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9th – 10th June 2025

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PREFACE

On the occasion of the 30th anniversary of the founding of the Faculty of Horticulture and Landscape Engineering, Slovak University of Agriculture in Nitra, we invited participants to the 27th international conference ENVIRO 2025.

The conference was organized by the Faculty of Horticulture and Landscape Engineering (FHLE), Slovak University of Agriculture in Nitra (SUA in Nitra), Slovakia, and the Faculty of Environmental Engineering and Land Surveying, University of Agriculture in Krakow (UA), Poland. It took place at SUA in Nitra, Slovakia, on **9–10 June 2025**. The conference focused on issues related to soil and water protection and management in the landscape, the impacts of climate change, green circular and waste management, landscape architecture, horticulture, fruit growing, as well as viticultural and winemaking trends.

Abstracts in this proceeding were divided into two presentation formats—oral and poster sessions—and further categorized according to the seven thematic areas covered by the conference. The topics of the conference are listed below:

- Water and soil management, perspectives for its protection and use
- Biological, ecological, agricultural and technical measures in the landscape in connection with climate change
- Current research and innovations in waste and circular economy
- Outlook and perspectives for the protection, planning and design of the urban environment
- Current research through creation and innovations in landscape architecture
- New approaches, methods and technologies for the planning, design, establishment and management of green infrastructure
- Environmentally friendly horticulture technologies

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ORAL PRESENTATION

I. section

Water and soil management, perspectives for its protection and use

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ANTHROPOGENIC IMPACT: DYNAMICS ANALYSIS OF PHYSICO-CHEMICAL PARAMETERS IN A CATCHMENT PALEŚNIANKA STREAM

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The quality of surface water in both urban and rural areas faces significant challenges due to a variety of factors, including climate change, anthropogenic activities, and inadequate water management practices. The purpose of the paper was to identify and evaluate the impact of anthropogenic factors on water quality in a catchment with limited water quality data. The Paleśnianka stream flowing through the Lesser Poland region was selected for the study. Changes in the content of 16 selected physico-chemical indicators were evaluated at five monitoring sites of the Paleśnianka over a 12-month period.

The following conclusions may be drawn from the analysis of water quality data of the Paleśnianka stream catchment:

1. The ecological status of the surveyed section of the Paleśnianka stream was assessed as very good for water temperature, total suspended solids (except for point 7 - Class II), ammoniacal nitrogen (except for point 7 – SBG- State Below Good) and nitrate nitrogen. In contrast, good status was determined for dissolved oxygen, dissolved substances and BOD_5 (except for point 3 and 7 - SBG). For the analysed indicators such as COD_{Mn}, specific electrolytic conductivity, sulphates, chlorides, water pH (except for point 7 - class II) and phosphate phosphorus, the ecological status of the studied watercourse was found to be below good. Only the concentration of nitrite nitrogen varied. At the beginning of the analysed section of the watercourse, the waters were in very good and good condition, whereas the water condition changed to below good in the final section of the Paleśnianka stream;
2. The variability of the analysed physico-chemical indices in the analysed section of the watercourse depended on anthropogenic factors. In the upper part of the stream, the influence of agriculture and residential buildings was observed, while in the lower part the influence of a treatment plant that discharged wastewater into the studied watercourse during the study period was observed;
3. Significant differences in the concentrations of the analysed indicators occurred in the case of specific electrolytic conductivity and dissolved substances between points 4 and 7, and sodium and potassium between points: 1 a 6 and 1 a 7.

In the catchment area, it is recommended to introduce good practices for farmers to use natural and artificial fertilisers in an appropriate way to avoid the release of chemical compounds into the soil and water environment. Residents, on the other hand, are advised to familiarise themselves with the principles of water resources management in the catchment area. In the case of the wastewater treatment plant in Zakliczyn, it is recommended to improve the reduction of pollutants in the wastewater that are harmful to the environment.

Key words: *Surface water quality, river monitoring, physicochemical parameters, anthropogenic pressures, sustainable development*

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CHALLENGES, METHODS, AND STRATEGIES FOR REDUCING THE TRANSFER OF NONPOINT SOURCE POLLUTION FROM AGRICULTURAL AREAS TO SURFACE WATERS: A CASE STUDY OF THE PIEKARSKI RIVER CATCHMENT

