which one of the main tasks is to reduce the emission of nitrogen compounds in the atmosphere and the hydrosphere.

The agricultural sector has the most impact on the nitrogen circulation cycle in nature, as synthetic fertilizers are used in the crop sector, which stimulates the release of nitrogen oxide ( $N_2O$ ) and ammonia ( $NH_3$ ) into the air, as well as the leakage of nitrates ( $NO_3^-$ ) and ammonium ( $NH_4^+$ ) ions in the hydrosphere. On the other hand, the livestock sector is characterized by emissions of methane ( $CH_4$ ) and ammonium ( $NH_3$ ) into the atmosphere and the leakage of nitrate ( $NO_3^-$ ) and ammonium ( $NH_4^+$ ) ions in the hydrosphere. In order to achieve the aims of climate and environmental policy, it is necessary to introduce technologies that reduce the environmental impact of agriculture in a balanced way, not only in the context of the climate or environmental policy, but also are economically valid and ensure the sustainable circulation of nitrogen.

The aim of study is to develop an integrated conceptual model of nitrogen circulation for the agricultural sector that identifies incoming and outgoing nitrogen flows and allows to assess the conformity of the agricultural nitrogen flows with the limits set in the framework of climate and environmental policies. Incoming and outgoing nitrogen flows in the agricultural sector, which is associated to climate and environmental policy goals at the national level and dependent on population, as well as on social, geopolitical and economic factors. In the first phase of the study, a conceptual scheme for nitrogen flows in the agricultural sector was created, based on examples from the Netherlands and Denmark [1]. In the agricultural sector, crop and livestock, which has different incoming and outgoing nitrogen flows, are isolated separately. In the next step, the data to be used in conceptual model of nitrogen circulation, are identified and distributed, and additional calculation is created, which allows to obtain the necessary data by calculation. In the conclusion, nitrogen flows are quantified and parts of its movement cycle that have an impact on the hydrosphere and atmosphere are identified.

**Acknowledgments:** This research was developed thanks to the financial support of the Ministry of Environmental Protection and Regional Development within the framework of the project "Direct  $N_2O$  emissions from nitrogen fertilizers in typical Latvian conditions" and the Estonian – Latvian cross-border program project "Integrated Nitrogen Management System of the Gulf of Riga" within the framework of GURINIMAS.

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## **MODERN STATUS OF RIVERS OF IVATSEVICHY REGION (BELARUS)**

**Voldemar Frizen**

Baranovichy State University, Faculty of pedagogy and psychology, undergraduate student, Belarus

**Uladzimir Zuyeu**

Baranovichy State University, PhD candidate, Belarus

The hydrological network of Ivatsevichy region includes 16 rivers from which 10 originate in the area. Total length of the rivers of the region is 320 km. The longest rivers in borders of the area are Shchara (98 km from 325 km of total length), Grivda (53 of 85), Vislitsa (37,8 of 41,8), Zapruda (21,4 of 31,4). The rivers of the region belong to basins Baltic (9 rivers) and the Black Sea (7 rivers). The density of river network is 0.37 km/sq.km. The water volume of a local river drain is 10.7 m<sup>3</sup>/s or in absolute expression of 338 million m<sup>3</sup> [1].

Distinctive feature of the region is the big areas of the drained lands. Their area is 55 thousand hectares. For functioning of these lands in agriculture the network of drying channels from which the largest are Zhegulyansky, Hodakovsky, Kosowski, Obrovsky has been built. There are also 8 ponds and 5 reservoirs which perform function of accumulation of water.

Existence in the region of melioration networks provides mass dumping of water during the spring period that as a consequence reduces water balance of the territory. Some lakes are used for the recreational purposes; they are: Vygonoshchanskoe, Bobrovichskoe, Sominskoe, Vulkovskoe [2]. A noticeable negative anthropogenic impact is characteristic of the coastline of these lakes.

A unique object in the area is the Oginsky canal built in 1767-1783. It connects the Shchara and Yaselda rivers and performed the transport function till 1914. Now the project of reconstruction of the channel is developed. The ecological condition of water objects of the area is satisfactory. The main sources of pollution are the agrarian enterprises and the residential territory. There are protected natural territories.

Thus, the hydrological network of Ivatsevichy region is various. There are rivers which have kept the natural course. Marsh massifs in many places have changed the primary state because of drainage network that substantially has affected the volume of the water drain. Existence of karst lakes origin demands respect for standards of ecological safety at implementation of environmental management in the territory.

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# AMMONIA EMISSION MEASUREMENTS USING CAVITY RING-DOWN SPECTROSCOPY

**Olga Frolova**

Latvia University of Life Sciences and Technologies, Faculty of Environment and Civil Engineering,  
post-graduate student, Latvia

**Inga Grinfelde**

Latvia University of Life Sciences and Technologies, Mg.sc.env., researcher, Latvia

Ammonia (NH<sub>3</sub>) is one of the air pollutants. Its gaseous losses to atmosphere mostly is associated with agricultural activities, for example, it is estimated that in Latvia in 2016 almost 86 % were related to agriculture, from that 51 % originated from management of agricultural soils: use of mineral and organic fertilizers [2].

NH<sub>3</sub> impact can be contribution to emission of particulate matter (PM<sub>2.5</sub>) formed in reaction with acids (SO<sub>2</sub> and NO<sub>x</sub>) as well as NH<sub>3</sub> in particular form (NH<sub>4</sub>) deposited can cause exceeded input of nitrogen to water and soil (eutrophication, soil acidification) [1]. For quantification purpose and development of abatement strategies there is need for better understanding of processes related to NH<sub>3</sub> emission.

The aim of this study was to assess potential to use cavity ring-down spectrometer analyser Picarro G2508 for NH<sub>3</sub> emission measurements in soil air exchange layer using static chamber system. Its working range is up to 2 ppm for NH<sub>3</sub> and it measures simultaneously also N<sub>2</sub>O, CH<sub>4</sub>, CO<sub>2</sub>, H<sub>2</sub>O [3].

There are concerns about use of this methodology as NH<sub>3</sub> can be absorbed in tube connections between chamber and analyser [4]. This is also noted in Picarro G2508 datasheet as there is provided measurement rate 8 s, but there is no information of response time for NH<sub>3</sub> because determination of emission will depend on rate of absorption in the system. The concentrations measured will be representable [3].

Analysing available information on NH<sub>3</sub> measurements using cavity ring-down spectroscopy and especially Picarro G2508, there is not enough information on the most suitable methodology for deployment of it for correct soil flux measurements. There were mentioned some methods to avoid incorrect assessment of NH<sub>3</sub> emission, but they were grounded on brief experience [4]. That is why the research work on methodology issues needs to be done as continuous work for theoretical report.

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# ROOFTOP RAINWATER HARVESTING POTENTIAL IN TURKEY

**Abobakar Himat**

Selcuk University, Department of Environmental Engineering, MSc Student, Turkey

**Selim Dogan**

Selcuk University, Department of Environmental Engineering, PhD, Asst. Prof., Turkey

We are living in the world with limited freshwater resources (3%), while 97% of the world water is saline. The use of sea water as a fresh water source is not yet very economical. Turkey has 1400 m<sup>3</sup>/capita per year of water resources potential. The country is in the list of water stressed countries. Turkey will become a water poor country in the coming decade due to population increase and industrial development.

The rainwater can be collected and used for domestic (toilet flushing) and non-domestic (irrigation and industrial purposes) uses which not require drinking water quality. In Turkey, 30% of domestic water use is in toilet flushes. Buildings with large roofs are more effective and feasible for rooftop rainwater harvesting. Significant amount of water conservation can be achieved effectively when harvested rainwater is used in toilet reservoirs of places such as: universities, factories, public buildings and shopping malls with larger roof areas and where the amount of flush water use is higher than for other domestic use purposes. Excess harvested rainwater can be used to irrigate green areas of surroundings as well.

The analysis of rainfall series is crucial for estimating rainwater harvesting potential. Some precipitation regime analysis should be done prior to the estimation of rainwater harvesting in order to define the rainfall distribution.

In this study, homogeneity analysis of rainfall series, Mann-Kendall trend [1, 2] analysis and precipitation concentration index (PCI) [3] analysis of historical rainfall series have been conducted prior to the estimation of the rooftop rainwater harvesting potential in Turkey.

## **Acknowledgements**

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# **KAREZ: ANCIENT IRRIGATION AND WATER SUPPLY INFRASTRUCTURE IN AFGHANISTAN**

**Abobakar Himat**

Selcuk University, Department of Environmental Engineering, Master Student, Afghanistan

**Selim Dogan**

Selcuk University, Department of Environmental Engineering, Dr. Asst. Prof., Turkey

Karez (Qanat) is underground tunnel which is constructed in alluvial fan by digging the mother well of the system and extending underground tunnel in foothills of the mountains. This ancient infrastructure extracts groundwater to the surface by gravity without using any pumping equipment. Groundwater is the primary source for irrigation and water supply in warm and arid regions (southwestern part) of Afghanistan. The Karez system irrigates about 163,000 ha of land with 6000–7000 individual Karezes throughout Afghanistan [1, 4]. Nowadays due to drought most of the Karez systems has dried up.

Ancient Karez is environmental friendly and sustainable irrigation and water supply system in rural Afghanistan [2] and in some other countries. Many tube wells installed by farmers in rural regions of the country which caused the Karez extinction. Ancient Karez irrigation infrastructures are viable in hot, arid and semi-arid climate regions. Many Karez systems existed in southwestern regions of the country. Warm and arid climate of southwestern and lack of surface water is the main reason for concentrated Karez existence in these regions of the country [3]. The reasons for Karez construction is the absence of surface water resources (streams, rivers, lakes), being in an undeveloped remote region, inadequate precipitation rate, high evaporation rate and poor economic conditions. Sufficient slope is vital for extracting groundwater to the surface by gravity in Karez system. Karez is common water extraction technique in hot and arid regions where surface water is not available. The water table is shallow in the foothills of mountains. Most of the precipitation occurs as snow during the winter. Snow melts during the spring and summer seasons, so, the melted snow feeds unconfined aquifer and mother well of the system.

Mother well is the source of water and provides the majority of water for Karez. Installing the mother well in the foothill of the mountains is very difficult that needs experience and some knowledge about the groundwater route. Karez system would fail in case the mother well is not installed in the shallowest aquifer of the area. The flow path of groundwater can be interfered by installing the mother well of Karez in unconfined aquifer. The water of Karez is mostly fresh, cool, not contaminated. Natural treatment process occurs during the snow melt water infiltration.

Rehabilitation of destroyed or dried up Karez irrigation infrastructures is crucial for sustainable agricultural activities. In many parts of the country groundwater table depleted due to over-extraction of water via tube wells. The water resources management authorities should give priority for rehabilitation of these ancient water infrastructures.

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## **ECOLOGICAL SAFETY OF SPRINGWATER**

**Mikita Hvazdeu**

Baranovichy State University, Faculty of pedagogy and psychology, undergraduate student, Belarus

**Uladzimir Zuyeu**

Baranovichy State University, PhD candidate, Belarus

Springs are an exit of underground waters to a surface. Springs are a component of a natural landscape, they often are sources of the rivers. Springs have great environmental and aesthetic value. So far many springs are a source of drinking water. In too time the chemical composition of water of springs is reflection of an environmental situation in the region. For example, in many regions of Belarus the nitrate content, including in concentration hazardous to health is noted [1].

The Threshold Limit Value (TLV) of nitrates in drinking water is 45 mg/dm<sup>3</sup> [1].

We have studied water of springs of the Baranovichy district on the content of nitrates during the research in 2017-2018. Identification of nitrates was carried out by portable chemical laboratory Merck by a colorimetric method. We have explored 24 springs of the Baranovichy district (Brest region, Belarus). Chemical water analysis of springs which are used as a source of drinking water has been carried out. Only in 3 springs (Molchad-3, Tartaki, Yasenets) concentration of nitrates didn't exceed maximum allowable concentration.

In 11 explored springs (Berezouka-1, Gats, Girmantautsy, Dobry Bor, Kacharyzka, Kanushouschyna, Paulinava, Penchyn, Rabkovichy, Rogoznitsa, Vershok — 5.8% of all investigated) concentration of nitrates has made 1-2 maximum allowable concentrations; in 6 springs (Berezouka-2, Kuzevichy, Molchadz-1 and -2, Padgornaja, Torchytsy — 25%) concentration of nitrates has made 3-4 maximum allowable concentrations; in 4 springs (Bryksichy, Padkrynitsa, Rudashy, Tratsevichy — 16,7%) concentration of nitrates has made 4-5 maximum allowable concentrations.

Thus, 87.5% of the explored springs' water contained nitrates in concentration hazardous to health. For safety of consumption of spring water it is necessary to inform consumers of water on her bad quality. The study of springs of the region will be continued in 2018 with a frequency at least once a quarter.

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# MOISTURE EFFECT ON CO<sub>2</sub>, CH<sub>4</sub>, NH<sub>3</sub> AND N<sub>2</sub>O EMISSIONS FROM SOILS IN LATVIA

Liene Kalniņa, Olga Frolova

Latvia University of Life Sciences and Technologies, Faculty of Environment and Civil Engineering,  
post-graduate, students, Latvia

Kristīne Valujeva<sup>1</sup>, Inga Grīnfelde<sup>2</sup>

Latvia University of Life Sciences and Technologies, Faculty of Environment and Civil Engineering,  
Mg.sc.ing., Latvia; <sup>2</sup>Latvia University of Life Sciences and Technologies, Faculty of Environment and  
Civil Engineering, Mg.sc.env., Latvia

Industrial and agricultural activities produce greenhouse gases (GHG), such as carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>) and nitrous oxide (N<sub>2</sub>O). A large amount of GHG is generated by agricultural activities. GHG emissions' amount depend on land-use types, climate conditions and management practises. GHG emissions from the soil are caused by roots breathing, microorganism activity and chemical decomposition processes [1].

Organic soils produce more GHG than mineral soils. Organic soils are an important source of CO<sub>2</sub> and N<sub>2</sub>O, especially if agricultural land is drained. The most CH<sub>4</sub> is produced by peatlands; these soils are CO<sub>2</sub> sink. Drainage influences GHG emissions from soil due to changes in soil moisture content and mineralization process; after drainage, CO<sub>2</sub> and N<sub>2</sub>O emissions from organic soils are higher than in mineral soils [1].

In 1992, Latvia signed the United Nations Framework Convention on Climate Change in Rio de Janeiro [2]. In 1995 Saeima of Latvia ratified the United Nations Framework Convention on Climate Change with a view to reducing the concentration of GHG in the atmosphere [3]. By 2020 Latvia can increase emissions by 17% compared to 2005, but after 2020, the Paris Agreement will take place and the target for reducing GHG will be -6% compared to 2005 [4]. Therefore, it is important to find out what influences the emissions in Latvia, especially N<sub>2</sub>O emissions from agricultural activities, which produce around 60% of N<sub>2</sub>O emissions [1].

The aim of research was to determine the effect of soil moisture on the amount of CO<sub>2</sub>, CH<sub>4</sub>, NH<sub>3</sub> and N<sub>2</sub>O emissions from the soils in Latvia. Mineral soil samples were collected into the vicinity of Bērze, Mellupīte and Auce monitoring stations, which are located in Dobele, Saldus and Auce districts. Organic soils samples were taken from the fields with organic soil located in Jelgava and Mārupe districts. The soil samples were dried at the laboratory at room temperature, crushed and sifted. CO<sub>2</sub>, CH<sub>4</sub>, NH<sub>3</sub> and N<sub>2</sub>O measurements in soil samples were done by using Picarro G2508 analyser. Measurements demonstrated that GHG emissions depend on soil moisture and soil type as the highest concentration and emission rate was reached from wetted organic soil samples. Mineral soil measurements were more stable.

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# CHAMBER CONSTRUCTION OF PICARRO G2508 EFFECT ON MEASUREMENTS ACCURACY

Rūta Kalniņa

Latvia University of Life Sciences and Technologies, Faculty of Environment and Civil Engineering, undergraduate, Latvia

Inga Grīnfelde

Latvia University of Life Sciences and Technologies /Researcher of Scientific Laboratory of Forest and Water Resources, Mg.sc.env., Latvia

One of sectors which produce greenhouse gas (GHG) emissions is agriculture and with it related activities. Reducing of GHG emissions is actual in all planet because of Kyoto protocol and Paris Agreement. For example, according to data from year 2015, 60% of Latvia`s GHG emissions of agricultural sector produce nitrous oxide (N<sub>2</sub>O) [1]. The main factors which cause GHG emissions from soil are temperature, land use and land use change, vegetation and nutrients [2]. At this moment we have available equipment for GHG measurements but there is need for improving the accuracy of measurements and development of methodology how to make GHG measurements. The aim of the research is to estimate cavity ring down spectrometer Picarro G2508 chamber construction effect on measurements accuracy.

In this research direct field measurement method is used to estimate emissions. Picarro G2508 measures nitrous oxide (N<sub>2</sub>O), methane (CH<sub>4</sub>), carbon dioxide (CO<sub>2</sub>), ammonia (NH<sub>3</sub>), and water (H<sub>2</sub>O). Chamber with volume 3 liters is placed on 23 cm diameter base and is connected with Picarro G2508 using stainless steel and 9 m teflon tube (Fig. 1) [3]. For research are used different construction chambers – 1) non-transparent chamber, 2) non-transparent chamber with compensation tube (Fig. 2), 3) non-transparent chamber with hole above, 4) transparent chamber, 5) transparent chamber with compensation tube (Fig. 3) and 6) transparent chamber with hole above. Non-transparent chamber prevents photosynthesis effect from sun, to compensate air losses chamber has a hole in upper part which provides air supply, chamber with compensation tube disperse air in chamber equable and prevent air flow mixing with outside atmosphere.

Gas (N<sub>2</sub>O, CH<sub>4</sub>, CO<sub>2</sub>) concentration changes and from them calculated emission coefficients are different



Figure 1. Chamber connect with Picarro G2508



Figure 2. Non-transparent chamber with compensation tube



Figure 3. Transparent chamber with compensation tube

comparing non-transparent chambers and transparent chambers. In chambers with compensation tube gas concentration changes are stable and calculated emissions coefficients are with smallest standard error.