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The Potok Piekarski river , a lowland river situated in the Małopolska region of southern Poland, flows through a heterogeneous landscape composed of agricultural land use types. This catchment exemplifies a rural hydrological system increasingly exposed to diffuse anthropogenic pressures, particularly from intensifying agricultural practices. This study aimed to characterize the spatial variability of physicochemical water quality parameters in relation to land use, based monitoring conducted across 6 sampling sites in 2024. Comprehensive hydrochemical assessments included measurements of temperature, pH, dissolved oxygen, biochemical and chemical oxygen demand, electrolytic conductivity (EC), total dissolved solids (TDS), major ions (Cl^-, SO_4^{2-}), and nutrient species (NH_4^+, NO_2^-, NO_3^-, PO_4^{3-}). While most parameters remained within “good” or “very good” ecological status classes per national and EU regulations, Site 1 showed elevated levels of Cl^-, indicative of localized source pollution. There are one variables (Cl^-) exhibited statistically significant spatial variation ($p < 0.005$, respectively, Kruskal–Wallis test), confirming their sensitivity to land use impacts. Descriptive statistics were used to analyze the results, including the minimum, maximum, median, standard deviation, and coefficient of variation for each indicator at points. Cluster analysis was conducted to group points based on similarities in physical and chemical parameters, following the principle of internal similarity and external dissimilarity. Clusters of similar points were represented as branches on a hierarchical dendrogram, with distances estimated using Ward’s method to minimize variance within clusters. Statistical inference of the significance of differences in indicator values between measurement and site was carried out using the non-parametric Kruskal-Wallis test at a significance of $\alpha = 0.05$. This test was chosen due to the lack of normality of the distribution of most of the analyzed indicators according to the results of the Shapiro-Wilk test. Hierarchical cluster analysis distinguished distinct site groupings reflecting underlying land cover characteristics, with Site 1 emerging as a significant outlier. The results underscore the role of land management in modulating pollutant transport to surface waters and reinforce the necessity for integrative mitigation strategies—such as vegetative buffer zones, nutrient management plans, and precision agriculture—within catchment-scale planning frameworks. These findings contribute to the scientific basis for adaptive water resource governance and align with the principles of the EU Water Framework Directive (2000/60/EC), particularly in the context of safeguarding water bodies from diffuse agricultural pollution.

Key words: *Sustainable development, anthropogenic pressures, surface water quality, physicochemical parameters, river monitoring, agricultural catchment*

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COMPARING INITIAL AND REAPPLIED BIOCHAR EFFECTS ON SOIL PROPERTIES AND GREENHOUSE GAS EMISSIONS

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Biochar application has been widely studied for its potential to improve soil properties and mitigate climate change effects. However, its long-term impact, especially after multiple applications, remains less explored. This study evaluates changes in soil chemical and physical properties in a field experiment conducted since 2014, where biochar was initially applied at rates of 0, 10, and 20 $t.ha^{-1}$ (B0, B10, B20). A reapplication was carried out in 2018 using the same rates (reapB10, reapB20). The experimental setup also included three different nitrogen fertilization levels (N0, N1, N2), depending on the crop planted in the respective year. Corn (*Zea mays* L.) was planted in both 2015 and 2019. Soil and gas samples were collected in 2015 and 2019, representing the first year after the initial application and the first year after reapplication, respectively. The analyzed parameters included soil physical (water-filled pore space - WFPS, soil temperature, and bulk density - BD) and chemical (pH, NO_3^--N, and NH_4^+-N) properties. Soil overall daily N_2O fluxes were calculated as the average of daily N_2O emissions recorded on the same day as the soil sampling. The results revealed differences in soil properties when comparing treatments with the initial biochar application (2014) to those with biochar reapplication (2018), indicating that the reapplication had a greater effect on soil quality. While soil pH showed a consistent increase across all treatments (with increases of 0.34–11.88% in 2015 for initial application and 4.35–16.41% in 2019 for re-applied treatments), other parameters exhibited both increases and decreases. The increase in soil pH following biochar application is primarily due to its alkaline mineral content, its effect on enhancing cation exchange capacity, and its role in improving the soil´s buffering capacity. The content of soil mineral nitrogen varied in all treatments in both years. NH_4^+-N varied in both 2015 and 2019, with decreases ranging from 15.71% to 40.86% in 2015 and from 0.41% to 64.73% in 2019 in re-applied treatments. Similarly, NO_3^--N content showed variability, decreasing by 1.82–10.79% in the initial application treatments in 2015, and by 2.78% to 39.01% in 2019 in re-applied treatments. Biochar is known to decrease the concentration of NO_3^--N and NH_4^+-N due to its porous structure, which can adsorb and immobilize excess mineral nitrogen, thereby reducing leaching and gaseous nitrogen losses. In the results from 2015, treatments with the initial application varied, but WFPS increased by 6.01–17.55%, whereas in treatments with reapplication, only one sample (reapB20N1) showed higher WFPS compared to the control, with a 4.64% increase. Biochar increases WFPS by improving soil porosity, which allows for better water retention and infiltration. Due to its high porosity, biochar can trap water in small pores, enhancing the water-holding capacity of the soil. While the effect of biochar on soil temperature varied and was generally low (increasing by 0.20–1.60% in the initial application treatments and 2.01–3.31% in re-applied treatments), the overall effect of biochar on soil temperature can be influenced by its high reflectivity (black color), which increases heat absorption. Bulk density was measured twice per year (in spring and autumn) from undisturbed soil samples, and results varied across all treatments in both years. In spring, treatments with initial application had a lower bulk density (4.91–9.55%), and in re-applied treatments, the decrease was 4.50–7.58%. In autumn, bulk density in treatments