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# **MINED PEATLAND RESTORATION ALTERNATIVES IN CLIMATE POLITICS CONTEXT**

**Kristaps Knavins**

Latvia University of Life Sciences and Technologies, Faculty of Environment and Civil Engineering, undergraduate, Latvia

**Inga Grinfelde**

Latvia University of Life Sciences and Technologies, Scientific Laboratory of Forest and Water Resources, researcher, Latvia

Peatland mining has affected the natural habitat of mires in Latvia, its ecosystem functions, biodiversity and resilience. Besides the mentioned disturbances, in mine peatland the decaying of organic substances results in peatlands becoming greenhouse gas sources (GHG) such as CO<sub>2</sub>, N<sub>2</sub>O and CH<sub>4</sub> [1]. As these ecosystems are a source of GHG, their restoration can turn these activities as one of the potential solutions in reaching the goal of climate politics for reducing GHG emissions. After peatland restoration it's expected that the restored mire will affect carbon (C) accumulation, water flow and temperature regulation; it would improve the biodiversity of the area and other ecosystem functions [2; 3].

To determine the role of mined peatland restoration in climate politics context, the research was done using Intergovernmental Panel on Climate Change methodology to calculate emissions in different situations and also comparing the role of biological diversity in GHG emissions among four characteristic mires of Latvia - *Melnā ezera* mire, *Aklais* mire, *Rožu* mire and *Laugas* mire.

The GHG calculation results show strong evidence that extensive grassland is one of the best scenarios for cultivated peatlands and for revitalisation the suitable species are: *Calluna vulgaris*, *Andromeda polifolia*, *Oxycoccus palustris*, *Rhynchospora alba*, *Eriophorum vaginatum*, *Ledum palustre*, *Rubus chamemorus*, *Drosera rotundifolia*, *Empetrum nigrum*, *Carex limosa*, *Eriophorum polystachion*, *Carex rostrata* and *Scheuchzeria palustris*.

As the research progressed it was determined that there is a lack of researches regarding peatland restoration to determine emissions in specific peatland conditions.

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# FLOOD RISK MODELLING FOR THE CATCHMENT AREA OF THE RIVER BERZE

**Kārlis Krauze**

Latvia University of Life Sciences and Technologies, Faculty of Environment and Civil Engineering,  
Master student, Latvia

**Ainis Lagzdīņš**

Latvia University of Life Sciences and Technologies, Dr.sc.ing., professor, Latvia

The rivers of Latvia are characterized by a hydraulic regime that determines specific features of rivers such as floods, inundation, as well as periods of not much water in them [1].

The aim of the research is to identify the possible areas of flood risk and illustrate them in a cartographic material.

Considering the fact that, as a result of nature processes, it is impossible to avoid various outcomes, which have a negative influence not only on economic activity but can cause a threat to humans, it is necessary to develop course of action in cases of emergency, e.g., floods, likewise to identify the areas that have a higher level of flood risk.

Normative documentation in Latvia regulates the order in which to recognize flood risks and diminish their influence. European Parliament and Council Directive 2000/60/EC determine evaluation of flood risks and the order in which to manage them. The directive delegated the responsibility to all of the member states to develop flood risk evaluation, which later would be a basis of possible flood damage map designs, and flood risk maps [2].

To identify the possible regions of flood risk and endangered areas, the models of floods are made. They are also made for the analysis of hydraulic processes. The model of flood is made by combining topography 3D model with an orthophoto map, in addition, data processing and analysis is performed. Thus a material that provides visual idea of possible flood risks is obtained [2].

A number of data characterizing a river and its catchment area is used. Various field works are performed in order to obtain this data such as discharge rate of flow, water levels, measurements of transverse profile, the height of the terrain marks, and other data.

Flood modeling comprises a set of actions, where a number of data, i.e., the river and its surrounding characteristics, are taken into consideration. The main tasks in the process of flood modeling are hydraulic data acquisition and processing, calibration of flood models, modeling of a flood threat territory, mostly designed by considering various scenarios, and, finally, preparation of a cartography material that includes all the obtained information.

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# RESEARCH IN UTILIZATION OF ASH RECEIVED FROM PROCESS OF BURNING SLUDGE OF WASTEWATER IN SUE "VODOKANAL SPB"

**Daniil Kulik**

State Forest Technical University of Saint Petersburg, Institute of Technological Machines and Forest Transport, undergraduate student, Russia

**Oksana Zubova**

State Forest Technical University of Saint Petersburg, doctor, Russia

Nowadays the problem of utilization of municipal waste is an urgent problem. It is caused by different reasons (the population growth, the decline of the ecological situation in the world). Saint Petersburg is not an exception. The SUE "Vodokanal SPB" (The Water Canal of Saint Peterburg) has a strong necessity in neutralization of harmful waste.

The volume of wastewater is about 3 million per day so they try to reduce it. The SUE "Vodokanal SPB" introduced the schemes for processing sediments by burning in fluidized-bed furnaces layer. As a result, the volume decreased in 10 times. The ash from burning has one important advantage in comparison with dehydrated sediments: the pathogenic microflora and organic die when burning at high temperatures. It disinfects the product and deprives it of an unpleasant putrefactive odor. It is also necessary to remember that wastewater sewage contains heavy metals and carcinogens, as they include both precipitation industrial and household wastewater. As well as surface runoff, the sewerage system in St. Petersburg is, basically, of the mixed melting.

One of the ways to reduce the areas of landfills for ash from incineration of sewage sludge is the usage of ash as road-building materials. Any road construction is rather material-intensive production. For 1 km of two-line road requires in average 3000-6000 m<sup>3</sup> of the material. On Department of Industrial Transport of the State Technical Forest University of Saint Petersburg for several years, they do a research on the feasibility of using ash from incineration sewage sludge in forest road construction. [1], [3]

As a result, it was found that when mixing and compacting the ash mixture and mineral ratio, with the addition of binders (quicklime, concrete, bitumen), adsorption and chemisorption reactions occur, processes of chemical interaction. The consolidation of the mixture ensures convergence centers of crystallization, increasing contacts of particles and neoplasms, leading to an increase in polymerization and polycondensation reactions, processes physical adsorption, which provides a durable and waterproof material. [2]

According to research conducted by SUE "Vodokanal SPB", the main components of the ash are SiO<sub>2</sub> (more than 50%), iron phosphates, calcium, hematite, silicates of calcium, magnesium, iron, potassium, aluminum, sodium. The ash contains a small concentration (about 6%) of CaO. Analyses conducted at the Center of Water Research and Control of St. Petersburg, in the ash of heavy metal salts in dosages exceeding the MPC (Maximum Permissible Concentration) or close to these figures.

Due to the experiment, it happened that the silicium dioxide (SiO<sub>2</sub>) reacts with calcium dihydroxyde (Ca(OH)<sub>2</sub>). This process is longstanding.

Basing on the analysis of X-ray pictures of samples from a mixture of ash and soil, one can draw the following conclusions:

- coarse aggregate (sand) does not react with other components of the mixture (the diffraction pattern does not change during the hardening of the samples);
- the hardening process in the investigated zeolite and astringent systems is explained by the formation of a cementitious binder: due to the chemical interaction of fine-grained silicium dioxyde (SiO<sub>2</sub>) in the ash composition with calcium dihydroxide Ca(OH)<sub>2</sub>, which leads to the formation of hydromanilicates and calcium hydroaluminosilicates of the tobermorite group;
- due to the chemical interaction of finely dispersed silicium dioxyde (SiO<sub>2</sub>), which is part of the ash with water.

The research depicted that the process of hardening ash soil mixture with bindings passes normally. The silicium dioxide (SiO<sub>2</sub>) reacts with the aluminum oxides. This process is the capsulation of harmful wastes.

For the theoretical proof, there was the research of the main physical characteristics of mixture components. As the result of the experiment we have samples from a mixture of ash with a mass content 30 - 70% and the rest of the sand have the highest values of the compressive strength in air-wet and after the water absorption test, the lowest water absorption is achieved with an ash content of up to 50%.

When using as a mineral concrete, the compressive strength of both air-moist and water-saturated materials is greater than 7 MPa at ash doses of 30%, while the water absorption also sharply increases after 50% ash content.

For evaluation of the environmental safety of the proposed material, there was the ecological research of leachability of harmful components. The concentration of heavy metals and harmful substances do not exceed the MPC, and the road material in question meets the requirements of environmental safety.

Based on the results of the conducted studies, the conclusion is that the use of ash from the incineration of sewage sludge from SUE "Vodokanal SPb" makes it possible to obtain strong, waterproof, environmentally friendly material for the construction of both forest roads and public roads. The introduction of this material makes it possible to utilize large amounts of waste, which will lead to a reduction in the occupancy of existing landfills for the disposal of ash from the incineration of sewage sludge and will free from the need to divert land for new storage sites.

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# **STORMWATER IMPACT ON WASTEWATER AMOUNT IN JELGAVA WASTEWATER TREATMENT PLANT (WTP).**

**Rolands Leveika**

Latvia University of Life Sciences and Technologies, Faculty of Environment and Civil Engineering,  
Department of Environmental Engineering and Water Management, student, Latvia

**Linda Grinberga**

Latvia University of Life Sciences and Technologies, Mg.sc.ing., Latvia

The small amount of rainwater in the city is harmless, but in large amount, it can cause flood risks and also affect the operation of rainwater drainage and domestic sewage systems [1]. Wastewater management is the problem of discharging and treating the sewage generated by the human economic activities [2].

Climate change contributes to an increase of global air temperature, including in Latvia, and an increase in rainfall intensity. In this respect, precipitation in the city of Jelgava has been observed in recent years, which may negatively affect the operation of the WTP. Jelgava WTP is able to purify the amount of all incoming wastewater, but there are separate WTPs that cannot clean water, therefore part of it flows into water bodies uncleaned.

The purpose of the research is to estimate the wastewater amount in Jelgava WTP depending on the amount of precipitation. To do this, there are three main tasks: to evaluate the operation of the sewage and rain sewage system; to evaluate the Jelgava WTP wastewater substance (Biochemical Oxygen Consumption, Chemical Oxygen Consumption, Total Nitrogen, Total Phosphorus) from the outflow and inflow, as well as the impact of precipitation on the wastewater amount, using statistical methods; to give recommendations on reducing the impact of precipitation on wastewater treatment plants.

The literature on domestic and rain drainage in Latvia was collected in this study, as well as the problems of the drainage system in towns and villages around Jelgava. During the extraction and processing of data, the residual pollution was obtained in tonnes per year at the inlet and outlet, Jelgava precipitation and wastewater amount in Jelgava WTP.

Descriptive statistics were applied to the amount of precipitation and wastewater. The range of dynamics was applied to the concentration of quality indicators at the inlet and outlet. Comparing water chemical indicators 2016 with the average annual performance for 2006-2016, it can be concluded that there has been an increase in the BOD<sub>5</sub> and COD at the inlet, but relatively similar 2016 with the average annual performance for 2006-2016 to the exhaust. The average daily volume of the sewage entering the WTP in Jaslo (Poland) in the investigated 2010-2014 period was 13,045 m<sup>3</sup> [3], but WTP in Jelgava in the investigated 2016 was 11,441 m<sup>3</sup>.

Our task is to reduce the amount of the chemicals at inlet and outlet of wastewater treatment plants, in order to stop polluting the water basins and improve the quality of water in the future. We cannot reduce the amount of precipitation, but we can adapt the cities to the current conditions and deliberately build the urban environment, using available resources and knowledge.

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# INFLUENCE OF DECENTRALIZED SEWAGE SYSTEM ON INDIVIDUAL WELL DRINKING WATER CHEMICAL AND MICROBIOLOGICAL QUALITY

**Agnese Ozoliņa**

Latvia University of Life Sciences and Technologies, Faculty of Environment and Civil Engineering,  
ungraduate student

**Inga Grīnfelde**

Latvia University of Life Sciences and Technologies, Scientific Laboratory of Forest and Water  
resources, researcher, Latvia

The influence of decentralized sewage system on the environment becomes topical, but there is not enough attention paid to this, because of incorrectly installed and managed storage tanks, septic and local wastewater treatment plants. Therefore groundwaters which are used as drinking water sources become contaminated. This problem is topical in all Europe, because of high nitrogen content and microbiological pollution as a result of insufficient wastewater treatment [1].

Groundwater is frequently perceived as a relatively safe drinking water source because of water filtration through the overlying soil zones. However, increasing anthropogenic effect on the environment can create new contamination sources and overwhelm the soil waste assimilative capacity. Leaks from pit latrines are often identified as the main risk factors related to outbreaks in households dependent on groundwater [2].

In areas where there is little or no centralized sewerage system, there are used septic tanks, leach fields or pit latrines. When septic tanks or pit latrines are badly constructed, sited or maintained, they can contaminate soil and local water supplies. Chemicals may flow through soil layers, water aquifers and contaminate drinking water sources [3].

The aim of the research is to evaluate the influence of decentralized sewage system of individual well drinking water chemical and microbiological quality in *Jekabpils* town.

To determine individual well drinking water chemical and microbiological quality, there were obtained drinking water samples from centralized and decentralized water distribution systems in *Jekabpils*. These samples were analysed at a laboratory. It was concluded that an essential derogation of norms was observed for iron concentration, turbidity, Coliform bacteria and *Escherichia coli*.

There were analysed 20 drinking water samples. Half of them contained elevated iron concentration, which exceeded permissible norm (0, 2 mg/l) 15 times. Turbidity was elevated in 8 samples, where permissible norm (3 NTU) was exceeded almost 9 times. Microbiological indicator permissible norm was 0 KVV/100 ml and there was found elevated Coliform bacteria count in 6 samples (2-650 KVV/100 ml), but *Escherichia coli* count was elevated in 4 samples (3-50 KVV/100 ml).

Elevated iron concentration and turbidity mostly were found in drinking water samples which were obtained from artesian wells. It can be explained by the elevated iron concentration in soil layers that is widespread in Latvia. Microbiological indicators mostly were found in drinking water samples which were obtained from dug wells located in private household areas. It can be explained by the presence of pit latrines which are badly sited, constructed or maintained.

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# DISTRIBUTION OF SHORT-TERM POLLUTION OF CHEMICAL ELEMENTS IN JELGAVA CITY

**Jovita Pilecka**

Latvia University of Life Science and Technologies, Faculty of Environment and Civil Engineering,  
undergraduate student, Latvia

**Inga Grinfelde**

Latvia University of Life Science and Technologies, Faculty of Environment and Civil Engineering,  
Researcher of Scientific Laboratory of Forest and Water Resources, Latvia

Traffic is the main source of pollutants in the city [3]. Various recent studies show that air pollution will be the cause of premature human death in the coming decades. Especially cities are hotspots of pollution and urban dwellers are particularly exposed to this pollution [1]. The pace of car and traffic growth is very rapid, but investment in infrastructure is low. Emissions from heavy traffic are one of the largest air pollutants in China [2]. Kuoppamäki et al. writes that pollution in snow increases at intensively used roads [3].

In northern climatic conditions, it has been demonstrated that snow conditions are the ideal means for investigating pollution loads for several reasons: 1) snow samples are easy to collect and analyse; 2) the time of deposition is determined according to meteorological data; 3) the large surface area and the slow falling of snowflakes allow the full uptake of both organic and inorganic pollutants from the atmosphere [3]. The study sets out the following tasks: 1. To get acquainted with the experience of existing studies for identifying chemical elements in the urban environment; 2. To sample sampling and sample analysis; 3. to analyse the prevalence of pollution of chemical elements and make proposals to limit pollution. The inductively related plasma atomic emission spectroscopy (ICP–AES) method was used to detect chemical elements in melting snow water. The cluster analysis method was used for data analysis.

Mostly there is clean air in the area, but some monitoring points stand out with particularly high concentrations of chemical elements. Preliminary results show that there is high pollution in the city resulting from the impact of private home heating systems and transport exhaust.

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# THE MODELLING OF SEDIMENTATION PONDS EFFICIENCY FOR THE BERZE RIVER BASIN

Lina Salmiņa

Latvia University of Life Sciences and Technologies, Faculty of Environment and Civil Engineering, undergraduate student, Latvia

Artūrs Veinbergs

Latvia University of Life Sciences and Technologies, Mg.sc.ing., Latvia

By signing convention of the Baltic Marine Environment Protection Commission (HELCOM) in 1994, Latvia is committed to preserve the ecological status and biodiversity of the Baltic Sea. Pollution from agricultural sources, mainly nitrogen and phosphorus compounds, is a major cause of eutrophication in the Baltic Sea. To effectively reduce further pollution in watercourses it's recommended to apply environmentally friendly drainage system elements such as wetlands and sedimentation ponds.

The aim of this study is to identify the efficiency of sedimentation ponds. For this study the modelling tool of Hydrological Predictions for the Environment (HYPE) [2] was chosen. The model has been successfully applied to the watercourses of different European countries as well as worldwide [1, 3]. Model can be successfully applied for the mesoscale rivers in Latvian conditions and has been previously used for the Berze River basin [4].

In this study HYPE was applied to simulate the discharge, nitrogen and phosphorus concentrations and transfer in the Berze River basin located in Zemgale region in Latvia. The efficiency of sedimentation ponds in the Berze River basin (872 km<sup>2</sup>) was also evaluated by using HYPE.

The model has previously been calibrated [4] based on the following defined constant values in the catchment area of the Berze River: type of land use, soil types, drainage conditions, digital elevation model, contribution of point sources, fertilizer volume and distribution and management of agricultural crops. The variables in the model are the amount of daily precipitation (mm) and the average daily temperature (° C). The Berze River basin has been divided into 15 sub-basins.

Within the framework of the research, data on several wetlands in Sweden, Finland and Norway has been collected. By analyzing the results of these studies, it's predicted to achieve equivalent results also for the Berze River. The results of research in the Nordic countries show that phosphorus and nitrogen loads decrease if share of wetlands in the catchments increases. It's characterized by a linear relationship with the determination coefficient  $R^2 = 0.45$  and  $R^2 = 0.82$  for phosphorus and nitrogen respectively.

The obtained efficiency data for wetlands were used to adapt the structure of the HYPE model for modelling the efficiency of sedimentation ponds in the Berze River. To achieve the aim of the research, modelling for the Berze River basin are continued. It's predicted that catchment modelling is a useful method for analysing sedimentation pond and constructed wetland designing plans for Latvian conditions.

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# DEVELOPMENT OF NITROGEN BALANCE FOR THE LATVIAN AGRICULTURAL SECTOR

Elīna Austra Silīņa

Latvia University of Life Sciences and Technologies, Environment and Civil engineering faculty,  
Environmental and Water Management, Latvia

Inga Grīnfelde

Latvia University of Life Sciences and Technologies, Mg.sc.ing, Latvia

In the last century, the Baltic Sea has become more eutrophic. Agricultural activities are located in 25% of the total catchment area of the Baltic Sea, which takes 1.7 million km<sup>2</sup> [1]. By intensifying agricultural production, synthetic fertilizer increases. The total amount of nitrogen and phosphorus in global cycles is increasing, resulting in a large surplus of nutrients. The part of nitrogen comes to the Baltic Sea where it feeds the growing algae [1]. In Latvia, the amount of agricultural land has increased from 1877.7 thousand hectares in year 2013 to 1930.8 thousand hectares in year 2016. The amount of synthetic fertilizer used in agriculture is increasing, for example from 72.9 thousand tons in year 2014 to 78.3 thousand tons in year 2015 of mineral nitrogen [2]. The methodology for calculating of nitrogen balance has not yet been developed and approved in Latvia. The main task of this study is to develop a nitrogen balance for Latvia and to calculate the nitrogen balance for Pēterupe, which is located in the Saulkrasti area and flows into the Gulf of Riga. The allowable concentration of nitrates (NO<sub>3</sub>-) in water is 50 mg/l (or 11.3 mg/l nitric nitrogen N/NO<sub>3</sub>).

In this scientific research, for the example is taken Denmark research work [4] and the Eurostat methodology [5], which allows the development of a nitrogen budget for Latvian agricultural sector.

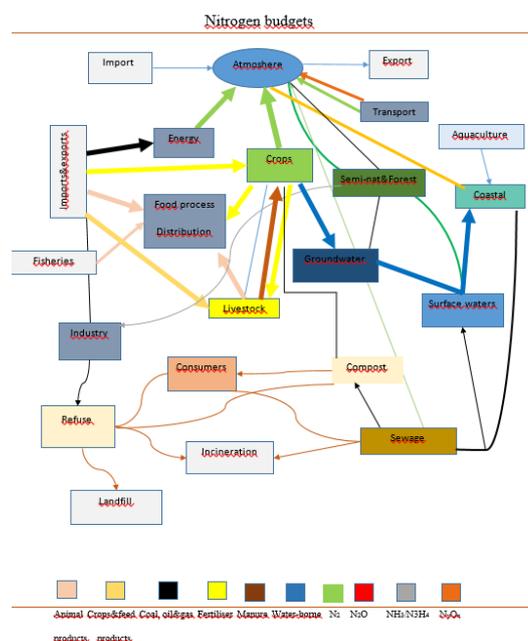
Nitrogen balance is the amount of nitrogen received and returned from other sectors and natural environment. It depends on the various factors that affect it.

This indicates the overall risk to the environment - air, water and soil. The nitrogen cycle, when it can pass through many of the complex chemical and biological changes both in the atmosphere and on the soil, combine organic and non-organic, and return to water, soil or air.

After the developed methodology, it would be easier to understand and calculate how much nitrogen emit into air, water and soil.

The first picture shows the possible nitrogen budget for the Latvian agricultural sector.

According to this framework, nitrogen budget is calculated for Pēterupe, as there is a large proportion of agricultural land in the catchment area of Pēterupe. As well as Pēterupe flow into the Gulf of Riga and can have an effect on the overall nitrogen balance of the Baltic Sea.



(1.figure, Nitrogen budgets [4])

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# **ANALYSIS OF MORFOLOGICAL COMPOSITION OF MUNICIPAL WASTE IN REGION OF LIEPAJA**

**Sindija Smiukse**

Latvia University of Life Sciences and Technologies, Faculty of Environment and Civil Engineering, undergraduate student, Latvia

**Ritvars Sudars**

Latvia University of Life Sciences and Technologies, Dr. sc. ing, professor, leading researcher, Latvia

Based on European Directives, 1999/31/EC, 2008/98/EC, by 2030 60% of municipal waste must be recycled and reused in Latvia. Only 20% of this waste is to be stored in landfills [1]. There is currently no system for determining waste composition in Latvia and there is no statistical data collected on regular basis on the composition of waste.

Regional waste plans for three Latvian waste management regions (WMR) have been developed for 2013-2020, one of them is Liepaja, whose performance is higher than the rest of Latvia's WMR.

The purpose of this research is to provide an analysis of the morphological composition of municipal waste in the region of Liepaja, and an assessment for reducing the load on landfills. Work tasks: data collection and analysis of regulatory documents on municipal waste; adapting existing methodologies to account for the amount and types of municipal waste; evaluation of obtained data to assess whether the waste management targets can be achieved (i.e. reducing the amount of disposed waste). This study is being conducted in two parts that include a statistical data analysis and an expert interview.

According to data from the Latvian Environment, Geology and Meteorological Centre and Central Statistical Administration database, the amount of Latvian WMR municipal waste per capita in 2016, ranged from 0.136 to 1.196 tons. In Liepaja's WMR was 0.978 tons per capita. In 2016, the amount of waste buried in Latvia's WMR was 558 thousand tons, representing 36% of the waste collected in 2016. Analysis of the morphological composition of municipal waste in the region of Liepaja has been made from 20.07.2014 to 25.07.2017. It showed that the dominant type in these waste samples were plastic and rubber, with the total contents being 60%. Glass (30.5%), paper/paperboard (46.7%), wood (63.5%), biodegradable waste (23%) were also covered within these samples.

The region of Liepaja waste landfill "Kivites" specialists report that all imported municipal waste is subject to pre-treatment and approximately 10% of municipal waste has been buried.

In "Kivites" the amount of accepted waste is relatively high although the waste stream is stable. Therefore providing the possibility of establishing an appropriate infrastructure and thereby creating an economically justified waste disposal system.

In order to reduce the amount of disposed waste, it is necessary to obtain specific information on the types and quantities of waste in all WMRs. This would allow to make an assessment of possible actions for the division of waste by fractions and choose the appropriate technological solutions.

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# CHANGE OF SOURCES OF THE RIVERS AS ENVIRONMENTAL PROBLEM

**Victoria Turko**

Baranovichy State University/Faculty of Pedagogy and Psychology/undergraduate student, Republic of Belarus

**Uladzimir Zuyeu**

Baranovichy State University/ PhD candidate, Republic of Belarus

The river — a natural water stream of the considerable sizes with the natural course on the course from a source down to the mouth and eating at the expense of a superficial and underground drain from his pool. A river drain — one of components of water balance of earth. The river mode in general — fluctuations of water levels, the movement of deposits (a firm drain), formation of river courses is defined by the mode of river drains. The mode of a river drain depends on many reasons as natural, and from impact of anthropogenic activity [1].

Source of the rivers — the point has begun beds of the river, a constant water stream. On the map the source usually is represented a conditional point. The hydrological mode — the natural changes of hydrological elements of a water object in time caused physiographic and first of all by climatic conditions of the pool [1].

The hydrological mode includes long-term intra annual or seasonal and daily fluctuations: water level; water expenses; ice; water temperatures; quantity and composition of solid material which is transferred by a stream; structure and concentration of the dissolved chemicals; changes of the bed of the river. Therefore studying of cards of the different periods allows to estimate dynamics of the hydrological mode of the territory which reflect influence as natural factors, and impact of anthropogenic activity [2].

On the example of sources of the rivers of the basin of Neman it is possible to track similar interrelation. Maps 19th century, 1950, 1980 of years and modern, have been studied 2016.

The Kotra river (the right inflow of Neman) — before her source was on coordinates N 54.0170, E 24.6714 (1950-1980), now he is noted on coordinates N 54.0142, E 24.6422. The Neris river (the right inflow of Neman) — earlier N 54.6937, E 27.8708 (the second half of the 19th century), now — N 54.6903, E 27.8672. The Ditva river (the right inflow of Neman) — earlier N 54.1543, E 25.1019 (1950-1980), and now — N 54.1534, E 25.0993. The Izva river (the left inflow of Neman), earlier N 53.6616, E 25.6774 (1950-1980), and now — N 53.6628, E 25.6905.

Thus, all explored rivers have changed the provision of the sources that is the evidence of change of the hydrological mode of the territory of a reservoir. The reasons of such changes demand further research.

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# AIR POLLUTION WITH HEAVY METALS: CASE STUDY IN JELGAVA

**Kristaps Zalitis**

Latvia University of Life Science and Technologies, Faculty of Environment and Civil Engineering, undergraduate, Latvia

**Inga Grinfelde, Jovita Pilecka**

Latvia University of Life Science and Technologies /Researcher of Scientific Laboratory of Forest and Water Resources, Mg.sc.env.,Latvia

Air pollution is one of most serious environmental pollution hazard to human health. It is recognised not only in city centres but also in rural areas, and it is one of the main environmental problem of the World. [1] The complexity of air pollution reduction is related with wild range of gases and particles emitted from different sources. Pollutants can generate exhaust gases or they can be formed as a result of the reaction in the atmosphere. The first includes solid particles and gaseous pollutants such as sulphur oxides, nitrogen oxides and carbon monoxide. The second category includes ozone formed from nitrogen oxides and hydrocarbons, as well as particle sulphate and nitrate sprays produced in the atmosphere from sulphur and nitrogen oxide gases. [3]

In this work snow and their melted water composition were analysed, paying special attention to heavy metals. The study period is from 2016-2018. The snow is collected from 20 locations in Jelgava and one sample in south-west part in Jelgava (see Figure 1). Jelgava was chosen because it is the fourth largest city in Latvia with 62 thousand inhabitants, and due to its developed road infrastructure, the city every day cross in average 40 000 cars that are one of the largest air pollution sources. [2]

The results show a strong impact of air transport generated pollution on air quality in Jelgava City. The positive effect on air quality show open water bodies and open urban landscape.

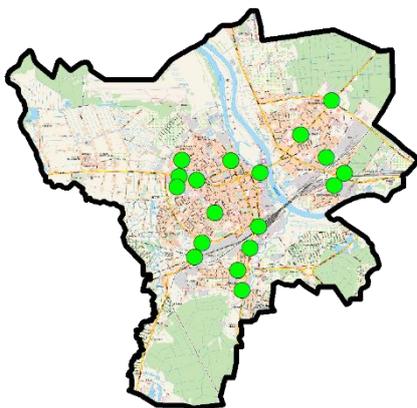


Figure 1: The snow sampling points in Jelgava city

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## **FORESTRY AND WOOD PROCESSING**

## COMMERCIAL THINNING IN LATVIA

**Diāna Agafonova**

Latvia University of Life Sciences and Technologies, Forest Faculty, undergraduate student, Latvia

**Olga Miežīte**

Latvia University of Life Sciences and Technologies, Professor Dr.silv., Latvia

**Edgars Dubrovskis**

Latvia University of Life Sciences and Technologies, Lecturer Mg. silv., Latvia

Commercial thinning in forest stands is carried out before final felling, and the number of thinnings depends on the forest type. It improves the quality of the remaining trees, growing conditions and health status of the stand and increases its economic value. In several countries thinning is an alternative way to gain more valuable wood in final felling. Therefore, commercial thinning is topical today and will also be carried out in the future. An important factor is the planning of the intensity of thinning so that the remaining forest stand after this process could form a larger growing stock increment.

European countries prefer thinning from below. For example, in Sweden in the stands thinned from below the damage from breakage was observed to be lower compared with the damage in the stands thinned from above. Thinning significantly influences the development of the tree crowns and the radial growth but it has a minimal impact on the predominant height of the stands [1]. It is predictable that the risk of snow breakage will decrease in Latvia. Due to global climate changes it will become warmer and more humid, but according to scientists' forecasts wind intensity will increase, thus increasing the risk factor of wind damage in forest stands.

JSC "Latvian State Forests" (AS "LVM") practises thinning from below, cutting the trees which are falling behind in growth (4th and 5th Kraft's class damaged trees with bad trunk or crown characteristics) and tree species that are inappropriate for growing conditions which can be also dominant and predominant (1st, 2nd, 3rd Kraft's class) trees [2, 3]. In the future in Latvia it would be advisable to carry out combined commercial thinning evaluating the health status of each tree, the ability to increase growth increment and predicting the impact of each tree on the current and future state of the forest stand.

In the future further research on the impact of thinning intensity on forest stand development and the growing stock increment of remaining trees should be carried out.

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# ANALYSIS OF PRODUCTIVITY OF FOREST PLANTING MACHINES AND ASSESSMENT OF APPLICATION OPTIONS

Mārtiņš Augusts

Latvia University of Life Sciences and Technologies, Forest Faculty, undergraduate student, Latvia

Solveiga Luguza<sup>1</sup>, Dagnija Lazdiņa<sup>2</sup>

<sup>1</sup>Latvia University of Life Sciences and Technologies, Mg.silv., Latvia, <sup>2</sup>Latvian State Forest Research Institute "Silava", Dr.silv., Latvia

At present mechanical forest planting in Latvia is not used but in Finland about ten years ago approximately 2% of the artificially regenerated forest area was planted mechanically [1]. The first experiments of mechanized forest planting in Latvia were carried out in the 80s of the 20th century but the results were poor.

Since 2007 the scientists of the Latvian State Forest Research Institute "Silava" have been working on the research of regeneration using spot mounding and manual planting as well as mechanical planting [2].

Mechanical mounding reduces the impact of the surrounding vegetation on the planted trees and improves soil drainage in wet sites [3].

The hypothesis of this study is that the time spent on forest regeneration using a planter is shorter than using a moulder with subsequent manual planting, and total costs of forest regeneration are lower.

The costs of forest tending after forest planting are considerable. The data about the necessity of tending during the four years after planting were collected in 230 sites located in JSC "Latvia's State Forests" Zemgale Forestry. The comparison of site preparation with mounding and disk trenching was carried out. In five forest compartments of Klīve forest district, the success of forest regeneration was studied and documented after mechanized forest planting, and work time accounting was performed.

Forest regeneration with mounding costs 2.8 - 4.2 times more, but mechanized planting six times more than using a disk trencher, but saving on the tending costs reduces total costs by 35%, and there is no need for supplemental planting due to excess moisture.

All the information was obtained in collaboration with the LSFRI "Silava".

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# THE IMPACT OF VARIOUS FACTORS ON SCOTS PINE (*PINUS SYLVESTRIS* L.) YOUNG STANDS

Evita Bauere

Latvia University of Life Sciences and Technologies, Forest faculty, undergraduate student, Latvia

Olga Miezīte

Latvia University of Life Sciences and Technologies, Dr. silv., Latvia

Scots pine (*Pinus sylvestris* L.) is always assessed as important in the national economy of Latvia. According to State Forest Service data for reference year 2017, Scots Pine occupies 34 % of forest land (3.32 million ha). Pine wood is used in shipbuilding, construction, furniture manufacturing, etc, all of that requires high-quality wood. To achieve forest stands with straight and strong trees, it is important to eliminate trees with defects at young age, to provide best site conditions for vigorous and healthy trees.

Biotic factors play a significant role in the growth of young trees. Firstly, young trees are endangered from insects - weevils, sawflies, *Tortricidae*, *Hylastes spp.*, *Melolontha spp.*, etc. [1]. These factors often reduce the growth of trees, damage the quality of stems and can lead to the loss of viability. Secondly, young trees are exposed to various diseases - *Gremmeniella abietina* (Lagerb.), *Heterobasidion annosum* (Fr.) Bref. [1]. Infected trees have reduced photosynthetic capacity, disturbed water balance, and decreased of growth. Most critical danger is caused by such diseases as pine twisting rust (*Melampsora pinitorqua* (Rostr.) and needle cast *Lophodermium spp.* [4], there is also needle rust of pine *Coleosporium spp.* Pine twisting rust creates the curve of stem in the shape of letter „S”, non-lignified sprouts can even die [2]. Trees are unable to recover their vertical position, therefore they must be removed in pre-commercial thinning. Thirdly, great harm to young trees are caused by cervid animals - elk (*Alces alces* L.), deer (*Cervus elaphus* L.) and roe deer (*Capreolus capreolus* L.). Cervid animals browse on young trees, damage tree twigs, buds and bark [3]. Consequently, the stem quality is low and trees can develop multiple leader, it can even wilt. It is important to regularly observe and examine the young stands, to diminish or completely eliminate the risk factors.

Bachelor thesis will deal with the research on the impact of biotic factors on Scots pine pre-commercial thinning, comparing its damage intensity with the damage from abiotic factors as well as the impact of anthropogenic factors, i.e. seasonability of pre-commercial thinning, elimination of damaged trees and ensurance of stand stability.

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# HIGH SOIL MOISTURE EFFECT ON THE SANITARY CONDITION OF THE FOREST STAND

**Indra Berga**

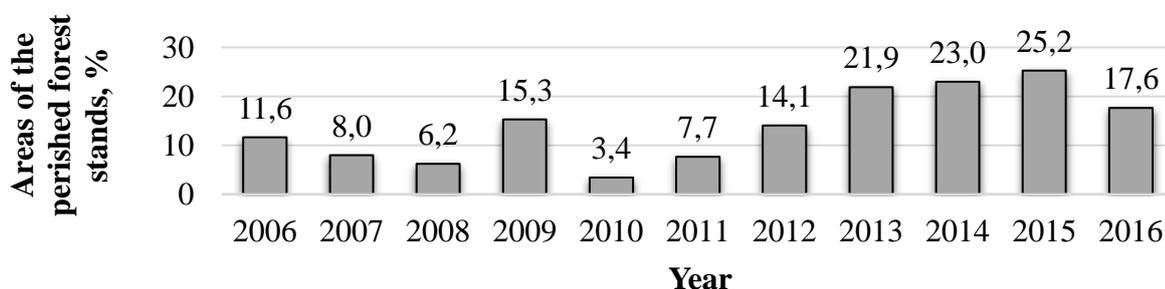
Latvia University of Life Sciences and Technologies, Forest Faculty, post-graduate student, Latvia

**Olga Miežīte**

Latvia University of Life Sciences and Technologies, Professor Dr. Silv., Latvia

**Inga Grīnfelde**

Latvia University of Life Sciences and Technologies, researcher, Latvia High soil moisture in the forest is a problem faced by forest owners. Short term and long term forest soil moisture should be distinguished. The effect of high soil moisture and problems associated with the two types are topical and researchable. High soil moisture is the most important impact factor of the sanitary condition of the forest stand (Fig.1) right after windfalls and windbreaks (52%). Due to high soil moisture 204 ha (17.6%) of the stands were destroyed in 2016. Thus, compared to 2015, the area of the stands destroyed due to high soil moisture, has decreased by 7.6%. The annual statistics of the State Forest Service prove that high soil moisture in the forest stand compared to other damaging factors is crucial ( $p < 0.05$ ) [1].