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with initial application was lower by 0.60–3.21% compared to the re-applied treatments, where the decrease ranged from 0.67% to 7.44%. Due to the low density of biochar, its addition to soil can decrease the bulk density (BD), improving soil structure and aeration. Additionally, improved aeration can help reduce anaerobic conditions in the soil, which indirectly lowers soil N_2O emissions, as these conditions are typically conducive to higher N_2O production. Soil cumulative N_2O emissions varied across all treatments. In general, treatments with the initial application had cumulative N_2O emissions lower by 19.75–41.13%, whereas treatments with biochar reapplication showed a decrease of 30.22–67.47%. Biochar has been shown in numerous studies to reduce greenhouse gas emissions, including N_2O, due to its highly porous structure, which enhances soil aeration and reduces anaerobic conditions that favor N_2O production. Additionally, biochar´s high cation exchange capacity (CEC) allows it to immobilize excess mineral nitrogen, such as ammonium (NH_4^+) and nitrate (NO_3^-), thereby reducing the amount of nitrogen available for denitrification processes that produce N_2O. This study provides valuable insights into the positive effects of biochar on agricultural soils and its potential as a soil amendment. Understanding these changes is crucial for optimizing biochar use in sustainable land management practices.

Key words: *field experiment, biochar, reapplication, soil*

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COMPREHENSIVE REMEDIATION STRATEGIES FOR THE HEAVILY CONTAMINATED KALINA POND IN POLAND

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Anthropogenic pollution poses a serious environmental challenge, impacting the lithosphere, atmosphere, and especially the hydrosphere. One of the most polluted water bodies in Poland was Kalina Pond in Świętochłowice, severely contaminated after decades of industrial activity. A 20–40 cm thick layer of toxic bottom sediment accumulated, containing hazardous xenobiotics such as phenols and polycyclic aromatic hydrocarbons (PAHs). Given the extent of xenobiotics, a multi-stage remediation process was implemented, integrating mechanical, thermal, and biological methods. To remove the most contaminated sludge, mechanical dredging was applied, followed by thermal desorption, which was carried out during the first nine months of remediation to eliminate volatile and semi-volatile organic compounds. To further accelerate pollutant degradation, bioremediation played a crucial role. Autochthonous microorganisms were isolated from contaminated water, soil, and sediments, then subjected to selective pressure under sublethal xenobiotic concentrations. This process enabled the development of a specialized extremophilic bacterial consortium capable of efficiently degrading toxic compounds. Prior to field application the installation of an aeration system was applied and bioprocess parameters were optimized to maximize microbial activity. The remediation strategy proved highly effective. The application of physico-chemical technologies has enabled the elimination of the majority of contaminants. The recultivation process was concluded through the implementation of bioremediation procedures. After four months of biotreatment, results demonstrated a 72% reduction in chemical oxygen demand (COD), a 97% decrease in PAH concentrations, and complete elimination of BTEX and phenolic compounds. The applied measures significantly restored biodiversity, enabling the reintroduction of aquatic life, including certain fish species. The successful restoration of Kalina Pond highlights the potential of integrating bioremediation with mechanical and thermal interventions for reclaiming heavily contaminated aquatic environments. This case study offers valuable insights into sustainable and efficient approaches for large-scale environmental restoration projects.

Key words*: Environmental restoration, Biodegradation, Kalina pond, Extremophilic bacteria*

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LONGTERM EFFECT OF BIOCHAR ON SELECTED SOIL CHEMICAL PROPERTIES IN CROPLAND IN THE SLOVAKIA