**Figure 1. Areas of the forest stands perished due to high soil moisture (2006-2016) in Latvia, % [1]**

Beavers and the lack of reclamation systems maintenance often cause short term forest flooding. If the problem is detected and solved in time, it does not affect the parameters of the forest stands, including the average tree growth significantly ( $p < 0.05$ ). As a result of long term moisture, the water mode is changing and woodlands start to transform into wetlands. The soil starts grafting or gleaming, which is characterised by irregular oxygen access to root systems [2], the dead plants do not decompose and vegetation typical to the swamps start to appear [3].

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# **DISEASE *PHYTOPHTHORA ALNI* DISTRIBUTION IN BLACK ALDER AND GREY ALDER FOREST STANDS**

**Liene Butkus**

Latvia University of Life Sciences and Technologies, Faculty of Agriculture, Master student, Latvia

**Olga Miezīte**

Latvia University of Life Sciences and Technologies, Professor Dr.silv.

**Edgars Dubrovskis**

Latvia University of Life Sciences and Technologies, Mg.silv., Latvia

Latvia is rich in forests – the woods cover more than half (51%) of its territory. Most of the forest areas are occupied by pine, birch and spruce, but equally important tree species are grey alder and black alder, which occupy 10% of the total forest area. Alder wood is most often used in the furniture industry and for energy wood (pellets, chips). Black and grey alder have several environmentally-friendly uses, for example, they restrict soil erosion processes, improve soil and are often used as ornamental trees. They also filter water, stabilize and cleanse flooded soils [1].

According to statistics, in many countries alder stands are reduced by *Phytophthora sp.*. This disease was first reported in 1993 in England, while in 2003 more than 15% of grey alder and black alder stands were infected with this disease. Scientific studies have shown that the area of alder stands is decreasing directly on the banks of the streams and rivers, which is promoted by *Phytophthora sp.*, their prevalence is enhanced by zoospores. They spread with water, stem bark residues and soil which contain the causative agent of mycelia. The symptoms of the disease are the following: tar-colored patches appear on the trunk, leaves become small and yellowish, trees disappear completely in a couple of years [2]. According to the information provided to the public by the State Plant Protection Service, the disease was first detected in Latvia in 2016 and its prevalence has not yet been studied [3].

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# MEASUREMENT PRECISION OF FOREST STAND CHARACTERISTICS AND THE TIME REQUIRED FOR MEASUREMENTS

Oskars Deaks

Latvia University of Life Sciences and Technologies, Forest Faculty, undergraduate student, Latvia

Edgars Dubrovskis

Latvia University of Life Sciences and Technologies, Mg.silv., lecturer, Latvia

Forest mensuration (measuring trees and forests) has come of age. Quantitative information on stand and tree characteristics, such as the number of trees, height, diameter and volume is basic to make decisions in forest management. The data on these characteristics and the forest environment can be obtained using traditional (ground) methods or by remote sensing (RS) techniques. Currently, ground methods are being more often replaced by automated data collection based on aerial and satellite images or data from airborne laser scanning, thanks to their cost and time efficiency. Photogrammetry methods have been applied to forest mapping for a long time, and ground geodetic methods were used only in cases where details were not achievable from orthophotos. The main advantage of ALS lies in the 3D point cloud obtainable by laser impulses passing through the tree crowns. The development of ALS started during the 1970s and 1980s, and suitable scanning methods were derived during the 1990s. The first applications were topographically oriented. Since then, the development of this technology has been fast and ALS is currently used in a wide range of applications, including forestry.

There is an impressive applications which foresters and woodland owners can use to measure trees and areas, and also calculate the stand basal area, using an iPhone smartphone. The iHypsometer is a free (in the 'Lite' version) tool for estimating the tree height. The iBitterlich is a free app for calculating the forest stand basal area.

It would be recommended to do further research on the measurement precision of forest stand characteristics and the time required to make these measurements.

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# THE USE OF CHESTNUTS IN FRANCE: HISTORICAL FACTS, PROPERTIES AND OPPORTUNITIES

Paul Douls, Adrien Estève

École Supérieure du Bois, post-graduate students, France

Solveiga Luguza

Latvia University of Life Sciences and Technologies, Mg.silv., Latvia

Chestnut consumption has played a leading role in the diet of French people throughout history. The aim of the research is to highlight this fact and promote the benefits of this fruit.

Chestnut trees (*Castanea sativa* Mill.) arrived in France from Greece via Italy during the first century AD. Since then, they have thrived and progressively developed throughout the country. Because wild chestnut trees provide nice quality wood but mediocre fruit, years ago people started selecting and growing the fruit-varieties, using grafting to sustain them.

This fruit used to be essential for people in rural areas, meaning almost the entire population. Indeed, its properties enabled it to replace cereals in regions where harvests were uncertain. In some years chestnuts were the only available rich food during the winter [3].

Consequently, chestnut consumption was associated with this precarious rural life. Recent modifications in rural areas linked with the appearance of a consumer society, transformed their former habits: people wanted to be independent from their ancestors' way of life and stopped eating chestnuts. Paradoxically, this fruit was and still is commonly used as a side dish for expensive festive meals [2].

Characterising the properties of chestnuts with regard to their components, they have a high carbohydrate content, (26.1 g/100 g of mass). As the key elements, carbohydrates are the fastest source of energy for the human body and are involved in the anabolism of protein. The most important vitamin in chestnuts is vitamin B3 (1.5 mg/100 g of mass). This vitamin is needed for the release of energy and the metabolism of carbohydrates. The main trace element of chestnuts is potassium (359 mg/100 g of mass) which is essential for the contraction of cardiac muscles and the regulation of blood pressure [1].

To conclude, the consumption of chestnuts used to be a necessity during periods when food was scarce in France, thanks to their nutritional properties. Because food production will have a crucial role in France in the future, as it already is in other countries, perhaps alternative sources of nourishment such as chestnuts will be re-established.

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# TREE STAND VOLUME IN PLACES WITH DIFFERENT MAGNETIC FIELDS IN THE OGRE REGION, FORESTS OF *HYLOCOMIOSA* FOREST SITE TYPE

**Sandra Galina**

Latvia University of Life Sciences and Technologies, The Faculty of Forestry, Mg. silv., doctoral student,  
Latvia

**Aigars Indriksons**

Latvia University of Life Sciences and Technologies, Dr. silv., Assoc. Prof., Latvia

Nature is constantly changing and rejuvenating, which is also a natural component and an energy system. As researchers have shown, trees swallow Earth's magnetic field, and they have their own characteristic frequency.[1]. Through this scientific research the author tried to understand and analyse the Earth and Space Information System more deeply, to explore how trees reflect the unity of the Earth in places with different magnetic fields and how trees have established links with the world. The results of the author's previous studies [2], using the data of magnetic anomalies (magnetic field deviations) created digitally and non-parametric statistical correlation analysis method, including the calculation of the Spearman correlation coefficient and other methods, showed that tree stand volumes are very slightly impacted by the magnetic field. There were weak correlations between the maximum values of magnetic field deviations (nT) and the stand volume ( $\text{m}^3 \text{ha}^{-1}$ ), average height (m), average diameter (cm) with and without age control. In general, the stock was steadily growing in places where the magnetic field deviations were at intervals from + 300-1000 nT. At large scenes in places where the magnetic field deviations were from 1000 to 3050 nT the stock grew faster, from 3050 nT – it began to fall [2]. Research is ongoing to find correlations, reflecting the relationship between the magnetic field's deviation value and the forest site type and species at different age intervals. The studies were carried out by selecting the places with specific magnetic field deviation intervals from -300 to 300; from 301 to 1000 nT; from 1000 and higher in the forest site type *Hylocomiosa* with the dominant tree species Scots pine (*Pinus sylvestris* L.), Norway spruce (*Picea abies* L. Karsten) and birch (*Betula* sp.), which occupies 20.2% of Latvian forests [3]. The aim of the experiment for the study of wood stock and related quantities was selected on the basis of Latvia's magnetic field deviations map of Ogre's region. The average tree stand volume increase along with the deviation of the magnetized field deviations at intervals from -300 to 300; from 301 to 1000. In all the investigated sites, the growth of the tree stand's volume in the magnetic field interval from 1001 and above was observed to a certain degree and then started to decrease.

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## LOGGING IMPACT ON BIRDS NESTING IN THE FOREST

Simona Gersebeka

Latvia University of Life Sciences and Technologies, Forest Faculty, post-graduate student, Latvia

Aigars Indriksons

Latvia University of Life Sciences and Technologies, Dr.silv., Latvia

Discussions of forest work prohibition during birds' breeding season have lasted for about five years, but still a final decision has not been reached. The Latvian Ornithological Society calls for a logging and reforestation work interruption from April 1st to June 30th. To take such a serious decision, both positive and negative aspects should be considered.

Birds have adapted to evolving conditions that occur in forests as a result of natural processes. That is why forest management like logging, when trees have not yet reached their biological age, have a significant impact on the condition of the species depending on the very large size of old trees, hallows, dead trees, ditches and others old forest-specific structures. [1, 2, 3]

During field work, a visual inspection of the territory was carried out to do the inventory of the land and forest stands of the selected forest fund, determining the variety of vegetation, the impact of the infrastructure and economic activity on the particular forest area and determining the taxonomic structure of forest birds. This study was conducted in the Joint Stock Company "Latvia's State Forests" Vidusdaugava forestry 507th district. In total, the areas of 24.4 ha or 16 felling sites were studied. The forest areas from all five forest types in Latvia were surveyed – forests on dry sites, mineral soil wetlands, wet peatlands, drained mineral soils and drained peatlands. The study reflects the data collected in the months of July and August 2017. A further survey of these forest areas is scheduled for April 2018 to identify landscapes, biodiversity and bird species replacement after logging. Bird surveys in all forest areas were carried out by a spot mapping technique. Mapping and sound recording were performed during a slow walk by a maximum of four ornithologists consistently covering the entire area of forest areas. The position of each individual bird detected either by sight or hearing was positioned by GPS or alternatively marked on a map.

As a result of the study, 5 bird nests were found, four hallow trees with a hallow diameter of more than 10 centimeters were found, and one of these hallows was the nest of the *Certhia familiaris* L. Altogether, about 70 birds were seen and heard in all the forest sites, which stayed or were located next to a particular forest stands.

The study revealed that the diversity and number of bird species depends on the type of forest and forest fragmentation, the nearby boundaries with other types of landscape, the proximity of the infrastructure and the proximity of other objects to the forest stand. The small number of nests and cavities found indicates the small age of trees and the lack of suitable large trees in the forest stand.

The logging process must strictly ensure that the design volumes are not exceeded and the use of nature-friendly technology and techniques that ensure the preservation of the ecosystem are admissible and they should be improved.

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# WOOD BIOMASS IN UNDERGROWTH AND UNDERSTOREY IN DRAINED FORESTS OF *MYRTILLOSA MEL.* FOREST SITE TYPE

**Mārtiņš Graudums**

Latvia University of Life Sciences and Technologies, Forest Faculty, Mg.sc.ing., doctoral student, Latvia

**Aigars Indriksons**

Latvia University of Life Sciences and Technologies, Dr.silv., associated professor, Latvia

Forest resources are the most significant natural resources in Latvia [3]. According to the second stage data of Forest Resource Monitoring, in 2014, Latvia had 3 575 thousand hectares of forest land, which accounts for approximately 55.3% of the total territory of Latvia, while the total wood stock is estimated at 668 million cubic meters. A considerable part of it can be used for energy production, thus practically providing for most of the necessary heating energy, a large part of the amount of electricity, as well as the amount of energy needed to provide transport movement. In recent years, the consumption of certain woody biomass products, such as chips and pellets, has had a tendency to grow due to the opportunity to use Latvia's own resources and export them and due to the increase in international financing for renewable energy projects. The price of fossil fuel increases and the development of strategic and regulatory decisions have contributed to that [1].

The forest undergrowth and understorey which according to the rules for cutting trees in forest lands are suggested partially to be preserved, contain a considerable amount of potential energy wood [4; 5].

In the forthcoming study on the assessment of energy wood resources, a sufficient number of plots to be established in drained forests are foreseen. In order to ascertain the exact potential of their energy extraction from drained forest site types in the country, as they reach or are close to the cutting age specific methodologies have been used [2].

The results obtained in *Myrtilla mel.* forest site type suggest that the biomass of naturally humid wood of shrubs from the understorey comprises of 22 665 kg per hectare but if calculated into the dry mass - 12 590 kg per hectare. The results suggest that this biomass is considerable and it is reasonable to use it for energy wood extraction simultaneously with the final felling.

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# CHANGES OF FOREST LAND AREAS IN CITIES OF LITHUANIA DURING 1950-2011

**Alina Gutaravičiūtė**

Aleksandras Stulginskis University, Institute of Land Management and Geomatics, Faculty of Water and Land Management, post-graduate student, Lithuania

**Daiva Tiškutė-Memgaudienė**

Aleksandras Stulginskis University, Dr.agr., Lithuania

The basics of modeling green spaces in Lithuania are Nature Frame as well as environmental conditions [1]. However, planning of green spaces in urban landscape strongly depends not only on environmental conditions and Nature Frame, but also on the structure of the plan, size and functions of the cities [2].

This study aims to evaluate changes of forest land areas in six major Lithuanian cities (Vilnius, Kaunas, Klaipėda, Šiauliai, Panevėžys, Alytus) during 1950-2011. Geodatabase of forest land areas in 1950 and geodatabase of the Lithuanian forest cadastre (2011) were used in this research. Geodata as well as data on forest land area in a particular city of Lithuania were gained using ArcGIS software, where ArcGIS Clip tool and statistics for the table were used. In order to obtain geodata of forest land in the investigated cities, recent boundaries of the cities were selected.

The results of this study revealed that forest land areas have increased in all the investigated cities of Lithuania excluding Panevėžys city (Table 1).

Table 1  
Forest land areas in cities of Lithuania in 1950 and 2011

Cities	Forest land area in 1950		Forest land area in 2011		Forest land area changes over 1950-2011	
	ha	%	ha	%	ha	%
Vilnius	10559.8	26.4	14376.9	35.9	3817.2	9.5
Kaunas	2697.3	17.2	3535.1	22.5	837.9	5.3
Klaipėda	1893.0	19.3	2060.5	21.0	167.5	1.7
Šiauliai	398.2	4.9	458.7	5.7	60.6	0.8
Panevėžys	163.9	3.3	122.4	2.4	-41.5	-0.9
Alytus	1142.12	29.0	1303.6	33.1	161.4	4.1

The changes of forest land areas within the period of 1950-2011 ranged from 0.8 % in Šiauliai city to 9.5 % in Vilnius city, while in Panevėžys city the forest land area has decreased by 0.9 %, i. e. from 163.9 ha to 122.4 ha, resulting in forest area proportion of 2.4 % in 2011.

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# CHANGES OF FOREST LAND AREAS IN DIFERENT LITHUANIAN COUNTIES: WITH LARGE AND SMALL FORESTED TERRITORIES

Monika Jankūnaitė

Aleksandras Stulginskis University/Institute of Land Management and Geomatics, Faculty of Water and Land Management, post-graduate student, Lithuania

Daiva Tiškutė-Memgaidienė

Aleksandras Stulginskis University, Dr.agr., Lithuania

According to Land Assessment, forest land area occupied 2178.9 thous. ha (33.5 %) of Lithuania's territory in 2017, as reported by official statistics of Lithuania [3]. Two centuries ago the forest cover proportion in Lithuania was about 40 %. According to Markovienė forest land area decreased, and it was only 20 % in 1914, while in 1939 – only 17 % [1]. In 1950, forests covered 19.7 % of Lithuania territory, as stated by official statistics. This statement was denied by the study in 2012 where historical aerophotos and innovative GIS methods were employed. The study ascertained that forest land area in 1950 was 26.5 %, i. e. notably differing from the official statistics [2].

The aim of this study was as follows: first, to calculate forest land areas in Alytus, Vilnius, Marijampolė and Klaipėda Counties in 1950 and 2015, second, to compare the changes of forest land areas in Alytus and Vilnius Counties that are the most forested regions in Lithuania, with the changes of forest land areas in Marijampolė and Klaipėda Counties, where forests occupy minor territories.

In order to calculate the forest land area in a particular territory, forest geodatabase in 1950 and geodatabase of the Lithuanian forest cadastre (2015) were used. Geodata as well as data on forest land area in a particular county was obtained using ArcGIS software, where ArcGIS Clip tool and statistics for table were employed.

The results of the study revealed that the forest land area changes in different Lithuanian counties differed within the period of 1950-2015. However, forest land areas in all the investigated counties have increased (Table 1).

Table 1

Forest land area in Alytus, Vilnius, Marijampolė and Klaipėda Counties in 1950 and 2015

Counties	Forest land area in 1950		Forest land area in 2015		Forest land area changes over 1950-2015	
	ha	%	ha	%	ha	%
Alytus	204179.4	37.7	277309.2	51.2	73129.7	13.5
Vilnius	323695.5	33.2	435361.2	44.6	111665.8	11.4
Klaipėda	106429.3	20.4	145527.8	27.9	39098.5	7.5
Marijampolė	72137.3	16.2	90411.8	20.3	18274.6	4.1

The most noticeable changes of the forest land areas were found in Alytus County and Vilnius County which are characterized by larger forested areas in Lithuania. The forest land area has increased by 13.5 % in Alytus County and by 11.4 % in Vilnius County within the period of 1950-2015. In comparison, the increase of forest land areas in Lithuanian regions where agricultural traditions are more common, was much smaller. Forest land area in Marijampolė County has increased only by 4.1 %. However, the increase of forest land area in Klaipėda County was higher – 7.5 %.

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# DISTANCE OF INFLUENCE OF ASH FERTILIZERS ON NORWAY SPRUCE ANNUAL INCREMENT

Toms Kalvis

Latvia University of Life Sciences and Technologies, Forest Faculty, undergraduate student, Latvia

Solveiga Luguza<sup>1</sup>, Modris Okmanis<sup>2</sup>

<sup>1</sup>Latvia University of Life Sciences and Technologies, Mg.silv., Latvia, <sup>2</sup>Latvian State Forest Research Institute "Silava", Mg.silv., Latvia

In the past years in Latvia the use of bioenergy has increased. One of the main raw materials used in bioenergy production is forest biomass. As a result of using forest biomass as a fuel there is a noteworthy amount of ash produced. Wood ash contains calcium, magnesium, manganese, potassium and phosphorus. These properties make wood ash a suitable natural fertilizer for forest stands. Before applying wood ash, it is important to determine the way to do it. To use it more efficiently it is important to assess the wood ash fertilizer's distance of impact. Also by knowing the influence distance it would be possible to determine the most effective and productive way to apply the wood ash fertilizer [2, 3].

An experiment was carried out on mesotrophic drained peat soil (*Myrtillosa turf. mel.*) and drained mineral soil (*Myrtillosa mel.*) in 3 middle age Norway spruce stands. Nine systematically located square sample sub-plots (400 m<sup>2</sup>, 20×20 m) were set in each stand in the summer of 2011 with 11 m long buffer zone between them.

In August 2017, the increment cores of all trees from ash and control sample plots were collected at 1.3 m height with the Pressler borer. In total 364 cores were collected and analysed during the study. The cores were glued on desks and then the surface of cores was grinded so that each increment ring was visible. The prepared cores were scanned with a high resolution scanner Epson Expression 10000 XL. The annual increment rings were measured with WinDENDRO software, which provides 0.001 mm accuracy. The average annual radial increment of the last 17 years (12 years of retrospection period and 5 years for the evaluation of fertilization effect) was calculated for each stand and treatment. The additional volume increment was calculated according to I. Liepa (1996) [1].

The results show that additional tree increment is visible for one year after the wood ash was applied and lasted for five years. However, in the last year the additional increment decreased. That means that the wood ash effect was fading. The average tree volume increment for one year is 1 - 3 m<sup>3</sup> ha<sup>-1</sup>.

Analyzing the effect of ash in 10 m area outside the ash dispersion plots a significant ( $t = 4.68 > t_{0.05; 37} = 1.69$ ) and positive ( $4.2 \pm 0.9$  mm) cumulative radial increment was observed in only one of the stands, possibly due to wider tree roots, optimal light conditions and washing out of nutrients in the microrelief. The results show that ash fertilizer gives additional tree increment but only when it is distributed evenly throughout the stand.

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# IMPACT OF DOLOMITE QUARRY ON THE GROWTH OF SCOTS PINE TREE STAND IN THE NATURE RESERVE "LIELIE KANGARI"

Edmunds Kance

Latvia University of Life Sciences and Technologies, Faculty of Forestry, undergraduate student, Latvia

Aigars Indriksons

Latvia University of Life Sciences and Technologies, Assoc. Prof., Latvia

Over the last few decades, the amount of mining minerals in Latvian forests and mires, including peat and dolomite mining, has been increasing [2]. The activity of reconstruction of forest drainage systems is also increasing, especially in the state forest areas. It is important to determine the distance from dolomite quarries, at which their impact on forest stand or mire ecosystem ends. Near the Great Kangari Mire an extensive extraction of dolomite dominates in Ropazi District [2], closer to the western edge, which began in the 20th century in the 80s, but rapidly expanded beyond 2010 [3]. The research was carried out in two objects in the nature reserve "Lielie Kangari": Object 1 - in Ropazi District, the Quarter 620 subquarter 2 of the state forest (pure Scots pine (*Pinus sylvestris* L.) stand, forest site type - *Sphagnosa*, 94yrs old) 900-1400 m from dolomite quarries, in the area of the potential depression funnel - and Object 2 - in Suntaži rural territory (Ogre District), Quarter 633 subquarter 5 of state forest (pure Scots pine stand, forest site type - *Sphagnosa*, 97yrs old), outside of probable impact area of dolomite quarries. In each sample plot (with the radius of 7.98 m) in each object, forest dendrometric data were determined, drills in trees were made and 5-6 groundwater control wells 10 m from each other were made to determine groundwater level, so that there would be at least one well in the site instead of a typical forest stand, and one near the mire.

The aim of the study is to analyze the current fluctuations in the groundwater level, precipitation and possible differences between the objects that could potentially be caused by the activities of the surrounding area, analyzing the progress of the growth of forest - historical differences that could be explained by the extraction of minerals.

The average height of a forest stand is 16 m in object 1, 12.5 m in object 2, whereas the basal area of a forest stand on average is 31.8 m<sup>2</sup> in Object 1, while in Object 2 it is 14.0 m<sup>2</sup>, average wood of 17.9 cm in Object 1 and 15.2 cm in Object 2. The level of groundwater in Object 1 (taking into account the average of all wells) during the observation period (05.2017 to 12.2017) varied between 3 cm above the soil surface and 40 cm below the soil surface (average 12.1 cm below the soil surface), but in object 2 - between 5 cm above the soil surface and 30 cm below the soil surface (average 10.2 cm below the soil surface), the groundwater level of the objects did not differ significantly. The amount of precipitation in Object 2 was 25% more than in Object 1. There have been similar forest stand average stock volume increments per year in both objects for the last 12 years. Object 1 shows a significantly larger amount of wood, basal area and height of trees than Object 2, which may be related to both the minimum deeper groundwater level in Object 1 or historical impact drainage in Object 1, but there is no evidence of recent impact of dolomite quarries on Object 1.

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# ECOLOGICAL PROBLEMS OF LOGGING RESIDUES AND THEIR SOLUTION

**Maksim Kanishchev**

Saint-Petersburg Forest Technical University, Institute of Technological Machines and Transport of Forest, undergraduate student, Russia

**Lubov' Gromskaya**

Saint-Petersburg Forest Technical University, Candidate of Technical Sciences, Russia

Nowadays not only in Russia but also in the whole world pollution in the environment is growing rapidly. In the process of logging the environment is polluted by a large number of logging residues during logging operations and the problem of their effective collection has not yet been solved. The practice of logging enterprises in Russia shows that in the logging warehouses or landings of different types, especially in the lower warehouses, significant amount of woodworking waste is accumulated, which pollutes the environment. In the former USSR, research in the field of the structure of gas-generator plants was actively conducted from 1923 to 1965 and the results were published in more than 5,000 publications. It is noteworthy that the publication of books on this subject did not stop even during the war period. By the mid-sixties an active development of technologies and equipment for the gasification of solid fuels as a whole had stopped. This was primarily due to the proliferation of convenient and affordable fuels produced from gaseous (natural gas) and liquid (oil) fossil feedstocks.

A modern solution to this problem is the production and use of liquid biofuels produced from wood since it is the most promising resource. The final product is a liquid mixture of hydrocarbons or methyl-substituted fatty acids, similar in properties to traditional gasolines and diesel fuel. From an environmental point of view, net emissions of carbon dioxide to the atmosphere can be reduced by 150 million tons per year by transferring part of the vehicle pool to liquid fuels from woody biomass with the full use of waste from the global forest industry.

Technologies and the systems of machines make it possible to produce fuel chips usually from pre-dried woody biomass, which can be classified on the site of the grinding operation: 1) in the forest plot, the wood biomass is crushed into chips directly on the forest plot, 2) on the loading platform, the wood biomass is triturated from the forest plot to the site located at the logging road, where it is ground into chips, 3) in a specialized terminal, the biomass is transported to the terminal, where it is ground into chips, 4) at the consumer (mini-cogeneration plant, boiler room) - biomass is delivered to the consumer and crushed there.

Fine wood can be obtained by commercial dilution and non-commercial dilution, as well as by cleaning line objects (power lines, roadside forest roads). Crown tops and branches make up a significant part of the biomass of a tree, so the harvesting of fine wood allows one to obtain large volumes of raw materials. In the form of branches they are in greater demand by small boiler houses, where the requirements for the quality of fuel chips are higher than for large boiler plants. Modern fully mechanized technologies for fine wood harvesting are quite productive, but the cost of 1 m<sup>3</sup> of fuel chips, obtained from pre-dried fine wood (about 7-10 euros and requires state subsidies) is higher than the cost of wood chips from felling residues (about 3-5 euros per 1 m<sup>3</sup>).

At the initial stages of development of forest bioenergy in Russia, weekly wood should be considered as a source of raw materials for the production of wood fuels. But one should not forget that the same significant sources of raw materials for the production of wood fuel are from sawmilling and woodworking waste (as shown by the example of the Arkhangelsk region).

One of the examples of the provision of heat with solid biofuel is the Kovrov boilers, which were used in a project to replace obsolete boiler plant equipment in the village of Nerekhta and the village Shevinskaya Kovrovsky district of the Vladimir region boilers "Geyser-ENERGY" operating from wood chips of natural moisture. The operation of new automated boilers with a capacity of 2x1 MW made it possible to provide an efficient heat supply for two villages and to save significant amounts of budget money.

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# THE IMPACT OF ENVIRONMENTAL FACTORS ON ENGLISH OAK (*QUERCUS ROBUR* L.) PLANTS IN TREE NURSERIES

**Solvita Krodziniece**

Latvia University of Life Sciences and Technologies, Forest Faculty, doctoral student, Latvia

**Olga Miežīte**

Latvia University of Life Sciences and Technologies, Dr.silv., Professor, Latvia

**Aigars Indriksons**

Latvia University of Life Sciences and Technologies, Dr.silv., Assoc. Professor, Latvia

In Latvia, English oak planting material is grown both as bare-root seedlings and bare-root plants. Its breeding is difficult, because the quality of planting material is affected by both abiotic and biotic factors. The damage caused by various factors may be spread evenly and unevenly in the area of cultivating planting material. The most common damage to seedlings and plants can be observed already in the spring, when new leaves begin to unfold and new shoots develop. It is clear that differences in the inherent persistence of a tree (for example, frost resistance) cause varying degrees of damage, but this may vary for each tree.

After the winter season, the main causes of damage are water rats, earthworms, gnaws of hares and *Artiodactyla* (roes), heightened soil moisture (groundwater level). Of the risk factors for growing the planting material mentioned above, the most common are abiotic - damage to the frost and heightened groundwater level, and biotic damage – gnawing of *Artiodactyla*.

Temperature changes and adverse weather conditions are mainly damaging the open planted seedlings and plants. The long and warm autumn period contributes to frost damage for young immature shoots. The presence of frost damage is evidenced by the fact that the leaves of the previous summer shoots, wintering buds of oak plant material were of violet colour (mean incidence of damaged trees 0.5%).

The high humidity regime is determined by the amount of precipitation in the form of rain and snow. Part of the precipitation is evaporating, but if this process takes place too slowly, soil compaction takes place, organic matter leaks, trees suffer from the lack of oxygen in the soil, causing the death of the roots. In the swampy soil, the root system of the seedlings is damaged, which greatly contributes to the development of the lateral roots. Under these conditions, the growth is low. In the tree nurseries Norupe and Zabaki no high soil moisture was observed, but it was found in Jelgava tree nursery (mean incidence of damaged trees 25%).

In Jelgava tree nursery of Joint Stock Company “Latvian State Forests” gnaws of roes were observed (mean incidence of damaged trees 11.4%). The area has a low fence, and the nursery is located in Jelgava city area where hunting is prohibited, so the animals feel safe and have a feed base. The height of the gnaws depends on the thickness of the snow cover. The quality of oak's planting material is formed as a result of gnaws of *Artiodactyla*.

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# COMMON WALNUT *JUGLANS REGIA* L. PROSPECTIVE FORMS IN LATVIA

Mārcis Lavendels

Latvia University of Life Sciences and Technologies, Forest Faculty, undergraduate student, Latvia

Solveiga Luguza

Latvia University of Life Sciences and Technologies, Mg.silv., Latvia

The aim of the research is to find out the possibilities of growing and using common walnut *Juglans regia* L. for timber production in Latvia.

There is a great interest about the fact if common walnut can overcome the fluctuating weather conditions in Latvia still having high-quality trunk.

Growing *Juglans* for nuts and wood simultaneously, cannot reach sufficiently good wood results, because in order to grow nuts, crown thinning must be performed which is the reason for slowing down the timber production [1].

In the Atlas of Latvia 40 woody plants' localities where *Juglans regia* is found are mentioned, but the exact number of trees is unknown because more than one tree could be found in each locality [2].

Gunvaldis Vēsmiņš has found the trees of *Juglans regia* which show higher frost resistance comparing to others. Despite the fact that the terminal bud of this specimen is frozen, it can still form lower buds.

Research shows that *Juglans regia* acclimatization in Latvia has bright future, because the research of 33 trees of *Juglans regia* shows that most of them look very healthy.

In timber plantations walnuts should be planted  $1800 \text{ n} \cdot \text{ha}^{-1}$ . In this model production forecasts indicated  $35 - 60 \text{ m}^3 \cdot \text{ha}^{-1}$  at the age of 26 years and diameters between 20.7 – 26.5 cm [3].

Common walnut can reach different heights, the varieties with pendulous branches are usually not so high. In the forest of the same age trees it reaches greater height than separately growing trees. The tree height is not a characteristic feature that can be inherited genetically. From one mother tree, the trees grown from seeds significantly differ in height. Suitable growing conditions facilitate greater height. The height of an 80 year old tree can fluctuate from 15 to 30 meters. The maximum height is 38 m, but most often it reaches 10 - 20 m [4].

Most of walnuts in Latvia grow separately and, therefore, they are not growing very tall. The average height of the trees researched was 12 m and their diameter at breast height was 22 cm, but the highest was 19 m with 24.9 cm in diameter at breast height. The largest diameter at breast height was 57.5 cm and the tree was 15 m high. The correlation between the diameter and height was 0.69.

The average age of the researched trees was 35 years and the average timber volume of one tree was  $0.22 \text{ m}^3$  but the highest timber volume was  $0.128 \text{ m}^3$  per tree.

*Juglans regia* is a fast growing tree species - that means that an appropriate method should be found for growing these trees to obtain high-quality timber.

The forms of *Juglans regia* L. growing in Latvia should be further studied to find the most suitable trees for Latvia's climate.

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# FACTORS AFFECTING THE VOLUME OF ROUND TIMBER

**Maikls Mūrmanis**

Latvia University of Life Sciences and Technologies, Forest faculty, undergraduate student, Latvia

**Jānis Magaznieks**

Latvia University of Life Sciences and Technologies, Mg. sc. ing., Latvia

The main factor affecting the economic aspect of round timber selling and buying business is the volume of round timber. The precision of the calculation result of round timber volume is very important since this factor affects all stages of the business deal, regarding both – the buyer and the seller, because no one wants to overpay or get less economic benefit [3]. First of all, you can have an error in the result of round timber volume, if you use a different type of automatic laser measuring system, for example: 1D, 2D or 3D. 1D automatic laser measuring system are measuring assortment from one side. By using 2D system, measuring is performed from two sides, whereas in 3D measuring system the assortments are measured from 3 positions. 3D measuring system has the highest precision, because of measuring from different positions, and that is the reason why the average diameter is the most accurate. 1D automatically measuring system is the most inaccurate, for example, if the assortment is oval, you can get a diameter from the shortest or longest side [3]. The precision of laser measuring can be influenced by vibrations of timber measuring lines, the form of assortments, rounding off, sawdust which negatively influence the laser [2]. Secondly, if you choose an individual measuring method for timber volume, you can choose approximately 3 techniques: smallest diameter, middle diameter and both ends of assortment diameters method of round timber. All these techniques are affected by different factors, for example: wood defects, wood damages, snow and ice on assortments, measuring devices and instruments as well as the measuring person's education and experience. The technique with the highest accuracy is measuring both ends of assortment diameters [1]. Thirdly, the volume of round timber is affected by round timber wood defects. For example: irregularity of diameter, taper, compression wood, uncut branches, rot, insect damages and mechanical damages. If round timber has some of these wood defects or damages, then it is more difficult to measure the assortment correctly and get the highest precision value. The person who takes the measurements, needs to have appropriate education and experience to make the right decision [4]. Fourthly, the section of the trunk the assortment comes from, also affects the round timber volume. If the assortment is from the widest part of the trunk, it will likely have compression wood and mechanical damages. If the assortment is from the middle part of the trunk, it will have less compression wood, but maybe will have more uncut branches. If the assortment is from the top of the trunk, it can have uncut branches and mechanical damages. It is possible that the assortments have different wood defects, no matter which section of the trunk they are taken from. In this case, wrong diameter and volume measurement results are obtained [1, 4]. In conclusion, it should be noted that many factors can influence the result of round timber measurements and timber volume, and that is why sometimes there are uncertainties in the forest industry regarding the correct volume of timber. No one wants to overpay for round timber assortments, and no one wants to be underpaid. That is why it is very important to carry out experiments and research this subject. In future new methods need to be invented and the existing ones improved.

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# **ELECTRIC GUITAR BUILDING**

**Norberts Naglis**

Latvia University of Life Sciences and Technologies, Forest Faculty, undergraduate student, Latvia

**Aija Pētersone**

Latvia University of Life Sciences and Technologies, Mg.paed., Latvia

Many musicians decide to make their own instruments because they know what the best outcome is for them, they can adjust the instrument particularly for themselves. The highest standard that can be achieved is when the instrument and musician combine as one unit.

It is important to know the parts of the guitar before you start building your own musical instrument. Every part is important. The guitar is a means of amplifying and altering the pitch of a set of strings. On an electric guitar the strings' vibration is transformed by a pick-up, which converts the vibration of the string into electric current which then goes to the amplifier and makes the guitar sound louder than an acoustic guitar. There are several elements which you need to consider before making your own guitar - scale length, frets, neck depth, body shape, pick-ups and controls, truss rod, and, of course, the wood species [2].

An electric guitar is mostly built from two main parts – the body and the neck. The body of the guitar needs to be of a size to comfortably hold and be big enough to balance when the guitar is on a strap. The form of the guitar is important and the guitarist should be able to hold every part of it and reach the fretboard, and it must be of an adequate weight without being too heavy to hold. Every part must fit together in a way that enables each part to perform its correct function without impeding the guitar function and obstructing the player. The body shape is the decisive element of how the guitar will look when finished [1]. Guitars are made mostly of wood and wood makes a difference in the sound of an electric guitar. It is the finest and most satisfying material to work with. Some types of wood are better suited to a particular part of the guitar than others, and some types of wood have become the standard for a particular job [3]. For example, ebony and rosewood are used mostly for the fretboard. The choice of wood you make for your guitar mostly depends on what region you live in. More exotic woods cost more and these sorts of wood are slowly disappearing. Wood grain affects the wood strength. Straight-grained wood has more stability. Grain effect on the guitar texture, for example, the flame in curly maple, and some other woods, is caused by the weight of the tree compressing the grain in the lower parts of the tree, it can be very attractive, but it is quite unstable. There are many wood factors that influence the guitar builders' decisions on what type of wood is chosen for making a specific part [2]. Furthermore, each wood type has its advantages and disadvantages. The condition of wood is as also an important aspect. Ideally, the wood for building a guitar should be straight-grained, quarter-sawn and air dried. Quarter-sawn timber is much stronger than slab-sawn timber, but it is not too common, because of the waste which is caused by the method of sawing the timber. Air-drying of wood is not economical because of the long drying time. Thus, the best answer for the best material is to look at growth rings at the end of the plank. The growth rings should be as close as possible and perpendicular to the side face of the plank. If the growth rings are clearly semi-circular, the wood may very well curve across the plank and split [1].

The main conclusion to be drawn from the study of literature sources and the author's own experience is the following - in order to build an electric guitar one needs to consider the smallest detail in order to achieve the best results.

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# **PICEA PHYSOKERMES SCHRNK. IMPACT OF DAMAGE ON THE DIAMETER INCREMENT OF PICEA ABIES (L.) H.KARST. IN OXALIDOSA TURF. MEL.**

**Elīza Stokmane**

Latvia University of Life Sciences and Technologies, undergraduate, Latvia

**Olga Miezīte**

Latvia University of Life Sciences and Technologies, Professor. Dr.silv., Latvia

**Edgars Dubrovskis**

Latvia University of Life Sciences and Technologies, Mg.silv., Latvia

Under the influence of global warming forest stands are becoming more susceptible to different kinds of diseases and insects. For example, in Latvia, until the year 2009 spruce bud scale was found only on trees growing in parks. However, after the year 2009 it was also found on Norway spruce (*Picea abies* (L.) Karst.) in uneven age forest stands, especially in drained forests, including *Oxalidosa turf. mel.*

From the year 2009 till 2011, spruce bud scale was the fastest spreading in the countries of Northern Europe such as Latvia, Lithuania, Poland and others. Mostly spruce stands on mineral soils were damaged; however, this insect has various spreading areas, since it is common on naturally wet, dry and drained soils [3]. In 2010, the first spruce bud scale damage was found in Latvia. „Rīgas meži” LLC monitored Olaine and Tīreļi forest area and found that 24 % of the spruce trees were with damage signs and 10 % of the trees were already dead by the influence of the spruce bud scale proliferation. Although, in literature there is no evidence of connection between critical tree damage and spruce bud scale, this insect is often listed as a factor of tree weakening, thus making it more susceptible to other stress factors [3].

Spruce bud scale mostly damages spruce stands on dried peat soil, as it happened in the year 2011 in Lithuania where in the sanitation felling more than 100 hectares of spruce bud scale damaged stands were cut down. As ground water and potassium level often change in drained peat soils, it can cause the increase in the intensity of the damage, since potassium level in soil positively correlates with the trees' recovery indicators. In addition, the spreading of black sooty mold also increases the intensity of the damage. It uses excreted spruce bud scales honeydew as a feed base, colours it black and interferes with plants assimilation, breathing and decreases the trees' growth. In parks the trees' aesthetical value [2].

One way to restrict spruce bud scale is to use biological control methods, attaching the insect's natural enemies, for example, purposefully saving them. The most effective natural enemy is *Anthribus nebulosus* that can make spruce bud scale population decrease from 68 to 80 % [1], whereas, other natural enemies influence the population reduction, for example, *Coccophagus lycimnia* and *Scymnus abietis* is so minimal that we cannot manage without other activities [1]. Sound forest management measures reduce the damaged tree proportions caused by spruce bud scale. Still, before forest management, all the conditions in the forest should be evaluated and appropriate management option should be chosen.

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# THE ASSESSMENT OF OUTCOME OF OLD SCOTS PINE FOREST STANDS IN MEŽAPARKS, RIGA

Rūdolfs Tīrmanis

Latvia University of Life Sciences and Technologies, Forest Faculty, undergraduate, Latvia

Inga Straupe

Latvia University of Life Sciences and Technologies, Dr. silv., Professor, Latvia

Urban forest environment is a complicated social-economical system, as forests in cities provide contact with nature for people, and every year people are becoming more interested in recreational use of urban forests [1]. Nowadays, the main aim for urban forest management is to raise the forest's abilities to provide its recreational and social functions, maintain biological diversity and increase sustainability of forests at the same time. Performing special felling for landscape forming in urban Scots pine *Pinus sylvestris* L. forests might help solve the problems related to intensive use of forests, forest regeneration, aesthetic values and safety, while giving a chance to forest owners to gain economic value of forest management.

The aim of this study is to estimate the outcome of special cutting method, developed for old pine stands, in Riga's Mežaparks. The objectives of the study are to characterize a forest stand that is being prepared for a special landscape forming cuts and to measure the potential outcome of this cut, comparing the results to average relevant indicators in similar stands. To provide the data for the stand characteristics, each tree stem with a diameter over 5 cm was measured in the stand. In total, 25 trees from each species, representing all diameter groups, were measured to describe heights' distribution. The trees to be cut according to the method were measured in the same way. The collected data were used to calculate the stand's basal area, yield, diameter and heights' distribution for each species accordingly, as well as the potential volume of the trees to be cut. The areas of cutting were calculated.

The average yield of the stand was  $325 \text{ m}^3 \cdot \text{ha}^{-1}$ , 97% of which was Scots pine, for the upper tree layer, which is similar to average values in similar growing conditions of  $295 \text{ m}^3 \cdot \text{ha}^{-1}$  [2]. The second tree layer, however, consisted of Scots pine, small-leaved lime *Tilia cordata* Mill., Norway maple *Acer platanoides* L., common oak *Quercus robur* L. and silver birch *Betula pendula* Roth, which corresponds to sites with richer soils [3], showing the impact of urban environment and alerts about future problems of maintaining sustainability of the stand. The total area to be cut was 0.73 ha, which is 17 % of the total area of the stand, divided in 11 spots with the average area of  $665 \text{ m}^2$ . The total estimated yield of the cut was  $154 \text{ m}^3$  with the pine providing the biggest yield of  $132 \text{ m}^3$ . The average yield of  $35 \text{ m}^3 \cdot \text{ha}^{-1}$  is slightly higher than the average yield in landscaping cuts in Latvia on average for the last 3 years of  $29.5 \text{ m}^3 \cdot \text{ha}^{-1}$  [4], meaning that the specific method does not decrease the potential income for forest owner, however, this method benefits both social and ecological functions of urban forests directly, while other methods are mainly aimed at satisfying aesthetic needs of people.

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# GROWTH OF LABRADOR-TEA *LEDUM PALUSTRE* L. AFTER MANAGEMENT OF HERB LAYER AT CAPERCAILLIE *TETRAO UROGALLUS* L. MATING PLACE

Anete Zālīte

Latvia University of Life Sciences and Technologies, Forest faculty, undergraduate, Latvia

Inga Straupe

Latvia University of Life Sciences and Technologies, Dr. silv., Professor, Latvia

Capercaillie *Tetrao urogallus* L. lives in Boreal forest zone and in the territory of European Union was a highly valued game species, but now it has been established as protected. It is approved and used as an umbrella species for the assessment of biodiversity as well as the status of forest ecosystem [1]. Capercaillie prefers wet pine forests for living and it stays there for all its life. Surviving of birds depends on the appropriate food base which consists of pine needles and buds in winter, seeds and berries of dwarf shrubs especially Bilberry *Vaccinium myrtillus* L. in the summer time [2].

In the 1970s drainage of wet forestlands was carried out all over Latvia. As a result, 80% of mating-places were affected. The humidity conditions and herb layer of vegetation were changed in habitats [3].

The aim of the study is to find out how the management of herb layer affects the growth of Labrador-tea *Ledum palustre* L. In the mating place of Capercaillie.

Three sample plots of 10m x 30m (three repetitions) divided into three control plots 10m x 10m were established in the mating place. In each control plot different management of herb layer was performed. The first was the control area without management, in the second – cutting of Labrador-tea was performed in the entire plot, but in the third – cutting in zones was carried out. Vegetation survey using Braun-Blanquet method was conducted.

In the control area without management the cover of herb layer had increased. In the second area - it had decreased by 24%, but in third area - by 8%. The cover of Labrador-tea in the control area without management has a tendency to increase, but after cutting in the entire area of the plot it decreased by 39% and in the plot area after cutting in zones - by 33%.

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## **SOCIAL SCIENCES**

# STATISTICAL METHODS IN RESEARCH ON LITHUANIAN INHABITANTS' ATTITUDES TOWARDS BANK LOANS

**Beata Joneliūkšytė**

Šiauliai University, Department of Computer Science, undergraduate student, Lithuania

**Renata Macaitienė**

Šiauliai University, Dr., Professor, Lithuania

One of the relevant questions in the banking industry is identifying the factors that affect customers' decision to take out a loan from a particular bank; this has become essential for many banks in their effort to attract new customers and to maintain existing ones. These problems are investigated in many works, e.g. in [1, 2]. The purpose of the present study was to identify factors that influence Lithuanian customers' decision to take out a loan from commercial banks. A randomly selected sample of our citizens from various occupations (students, employees and businesspersons) was chosen in order to test our hypotheses.

A questionnaire with self-determined scales was created after ensuring the instrument's validity through confirmatory factor analysis. The quantitative methodology in the analysis was used.

In this talk, we will briefly mention the research methodology and used variables; for example, those that have been examined as potential factors influencing customers' decision to take out a loan, like demographics, service quality and satisfaction. Some aspects regarding the analysis of gender differences in the relative importance of choice criteria in respect to selecting a bank will be examined, and the opinion of bank customers on any extra services needed to be offered by banks also will be analysed.

However, we will focus on the presentation of statistical methods used in this research. More precisely, we will discuss the use of: parametric hypotheses for one sample, parametric hypotheses for two or more than two (dependent and independent) samples, nonparametric hypotheses (for verifying independence, homogeneity and distributions compatibility), correlation analysis, regression analysis and factor analysis [3]. Moreover, we will discuss the principles and possibilities of statistical methods' realisation using specialized software.

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# **SOCIO-ECONOMIC RESOURCE MAP OF THE MIGRATION OF ASYLUM SEEKERS AND REFUGEES IN ROMANIA**

**Karola Kalapati**

West University of Timișoara, Faculty of Sociology and Psychology, Sociology Department, Sociology Specialization, postgraduate student, Romania

**Melinda Dincă**

West University of Timișoara, Dr.sc.soc., Romania

This research aims to study the migration route and social and economic resources that facilitated the migration and seeking of asylum in Romania. With the start of the Syrian War in 2011, people started seeking safety in other countries. Their number increased as time passed, with number of asylum seekers in Europe peaking in 2015: 1,046,599 [1]. Taking a qualitative approach, we decided to use biographical interviews in order to create a comfort zone and to give the subjects of this research – asylum seekers and refugees – the opportunity to profoundly explore their life stories.

The interview guide is developed into five discussion topics: childhood and family, the trip to Romania, the arrival in Romania, the present situation and future plans. The interviews were conducted in 3 of the 6 cities in Romania which have a Regional Center for Accommodation and Procedures for Asylum Seekers: Timișoara, București and Galați. Fleeing from conflict zones such as Syria, Iraq, Afghanistan, the subjects of this study decided to leave everything behind and to seek safety in Europe. The main reason that is common for every subject of this study for leaving their homes is the wish to live and to have a normal life. Most of the subjects of this study came illegally to Romania. Almost all of them have turned to the help of smugglers, to whom they have paid between 200 and 2500 EUR for crossing borders.

During the interviews, the travel from the origin country to Romania was described. Turkey, Greece and Serbia are the countries where the subjects spent more time in refugee camps. Regarding the way of entering Romania, the people that entered legally came by plane and the people that entered illegally entered Romania by foot. Even though Germany is the most desired European country by asylum seekers, the subjects of this study want to remain in Romania as long as they are safe here. After asking for asylum in Romania, the subjects of this research discovered problems such as finding a job and finding a place to rent. Regarding the positive aspects of life in Romania, being in a safe place is the most valuable thing for them. Within this study, the research limitations regarded denial of access inside the Emergency Transit Center of Timișoara, the communication that took place in different languages than the researcher's native language and the train delays which led to the postponement or cancellation of some interviews.

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# **ALPACA BREEDING IN LATVIA**

**Ausma Kalniņa**

Latvia University of Life Sciences and Technologies, Faculty of Economics and Social Development,  
undergraduate student,  
Latvia

**Aina Dobele**

Latvia University of Life Sciences and Technologies, Dr. oec. Professor, Latvia

Traditionally, farming in Latvia has been a common practice to earn living for the household. Nowadays, agriculture for small farms is not cost-effective; therefore, the agricultural land that belongs to small farm owners is not used properly or not used at all. According to the statistics of Central Statistical Bureau of Latvia in 2016, approximately 76% of all the agricultural holdings were smaller than 20 hectares. These are defined as small farms, and raises the issue of economic performance against agricultural farms with area larger than 200 hectares [1].

The ability to function in different sectors shows that a small agricultural holding doesn't need to engage only in traditional agriculture to gain an economical benefit [2]. Deciding to make an agricultural holding multi-functional can have both economic and social benefits. For example, if a small farm has some kind of animals that are not meant for meat or milk extraction. then they can be used as a tourism object or for breeding, therefore having economic benefit. If these animals are tourism attractions, then the land can also serve a social function in educating people about the animals and the environment they live in.

At this moment, there are very few farms in Latvia that breed alpacas (of the camel family). There is no official statistic regarding their population, but based on media information, there are not many alpacas in Latvia. Alpacas are from camel family and share some resemblance with llama. Generally, alpacas are calm and easy to train, they do not fear humans, making them a great tourism attraction. Alpaca wool can bring economic benefit, and the animal can be bred for selection [3].

An agricultural holding that has a small agricultural land can have alpacas as one of the byway business with many functions. Alpacas cannot be bred for meat, so there are three ways to get an economical gain from alpacas: wool, selection and breeding and tourism. Alpacas are relatively easy to take care of; therefore, there is no need for special education to have these animals.

It can be concluded that small agricultural holdings have many possibilities aside from traditional agriculture to gain economic benefit. Mainly, if the farm can be multifunctional, it increases its chance to be successful. Alpaca farms can be beneficial both economically and socially, and increase the awareness of rural potential.

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# STRATEGIES OF DEVELOPMENT OF THE CROSS-BORDER ASSOCIATION “EUROREGION ‘BUG’”

**Dzmitry Navichuk**

Baranovichy State University, Faculty of pedagogy and psihology, undergraduate student, Belarus

**Uladzimir Zuyeu**

Baranovichy State University, PhD candidate, Belarus

Border areas, thanks to their special role in developments, are an important subject of interest for the regional policy pursued at the level of the European Union and certain countries and regions.

Now the Euroregion “Bug” act as members of Cross-border association: Lublin voivodeship (Republic of Poland), Brest region (Republic of Belarus) and Volyn region (Ukraine). The Euroregion also includes two districts of the Lviv region adjacent to borders of Poland [1].

The main objective of activity of Euroregion “Bug” is cooperation of border territories in the area: regional planning; communications, transport and communication; education, health care, culture, sport and tourism; environmental protection; response to emergency situations and natural disasters; assistance expansion of contacts between inhabitants of border territories and also development of cooperation between institutions and subjects of economic activity.

To define the purposes and the direction of development of border cooperation in November, 2013, the strategic document of the Euroregion, “The strategy of border cooperation for 2014-2020,” has been accepted [2]. In four areas, the following purposes and the directions of strategic actions have been formulated: economic cooperation; environment, culture and tourism; communication and boundary infrastructure; science and higher education.

The common goal is to increase social and economic competitiveness of the cross-border area in the European, national, regional and local aspects due to effective use of endogenous potentials and mitigation of the restrictions connected with functioning of external border of the European Union has been formulated.

The level of development of the cross-border region regarding strengths, weaknesses, opportunities and threats has been estimated.

Having analysed strategy, it is possible to draw the conclusion that realization of strategy will provide sustainable development of the region, will improve his tourist appeal.

Cross-border initiatives play an important role for development of good neighbourly relations between residents of border areas and to help expand mutual understanding.

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## CHARACTERISTICS OF THE SPORTS FACILITIES IN LATVIA

**Ieva Opolska**

Latvia University of Life Sciences and Technologies, Faculty of Economics and Social Development,  
Doctoral student, Latvia

**Līga Proškina**

Latvia University of Life Sciences and Technologies, Faculty of Economics and Social Development,  
Dr.oec., Assistant Professor, Latvia

One of the main tasks of sport policy is to give a chance for each an individual to do sports, regardless of age, gender, race, religion affliction or mental and physical ability, and creating the necessary legal, economic and social conditions for it. The realization of sports goals is not possible without modern sports facilities and sports events taking place in them, attracting the inhabitants, encouraging their desire to participate in sporting activities, improving themselves and taking care of health.

Targeted investment in infrastructure, as well as in a healthy and active lifestyle, is investment in the long-term development of Latvia, as it provides significant support to the promotion of the health of the population and improvement of the quality of the work force - by forming healthy, physically and mentally developed personalities.

Furthermore, investing in sports, as well as in healthy and active lifestyles in the regions, contributes polycentric development. By investing in the sports development, building healthy and active lifestyles infrastructure, in the future, less money will have to be invested in healthcare and crime, as it promotes the fight against the causes of these problems.

The aim of the research is to determine sports objectives in Latvia, how they are divided and what the benefits are of them.

At the moment, 1213 sports canters and 3132 sports facilities have been registered in the register of sports bases [4]. Sports facilities in Latvia are categorized according to their importance, the highest of them being the national sports facility. A national sports facility is a structure, as well as the environment built or adapted exclusively for sport (fields, tracks for sports activities, health tracks, etc.), which has been granted the status of a national sports facility in accordance with the procedures specified in this law, regardless of the ownership of the structure or the environment [2]. National sports facilities are the only ones to have annual national budgets provided for through public funding. In 2018, funding for sports facilities from the state is 12,35 million euros [1].

A study conducted by the Latvian Sports Federation Council and Kantar TNS in 2017 (n = 1030) found that 57% of the surveyed have free sports facilities near the place where they live. 43% indicated that free gym equipment available near the home would motivate more do sport and physical activities [3].

The conclusions of the paper are: 1) In Latvia are 1213 sports centers and 3132 sports which are registered in the sports register. 2) Sports bases can be divided into 3 groups: the national sports facilities, sports facilities for educational institutions and others facilities. 3) Well-developed sports facilities can promote people's desire to do sports, thus reducing the risk of deteriorating health.

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# **ANALYSIS AND DEVELOPMENT OF OPPORTUNITIES FOR THE SUGAR INDUSTRY OF INDIA**

**Hemant Kishor Patil**

Latvia University of Life Sciences and Technologies, Faculty of Economics and Social Development,  
Latvia

**Lasma Licite**

Latvia University of Life Sciences and Technologies, Faculty of Economics and Social Development,  
Dr.oec, Assistant Professor, Latvia

India is the second largest producer of sugar in the world, with a share of over 15%, and the top consumer of sugar in the world [1]. The sugar industry has great significance, which cannot be devalued in its relation to agricultural and industrial economy of the rural region of India. The sugar industry supports over 60 million farmers and their families, and delivers value added to the farming sector. [2].

The research aims to develop scenarios on how to develop the Indian sugar industry based on international and national experiences regarding the sugar industry. To achieve the aim, the following specific research tasks were set: 1) to examine the sugar industry in India; 2) to examine the legal framework of sugar industry in India; 3) to develop scenarios on how to develop the sugar industry in India. The monographic and descriptive methods and scenario method were employed to achieve the aim and perform the tasks.

The sugar industry is predominantly the agro-based industry in India. In India, there are 716 established mills and the sugar production of India is 25.5 million of tons. However, the sugar produced in India is not enough to fulfil the domestic demand. If the sugarcane production will not increase in the coming years, then the domestic sugar prices will obviously increase and India will face sugar shortages in the coming years.

The Indian sugar industry is working under public, private and co-operative units. The Indian government has a strict policy for the import of sugar. In 2015, import duty was increased from 25% to 40% to stop the import of sugar and improve export of sugar. The Indian government hardly wants to stop the import of sugar and export more sugar to the international market. As a result of this, government of India is arranging the various activities and providing subsidies to increase the sugarcane and sugar production.

There were 3 scenarios developed to develop the Indian sugar industry – Farmer support, Factory owners and Government support scenario. The government support scenario is the best and effective to develop the Indian sugar industry by removing outdated and faulty policies from the sugar sector and allowing all sugar factories to increase the sugar mill capacity more than 5000 TCD. This would help to develop the sugar industry by producing double sugar compared to the current situation. On the other hand, the government has to increase sugarcane prices paid to the sugarcane growers as it can help to encourage the farmers to cultivate more sugarcane and increase the area under the sugarcane crop to develop the Indian sugar industry.

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# EXPECTATIONS OF GENERATION Y IN THE LABOUR MARKET

**Linda Perkune**

Latvia University of Life Sciences and Technologies, Faculty of Economics and Social Development,  
MBA, Latvia

**Lasma Licite**

Latvia University of Life Sciences and Technologies, Faculty of Economics and Social Development,  
Dr.oec., Assistant Professor, Latvia

The replacement of each generation brings a major change in society, because employers must be able to adapt to what can be offered and what the required generation of workers can offer [1]. Various studies have described the main features, values and potentials of “Millennials” or “generation Y” [2, 3]. The aim of the research is to ascertain the expectations of generation Y in labour market. In order to achieve this goal, the following tasks were set: 1) to study the habits and characteristics of generation Y; 2) to analyse the challenges of generation Y in the labour market. The primary research methods used were monographic, descriptive, logical, analysis and synthesis, induction and deduction.

The generation Y is a generation with birth years of 1981 through 1997, which followed the period of Generation X (born 1965-1980), which was preceded by the baby boom generation (born 1946-1964). The exact dates of the generation Y vary among researchers. They are popularly known as “me, me, me” generation, obsessed with technologies. They change their jobs often looking for better opportunities and seek the meaning of everything they do. Generation Y tend to be self-employed or work part time. They are good at multitasking but are easily distracted [4].

The portrait of a Millennial: he is highly educated and recognises the value of a lifetime spent learning. He is a victim of credentialism, which is a belief that person’s intelligence or work ability is based on academic qualification. Millennials are impatient and unwilling to wait; they expect promotions to be based on their achievements, and not years spent in company. They also want to have different careers in their lifetimes, because they are ambitious and obsessed with success. But surprisingly – they are willing to sacrifice their career for family. The representatives of generation Y probably think that they are better at their job than they really are [5].

The study results show that millennials look for a job with the meaning and values like their own. Also, it is important for them to work in the place that has an environmental or a social impact. The opportunity to combine work and social life plays a major role in generation’s Y expectations about the work place. Millennials need constant feedback from managers on their work and they have the need to be appreciated.

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## **STUDENTS' OPINION ABOUT INVOLVEMENT IN ERASMUS+ PROGRAMME**

**Elvita Prokofjeva**

Latvia University of Life Sciences and Technologies, Faculty of Economics and Social Development,  
Bachelor studies, Latvia

**Zenija Kruzmetra**

Latvia University of Life Sciences and Technologies, Faculty of Economics and Social Development, Dr.  
geogr., Assistant professor, Latvia

In modern times, students have far greater opportunities to expand their knowledge beyond the borders of Latvia. One of these options is the Erasmus + KA1 (learning mobility in higher education) program, which is offered to students in first level professional higher education programs, universities, and other higher education institutions in Latvia, and allows them to study or practice in one of the European Union (EU) and European Economic zone countries or EU candidate countries. The number of students in the Latvian University of Life Sciences and Technologies at the Faculty of Economics and Society Development has been stable in the Erasmus + program, but has declined significantly over the last three years. Today, economic instability is evident in many parts of the world, and in recent years there have been various terrorist acts abroad, which have left a significant impact on the population and on the level of social protection. The author believes that these are one of the most important factors influencing the decision to engage in the Erasmus + program. The purpose of this project is to ascertain why students at University of Life Sciences and Technologies in Faculty of Economics and Society Development do not participate in the Erasmus+ program.

The involvement of Latvia University of Life Sciences and Technologies students in the Erasmus + program has been observed since the beginning of the program, in the academic year 1999/2000, when the program involved 27 people. Through the 2016/2017 school year, the number of participants increased significantly each year and reached the highest levels with 260 applications for the program. At the start of the 2017/2018 school year, the number of people dropped sharply to 215 people, where only 90 students used mobility for study, which is comparable to the 2012/2013 level. [1]

The number of students in the Faculty of Economics and Society Development, which has entered the Erasmus + program, has been stable, however, it has declined significantly in the last three years. [2]

Marc Jans and Kurt de Backer have developed "Triangle of Youth Participation" where they contend that young people will actively participate in society when there is a dynamic balance between the three dimensions of their triangular model, namely challenge, capacity and connection. In essence, young people are actively involved in those parts of society where this dynamic balance exists between these three dimensions. [3]

Today's students have so many opportunities, and can gain experience through the opportunities provided by the Erasmus + program, but there are likely even more reasons why these opportunities are not being used.

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# **CHOICE OF ELECTRICITY PROVIDER FROM THE POINT OF VIEW OF THE USERS: THE ELEKTRUM EXAMPLE**

**Dace Putniņa**

Latvia University of Life Sciences and Technologies, Faculty of Economics and Social Development,  
undergraduate student, Latvia

**Līga Paula**

Latvia University of Life Sciences and Technologies, assist.prof. Dr.sc.soc., Latvia

The aim of the course project is to find out why electricity users choose electricity the utility company Elektrum. For the empirical study, the quantitative research method was used and electricity users were asked to participate in the online survey via webtool *visidati.lv*.

The theoretical part of the course project provides a theoretical explanation of the free market of electricity, its legal basis, participants and future development. The author of the course project gives insight also in topics such as the use of electricity in households, and the provision of state aid to customers. The main key word in the research of the course project from point of view of sociological theory is “choice”. The theoretical considerations of the course project are based on theories of M. Weber (purposeful rational, value-rational, traditional, affective action) and T. Parsons (willpower, generally accepted values, ect.) [1, 2, 3].

The author proposed the following hypothesis: The electricity consumer chooses electricity trader Elektrum as a stable electricity trader with a clear and efficient range of offers with the lowest possible price according to the service what they receive.

14 specifically formulated questions were included in the questionnaire. 101 respondents participated in the survey. The sample involved both female and male respondents with different occupations (both students and pensioners) and different income levels (from 200 and even above 1000 euros in average per family member). The hypothesis of the course project has been confirmed and it has been shown that the electricity consumers choose Elektrum as a reliable electricity supplier (92% consumers think that it is important or very important) with a comprehensible and attractive offer (76.1% consumers think it is important or very important) at the lowest and unchanged possible prices according to the obtained service (85.1% consumers think it is important or very important).

The following conclusions can be drawn:

- 1) Respondents choose more stable values and conditions; they are interested in a predictable and accurate cost system.
- 2) Respondents highly value the production and use of environmentally friendly energy for meeting basic requirements.
- 3) The payment methods, the constant lower price (according to the product selection), the determination of the payment deadline and the possibility of self-service are ranked with the highest mark.

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# APPROACHES OF ORGANIZATIONAL RESEARCH IN THE CASE OF COMPANY X

**Madara Ratkēviča**

Latvia University of Life Sciences and Technologies, Institute of Social Sciences and Humanities, Faculty of Economics and Social Development, undergraduate student, Latvia

**Ginta Kronberga**

Latvia University of Life Sciences and Technologies, Institute of Social Sciences and Humanities, Assistant Professor, Dr.sc.soc., Latvia

Approaches of organizational research enables examination of both theoretical and practical aspects of organizational research revealing ongoing business routine mechanisms which otherwise are covert from the sight of both outer and inner stakeholder groups [3]. Even when choosing an organization that seems to function quite efficiently as it is in case of the object of this study (*company x*), consequences of those mechanisms including activities may be detected in seemingly mutually unrelated departments of organization [1]. This research focuses on the largest company in its field in Latvia. It follows that manufacturing capacity is adequate in relation to the status of this company. This aspect means that any mistake in organizational business routine can become remarkably damaging for groups involved or an individual of the organization [2]. The aim of this research is to identify and to find possible solutions to problems in the company's business routine mechanisms using different approaches of organizational research.

Overall, five methods were used to attain the aim of the research: 1. Identification of external environmental factors. 2. Analysis of stakeholder groups of organization. 3. Analysis of competitiveness. 4. Mystery shopping including competitor research. 5. Action research.

Results of the research present the following conclusions: 1. According to the environmental uncertainty assessment model, the external environment of *company x* is rated as complex, though stable. 2. Technological development may transform the organization simultaneously, as the organization can use technologies to transform according to technological development maintaining a stable external environment. 3. Effects of different types of external environments can be modified throughout the positioning of an organization. 4. Informing secondary and primary involved groups demand choosing more popular informative communication tools – creating an informative system or using mass media. 5. To receive more accurate opinion of involved groups reviving such forgotten methods as comments books can be advantageous when analysing involved group goals and values. 6. In most cases the number of employees working concurrently at a store isn't the determinative factor of quality customer service. 7. The action research process can unfold reasons and offer solutions for most of the template problem cases – the only case where a solution couldn't be found isn't a component of daily business routine of *company x*.

Methodological conclusions: 1. The "close proximity" term should be defined correctly to the informants before data is collected (company which connects to its customers only throughout another company cannot be defined as with a close proximity with its consumers). 2. To avoid respondents' tolerance towards colleagues working in other same field companies therefore faulty data can creating a verge (margin) can be highly useful for processing received data. 3. Cultural and personal peculiarities of employees can influence results of mystery shopping for the mystery shopper interprets occurrence of the shopping process and those involved individuals.

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# AVAILABILITY OF WORKFORCE IN THE MECHANICAL ENGINEERING AND METALWORKING INDUSTRY

**Andris Sebins**

Latvia University of Life Sciences and Technologies, Faculty of Economics and Social Development,  
Bc.oec., Latvia

**Lasma Licite**

Latvia University of Life Sciences and Technologies, Faculty of Economics and Social Development,  
Dr.oec., Assistant Professor, Latvia

The manufacturing sector employs a considerable portion of the workforce and largely determines the economic potential of the country as well as its economic independence and the standard of living of the population [1]. It is also a great source of innovation [2]. Trends in the labour market considerably affect the operation of manufacturing enterprise. In 2015, mechanical engineering and metalworking enterprises employed 20 752 individuals, which accounted for 2.35% of the total nationally. The average level of labour productivity at the enterprises was slightly higher than the average in the manufacturing sector [3]. However, the enterprises were significantly affected by workforce availability and the remuneration level. The research aim was to examine availability of the workforce for the mechanical engineering and metalworking industry in Latvia. To achieve the aim, the following specific research tasks were set: 1) to describe the workforce context for the mechanical engineering and metalworking industry; 2) to analyse the availability of workforce of the mechanical engineering and metalworking industry. The monographic and descriptive methods as well as statistical analysis research methods were employed to achieve the aim and perform the tasks.

Considerable structural changes in the labour market have been observed since 2009, the lowest point of the economic recession when 38,208 residents emigrated from Latvia, and a year later – 39 651. This, in its turn, influences workforce availability for mechanical engineering and metalworking enterprises and does not contribute to the overall performance of the enterprises in the global markets.

There is also a lack of specialists of adequate qualification. Young individuals do not prefer enrolling in mechanics and metalworking study programmes; consequently, the number of graduates is insufficient for normal replacement of the workforce. In addition, there is a high student dropout rate in the engineering programmes. Nevertheless, experienced specialists and engineering graduates are very demanded in the labour market. Also, there is still a widespread perception that the mechanical engineering and metalworking industry is associated with difficult work at unattractive workplaces, even though nowadays most of the enterprises use equipment instead of labour.

Workforce availability for mechanical engineering and metalworking enterprises is also affected by the level of earnings. This might be explained by the fact that production costs must be as low as possible in order to have a competitive price on a product; it also relates to the inability to pay higher wages and salaries at the existing sales volumes and mark-ups. Average earnings in manufacturing in the country are below the average elsewhere. Nevertheless, the mechanical engineering and metalworking industry is one of the priority export industries supported in Latvia.

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## NEWCOMERS: AGENTS OF CHANGE IN RURAL AREAS OF LATVIA

**Inta Thapa**

Latvia University of Life Sciences and Technologies, Faculty of Economics and Social Development,  
Master studies, Latvia

**Zenija Kruzmetra**

Latvia University of Life Sciences and Technologies, Faculty of Economics and Social Development, Dr.  
geogr., Assistant Professor, Latvia

The rural areas of Latvia have been facing significant changes for an extended period of time [3]. Transformation processes can be observed in terms of both collapse and resurgence. The economy is changing by acquiring new forms [4] and becoming increasingly based on social relations and culture [1], in some areas depopulation has led to collapse of community links, elsewhere the arrival of newcomers from urban areas has launched innovative activity [2].

However, simultaneously with the depopulation of rural areas - the migration of the rural population to the urban areas of Latvia, as well as abroad [5] - there is an opposite process of counter-urbanization taking place. This has resulted not only in the flourishing of traditional activities in the rural areas but also development of new forms [3]. While some local residents leave the rural areas, on the other hand, there are vigorous city residents who have made a conscious decision to leave their city lives and embark on a path to a new and sometimes drastically different lifestyle with a clear plan. Thus, these newcomers become agents of change [3] by cleaning up the environment, promoting local economy, community education, incorporating new cultural and social activities.

Since no in-depth counter-urbanization studies have been performed in Latvia focusing on the impact of newcomers on the development of rural areas, it is important to learn more about the factors of rural areas causing city-dwellers to move to the countryside and how these newcomers promote the development of the rural areas. Thus, in the spring of 2018 a study was carried out in the rural areas of Latvia, focusing on the following research questions: 1) Whether and how the cultural, natural, social environment and other factors of the rural areas promote the relocation of city residents to countryside? 2) In what way the newcomers contribute to rural development? The **research object** is newcomers - change agents - in Latvian rural areas who have moved from cities to the countryside since 2008. The study involved 5 respondents - cases which represent diverse activities of the newcomers and their impact on the development of the rural environment. The author carried out a 1-1.5h long, semi structured in-depth interview with each respondent which was digitally recorded.

The research has shown that the most prominent factors that encouraged city-dwellers to move to rural areas were healthy natural environment, proximity of nature, relative peace, contrary to the stressful environment of a city, as well as the fact that the newcomers generally felt they have outgrown themselves in the city and wanted to see quality change in their lives. It was also concluded that the rural environment and the proximity of nature more or less have an impact on the internal potential of a person and promotes a more altruistic lifestyle that is more focused on social development.

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# DEVELOPMENT OF APPROACHES IN BUSINESS PROCESSES MANAGEMENT

**Tran Thi Thanh Thuy, Tran Thi Hai Yen**

St. Petersburg State Forestry University, Faculty of Economics and Management, doctoral students,  
Saint-Petersburg, Russia.

**Svetlana Tereshchenko, PhD (Ec)**

Saint Petersburg State Forest Technical University named after S.M.Kirov, Saint-Petersburg, Russia.

The history of business processes counts almost a century, although it was only at the beginning of 1990s that the term "business process" became widely used. It described how the organization performs its functions and tasks. The development of approaches to business processes management could be divided into three stages. The beginning of each was connected with an increase in interest to increasing the efficiency of enterprises and process management, which took place every time at a new quality level. The main characteristics of these stages are shown in the Table.1. They are associated with the relevant stages of information technology development and approaches to improving the company's activities. The beginning of the first stage was in the 1920s when the need to analyze business processes, describe them and operate in accordance with these descriptions was first realized.

During the first stage, flowcharts and oriented graphs were used to model business processes. In the 1980s, the first attempts were made to automate business processes by implementing software functions to monitor the sequence of actions and issue documents. The success of such systems inspired developers to extend a similar approach to automating other functional areas of business.

The second stage was to automate business processes in the 1990s. At that time, there was a management system that was used to arrange the sequence of work in a framework of the business processes of a company. This system was equipped with development tools that could theoretically be used in various models of business processes. The concept of the structure of the company was introduced. It was a set of activities: "business processes"- production, management, and infrastructure. Business processes included variety of specific processes during the whole period.

Table 1  
**The main stages in the history of business process management**

	<b>Modeling business process</b>	<b>Improving the activities of organizations</b>	<b>The application of information technologies</b>
<b>The first stage</b>	1920-1980s. Analysis of ways of the performance of works rationalization of labor operations. Model paper of low automation	The 1980s. Total quality management, continuous change. A scientific approach , consistent improvement	1980 - 1990s, the database management System. Data sharing applications that access databases
<b>The second stage</b>	The 1990s. Software for charting and analyzing of processes and static. Manual re-engineering a one-time creation of the model. Automation: CIS with workflow support ( WfMS, ERP)	The 1990s, Reengineering business processes, discrete changes. Unscientific approach radical transformation	The 1990s Distributed computing, function sharing, distributed applications

<b>The third stage</b>	<p>2000s</p> <p>Oriented business processes the software executable model. Iterating optimization and simulation tool integrated into a BPMS. Simulation and analysis models and dynamics, the conversion of models standardization of methodologies</p>	<p>The 2000s</p> <p>The Management of business processes (BPM). The continuity of change, flexibility, adaptability and scientific approach, interactive improvement</p>	<p>The 2000s</p> <p>The management of business processes, the joint execution of business processes distributed business processes</p>
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Thus, the whole history of the development of approaches to business process management leads to the conclusion about the importance of this direction for the improvement of the efficiency of organizations. The experience in management aimed at the increase of efficiency of business processes was gained during this period. However, this trend still performs an important role in business activities of the enterprises.

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## PERSONNEL MANAGEMENT IN NATIONAL AUTHORITY

**Uģis Vangalis**

Latvia University of Life Sciences and Technologies, Faculty of Economics and Social Development,  
undergraduate student, Latvia

**Līga Jankova**

Latvia University of Life Sciences and Technologies, Faculty of Economics and Social Development,  
Dr.oec., Latvia

The subject of this paper is the State Revenue Service, which is the third largest public administration institution in Latvia. At the beginning of 2017 it employed 4029 people. Also, in direct government departments, as in any other companies, the personnel management processes are very important. As the findings of Latvian researchers indicate, the personnel management system determines the person's desire and motivation to work in the chosen institution in order to achieve the goals of the company.(2). In today's situation, the problem of personnel management in the public administration institutions is an attempt to solve the outflow of employees into the commercial sector by providing a competitive remuneration, but the budget of state institutions is limited and less flexible than that of private companies, and it is strictly regulated by the statutory remuneration. And other intellectual motivation rewards for employees are insufficient. Efficiently organized personnel management in the company performs not only the recruitment function, but also motivates employees to remain loyal to the company in which they work. Also educated and professionally developed, by using the potential of each individual employee to achieve common goals(1). Personnel management needs to be very flexible, as it is strongly influenced by the external demand (4) - due to the optimization of public administration, changes in various laws and regulations and changes in public policy, the employee has to be flexible and able to adapt to continuous changes in the external environment. The **aim of this work** is to investigate the problems of personnel management in a public administration institution. Compared to private companies, the internal environment is less flexible, its operation and development are highly regulated. Personnel management in a public administration institution consists of different processes, which, in general, form a personnel management system. Each element of the personnel management process is significant in the overall system to ensure a quality of end-result. At the institution there is a rotation of employees, at the end of the employment term. The employer asks for the reason why the employee chooses to terminate the employment, which indicates the desire to change something in his / her staff management. The reasons for leaving are related to the style of management and psychological climate in the workplace.

**Proposals:** **1.** Improvement of personnel management requires the introduction of a 360 degree assessment method for the evaluation of all employees. This will improve the rating system and will prevent a biased decision based on subjective considerations. **2.** Improve the institution's internal communication and communication between employees and managers using motivational methods that are not related to material gains. **3.** Measures should be taken to increase the prestige of the institution and the number of potential employees who would like to work in the institution.

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## CHANGES IN THE AREA OF FOREST LAND IN THE TERRITORY OF LATVIA

**Marija Vilne**

Latvia University of Life Sciences and Technologies, Faculty of Economics and Social Development,  
undergraduate student, Latvia

**Aina Muška**

Latvia University of Life Sciences and Technologies, Faculty of Economics and Social Development,  
Assoc. Prof. Dr.oec, Latvia

**Simona Zvirgzdiņa**

Latvia University of Life Sciences and Technologies, Faculty of Economics and Social Development,  
guest lecturer Mg. proj. mgmt., Latvia

Before 1914, in the present territory of Latvia, forest land occupied 27.7% of the total land area. [1]. In 1990, it already reached 49%. [2] After restoring national independence in 1991, Latvia's forest area continues to grow steadily, increasing by about 60 000 hectares a year. [4] According to the Forest State Register, in 2015, forests in Latvia occupy 3.383 million hectares. Compared to other European countries, Latvia belongs to countries rich in forests. In Europe, forests occupy 33% of the land area on average, while in Latvia forest land occupies 52%. Latvia is the fourth most forested country in Europe, just Finland (77%), Sweden (76%) and Slovenia (63%) are ahead. State management holds 1.66 million ha (49%) of forests, while the forest of other keepers is estimated at 1.72 million ha (51%). [3] The process of enlargement of forest land is mainly linked to the afforestation of unused agricultural land – both for people to purposefully plant new stands and for trees to conquer new areas.

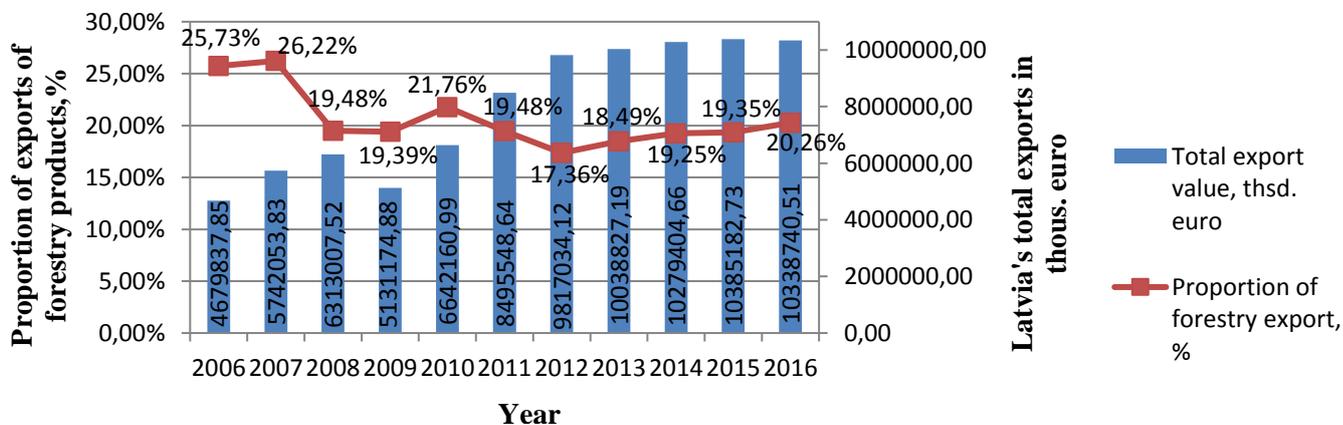
Information about the forest area in Latvia tends to vary, since there are different forest definitions and databases. The definition of the Latvian Forest Law is most commonly used, as well as the international one, developed by the European Forestry Commission (FAO). Based on the FAO definition, forest infrastructure facilities are included in the forest area. Information on forest area in Latvia is provided by three different sources:

1. Forest State Register (FSR), maintained by the State Forest Service (SFS);
2. State Land Service (SLS) real estate state cadastral information system;
3. Forest Statistical Inventory (FMSI) data obtained in the framework of forest monitoring carried out by the Latvian State Forestry Institute (LVSFI) Silava. [6]

Owing to its natural resources, Latvia can also increase forest sector exports that is being done successfully.

The forestry sector exports about 75% of its production. The export volume of Latvian forest products exceeds imports, thereby ensuring a positive external trade balance. [5]

The percentage share of exports of forestry products in Latvia's total exports in thsd. euro from 2007 to 2017 can be seen in the figure below.



Source: Author based on Central Statistical Bureau data.

Figure 1. Proportion of exports of forestry products (%) in Latvia's total exports (million EUR)

With the aim of preserving the Latvian national wealth – forests, for future generations, all the parties involved in the forest sector have agreed on all common fundamental principles. The Latvian Forest Policy is based on the principles of sustainable forest management, which focus on the management and use of forests to maintain their biodiversity, productivity, regenerative capacity, viability and the present and future potential to carry out relevant ecological, economic and social functions at the local level, nationally and globally and would not harm other ecosystems. [3]

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# MODERN APPROACHES TO THE DEFINITION OF SUSTAINABLE ENTERPRISE DEVELOPMENT

**Tran Thi Hai Yen, Tran Thi Thanh Thuy**

St. Petersburg State Forestry University, Faculty of Economics and Management, doctoral students,  
Saint-Petersburg, Russia.

**Svetlana Tereshchenko, PhD (Ec)**

Saint Petersburg State Forest Technical University named after S.M.Kirov, Saint-Petersburg, Russia

The problem of sustainable development assumes paramount importance, becomes the core of all economic policy and sets out the contours of all strategic decisions in the context of globalization of the economy. Sustainable development is the direction of development that the countries in the world today are striving for, which is the great hope of all mankind.

The term "sustainability of development" was first widely publicized as part of the World Conservation Strategy, developed by UNEP, the International Union for Conservation of Nature (IUCN) and the World Wildlife Fund in 1980.

In 1987, in Rio de Janeiro, the Commission on Environment and Development gave the first basic scientific definition of the concept of sustainable development. It defined sustainable development as "meeting the needs of the present, in which the ability of future generations to meet their own needs is not undermined" [5]. This important scientific conclusion has been supported by many scientists all over the world and to the present time does not lose relevance. This point of view emphasized two aspects of sustainable development: first, achieving a balance between people's economic activities and the state of the environment. Secondly, taking into account the interests not only of the present, but also of future generations.

At present, special attention is paid to the study of sustainable development of enterprises. The following basic approaches to the definition of sustainable enterprise development can be singled out: commercial approach, anthropocentric approach, environmental approach, integrated approach. If you choose only one approach and do not pay proper attention to others, enterprises may face the problem of losing competitiveness at the market, so there is another approach to the definition of sustainable enterprise development - integrated approach. The content of each approach is presented in Table 1.

Table 1. Modern approaches to the definition of sustainable enterprise development

Essence	Advantages	Disadvantages
<b>Commercial approach [3,6,8,14]</b>		
Sustainable development - development based on the maximization of the organization's profit	1) Allows to support the balance of production and business activity under the influence of internal and external factors 3) Gives real opportunity to use resources more efficiently 4) Provide investments in the production base of enterprises.	1) Does not take into account the internal factors of the enterprise, except financial, the greatest emphasis is given to financial risks. 2) The attention to the development of human resources of the enterprise is not paid. 3) There is a possibility of negative impact on the environment.
<b>Anthropocentric approach [7,11]</b>		
Man is the basis of development. Within the anthropocentric approach, special attention is paid to the development of human capital and the	1) Reduce internal social conflicts in the enterprise. 2) Attention is paid to raise the welfare of all employees. 3) Creation of conditions for the development of human resources through professional	1) Financial business matters are not taken into account 2) The problems of preserving the environment practically

solution of social problems.	education and effective social policy.	are not taken into account
Environmental approach [10,12,13,15]		
It is based on the desire to preserve natural resources and protect the environment. The main attention is paid to the assessment of environmental problems from the standpoint of the integrity and viability of ecosystems, i.e. setting the task of simultaneous provision of economic development and environmental protection. Priority is the needs of future generations.	1) Rational and efficient use of natural resources. Search for renewable resources that can replace non-renewable resources. 2) The ability to make long-term profits, increase capital with the rational use of natural resources. 3) The ability to meet the current need for resources through the use of renewable resources and environmental protection for future generations.	1) It takes a lot of time to find out the renewable resources. 2) It takes a lot of time to replace natural resources with renewable resources
Integrated approach [1,2,4,9]		
The inclusion of main features that are used in three described approaches. It is formulated on the basis of interaction between three factors: economy-society-environment. It assumes that sustainable development is a balanced activity of all elements: economic development, human resources, efficient use of resources and protection of the environment.	1) The balance of sustainable development of an enterprise based on economic activity, combined with the effective use of natural resources, ensuring the interests of people. 2) Obtaining high competitive advantages ensuring the position of the enterprise in the market. 3) The ability to produce high-quality products using effective tools for managing and using resource-saving technologies and fulfilling obligations to the state. 4) Understanding the priority of sustainable development as a certain balanced activity, which is its strategy.	Do not exist

On the basis of this table, we can conclude that the most acceptable approach to the sustainable development of the enterprise is an integrated approach. Thanks to it, enterprises will successfully achieve economic growth, increase competitiveness, achieve social and environmental goals, and also will meet the needs of the society in the frame of future generation development.

It can be concluded that sustainable development of the enterprise is such development that is providing:

3. Effective use of resources, which allows maximizing the profit received by the organization,
4. Development of human capital,
5. Use of technologies friendly to the environment.

Nowadays it is not enough to be effective only in economic development, but it is essential to pay attention also to social and ecological factors. Only combining these three approaches the enterprise can be effective in its development.

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# APPROACHES TO IMPACT EVALUATION OF SPECIAL ECONOMIC ZONES

**Dace Ziedina**

Latvia University of Life Sciences and Technologies, Faculty of Economics and Social Development,  
doctoral student, Latvia

**Modrite Pelse**

Latvia University of Life Sciences and Technologies, Faculty of Economics and Social Development,  
Dr.oec. Professor, Latvia

Special economic zones as a specific regional development instrument are widely used in many countries, especially in Eastern Europe. As with every regional development instrument, the impact of special economic zones needs to be evaluated to analyse its effectiveness. The aim of the research is to classify main approaches to impact evaluation of special economic zones.

**Performance management approach.** This is the most used approach to evaluate special economic zones, which involves a set of indicators (measurements) that allow the tracking of turning points in socio-economic development [1]. Indicators which are used in analysis should be universal, but at the same time specific features for special economic zone territories should be taken into account. Indicators of the performance management approach can be divided into four groups - indicators of socio-economic development, indicators of economic security, forecast indicators of crisis situations and indicators of the environment [1]. The performance management approach can be used to evaluate the impact of special economic zones within one country.

**Cluster analysis approach.** This approach consists of two parts - a cluster analysis with inputs in the form of macroeconomic indicators and its interpretation in the present situation [2]. Gross domestic product, inflation, wages, the employment rate of population, expenditures on research and development. They are mainly used as macroeconomic indicators. Cluster analysis approach can be used to evaluate the impact of special economic zones among countries.

**Comparison and analysis approach.** This approach allows the evaluation of regionally targeted indicators, such as investment, employment, productivity [3]. Monitoring ability is a core obstacle to choose indicators for comparison in dynamics. The comparison and analysis approach as an empirical model mainly use regressions to compare the impact of special economic zones. Results are typically estimated by exploiting time and spatial differencing (territories without and with special economic zones). This approach is place-based and can be used to evaluate the impact of special economic zones within one country.

**Conclusion.** Researchers persistently disagree on the role that special economic zones play in regional development. For that reason, it is needed to use scientific ally approved or tested approaches to evaluate the impact or effectiveness of the special economic zones.

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## **PEDAGOGY**

# LANGUAGE TEACHING SKILLS FOR SELF-DIRECTED LEARNING

**Baiba Pušinska**

University of Life Sciences and Technologies, Faculty of Engineering, Institute of Education and Home Economics, post-graduate, Latvia

**Baiba Briede**

Dr. paed. University of Life Sciences and Technologies, Faculty of Engineering, Institute of Education and Home Economics, Latvia

The impact of technological and other changes is shortening the shelf-life of employees' existing skill sets. Every individual should be ready to acquire new knowledge becoming a member of lifelong learning cycle. **The aim** of the study is to describe a new set of language teaching / learning skills in the context of predicted changes in the technologies and labour market in the 21st century.

It is important to stress that Education is the topic of the day. It is understandable: we are living in the era when universal education finally has become a standard in the developed countries. Foreign languages learning is a must of the global world. Basic foreign language skills, including 4 basic language skills - listening, speaking, reading and writing, are essential. They are being developed for complete communication. The New Learning Paradigm, postulating that students need to be taught the 21st century skills rather than traditional core subjects. Oxford University has announced 4Cs language teaching skills - **Communication, Collaboration, Critical Thinking, Creativity** [1]. For the first time 4Cs were defined by organization The Partnership for the 21st Century Skills in the USA. Firstly, Critical thinking refers to a student's ability to think deeply and to solve non-familiar problems in different ways. Secondly, the communication is about understanding, sharing ideas, it should be effectively used in diverse environments. Thirdly, collaboration means the skills of teamwork, working cooperatively with others. Creativity and innovation refer to new uses of ideas to add social or economic value [2]. Summarising, 4 Cs learners are encouraged to utilize higher-order thinking skills that involve thinking outside the square, analysing, evaluating, elaborating, implementing and creating.

English language classroom is the perfect place to build 21st century skills. As it is already known learning takes place best in environments where students feel empowered to learn. It is important to give students the opportunity to be self-learners, it involves students in self-directed learning [1]. Purposefully managed self-directed studies are highly important because they put a stress on each student's higher responsibility, initiative, independence, collaboration and self-assessment [3]. Such learning guarantees awareness, lifelong learning which could be implemented using lifelong learning cycle.

In conclusion, 4C language skills and basic language skills considered as competences needed for life and career are obtained especially through self-directed learning. The 21<sup>st</sup> century skills help students to reach greater self-awareness; to be ready for changes and for lifelong learning.

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# PROMOTING TEACHER'S ECOLOGICAL COMPETENCE IN EDUCATIONAL ENVIRONMENT

**Zaiga Vindedze**

Latvia University of Life Sciences and Technologies, Faculty of Engineering, post-graduate student,  
Latvia

**Natalja Vronska**

Latvia University of Life Sciences and Technologies, Dr. paed., Latvia

Nowadays it is very important to make studies on ecological competence, because it has a powerful influence on educational environment. Ecological competence is related to concepts like *sustainability, ecological approach and environmental education*. Several scientists have defined 'ecological competence' in their works, where they all are linking its essence to the personal self-improvement and to the man's readiness for adequate actions to the transformation of the existing social and natural reality. At the end ecological competence becomes the criteria of the professional competence of all specialists [1]. In human ecology, the person and the environment are viewed as being interconnected in an active process of mutual influence and change [2].

So, from the outset, a good teacher should know the importance and concept of ecological education, and should themselves be educated in this field. The teacher as a professional specialist in his area should think and act ecologically, to be oriented as a 'teacher in educational environment' not 'teacher and educational environment'. Educational environment contain +2 more levels of different environments – pedagogical environment and formal teaching/learning environment. Thus, scientists define the educational environment as a mutually dependent structure of environmental systems [2].

The educational environment is an environment that in itself promotes development processes and results in person, as the purpose of education is to create opportunities for everyone to form a mentally and physically developed, free and responsible creative cultural personality. [3].

Competence development is being implemented in different fields or in different environments [4]. Competence is based on experience and is formed, and is improved in action; competence development is a recursive process: using competence in an action it not only allows achieving a certain quality of activity, but also develops competence [5].

It can be concluded that every teacher has to carry out his/her ecological competence in action in order to consummate and to develop it and to do it at any level of the educational environment.

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