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Applying biochar with N-fertilizers has been suggested as an effective method for increasing N availability and soil organic carbon (SOC) in soils. The importance of soil pH lies in its ability to significantly impact SOC by regulating the availability of soil nutrients, the turnover of organic matter, and a variety of other soil processes. This study is a unique investigation about changes of inorganic N, SOC, and pH in Haplic Luvisol for 7 years (2014–2020) in the rain-fed field experiment on the agricultural land in Central Europe. In this study, it was hypothesized that the continuous interaction of paper fibre sludge and grain husks (1:1 ratio) biochar and N-fertilizer will improve soil inorganic N and SOC content leading to a permanent ameliorating effect in the chemical properties and soil fertility. Therefore, this study aimed to (i) evaluate the effect of biochar aging and N-fertilizer application on changes in NO_3^- and NH_4^+ contents in the soil for 7 years, (ii) determine the changes of soil pH over 7 years with combined application of biochar and N-fertilizer, and (iii) evaluate the changes of SOC content after the application of biochar and N-fertilizer in the soils over 7 years. The research was conducted as a rain-fed field experiment with a crop rotation including spring barley, maize, spring wheat, and pea. Biochar was initially applied at rates of 0, 10, and 20 t ha^{-1} in 2014 and was reapplied to selected plots in 2018. It was also combined with N-fertilizer at three levels (N0, N1, and N2). The results revealed a significant interactive effect between biochar application and N-fertilizer on NO_3^- and NH_4^+ contents. Interestingly, applying 10 t ha^{-1} of biochar consistently reduced soil inorganic N levels across most of the monitored months. Higher biochar application rates led to a significant increase in soil pH, demonstrating a clear negative correlation between pH and inorganic N content. Biochar application significantly increased SOC compared to the control, particularly following the reapplication in 2018. However, this effect showed a gradual decline over time. The findings suggest that biochar treatments may enhance N-fertilizer efficiency, but the long-term effects on N mineralization depend on the specific soil and biochar properties. With the exception of applying 20 t ha^{-1} of biochar at the N2 level in 2019, biochar had no significant impact on crop yields. The examined soil properties, including those influenced by biochar, had nuanced effects on various aspects of crop yield.

Key words: *biochar, long-term field experiment, soil organic carbon, pH, NO_3^- and NH_4^+*

Acknowledgement: *Work was supported by the Slovak Research and Development Agency under the contract No. APVV-21-0089.*

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MUNICIPAL WASTEWATER TREATMENT USING FLUIDIZED BED BIOREACTORS WITH BIOFILMS FIXED ON NATURAL SUPPORTS DERIVED FROM CACTI

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In recent years, the population in Western Guatemala has grown, increasing the demand for water and basic services, alongside a rise in waste production. Notably, wastewater generation has had a significant environmental impact on water bodies, leading to eutrophication, unpleasant odors, discoloration, and other harmful effects that negatively influence the quality of life and health of individuals in neighboring communities. Given this issue and the country's economic and social conditions, it is essential to develop viable alternatives for wastewater treatment that are efficient, cost-effective, and replicable. This project focused on assessing the technical feasibility of using fluidized bed bioreactors under aerobic and anaerobic conditions, employing natural supports derived from cactus materials native to Guatemala as an improvement over conventional plastic supports for wastewater treatment. The study was applied to water similar to that found in the Upper Samalá River Basin, which was characterized. The research was divided into four stages: 1) Characterization of wastewater from the basin of interest. 2) Collection, treatment, and characterization of two cactus materials (*Stenocereus* spp. & *Opuntia imbricata*) to be used as supports in the fluidized reactors. 3) Evaluation of treatment in fluidized bed bioreactors under aerobic and anaerobic conditions. 4) Development of mathematical models to describe the experimental data. The main results of the research included the removal of chemical oxygen demand (COD) in synthetic wastewater, achieving a range of 50% to 63% using fluidized bed reactors. During the research period, the Samalá River showed average COD values of 96.38 and 277, with standard deviations of 63.08 and 198.27, respectively. Biological oxygen demand (BOD) averaged 68.38 and 129.40, with standard deviations of 39.02 and 92.72. Nitrogen levels averaged 2.16 and 17.40, with standard deviations of 1.89 and 3.30. Phosphorus levels averaged 3.55 and 11.11, with standard deviations of 2.72 and 2.43. The most efficient natural support and method for treatment was *Stenocereus* spp. with aeration, achieving a reduction of 86.76% in COD. The reaction exhibited zero-order kinetics with an equation of $K = -1.75x10^{-4} \pm 0.15$.

Keywords: *wastewater, bioreactor, biofilms, cacti, aerobic, anaerobic*

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PARAMETERIZING V-NOTCH WEIR EQUATIONS FOR FLOW MONITORING IN A TUBULAR SHAPE OF A DRAINAGE CONTROL STRUCTURE

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Agriculture is a major source of losses of dissolved nutrients (mainly nitrate, NO_3^-) to the environment and contributes to the eutrophication of aquatic ecosystems worldwide. The accurate estimation of drainage discharge is important for calculating nutrient loads delivered to surface water and assessing the performance of edge-of-field conservation practices. Triangular sharp-crested weirs are commonly used to measure low-flow measurements in open channels. These solutions are also increasingly installed in underground controlled drainage structures. Determination of drainage flow rates involves monitoring of water depth (head) use of an appropriate equation for the V-notch weir installed within the control structure to accurately estimate flow rate. Therefore, it is relatively easy to calculate the flow from standard equations, by using only recording of water levels. These types of weirs can provide inexpensive measurements of flow volumes and resulting nutrient loads from subsurface drainage systems and associated conservation practices. Research conducted in this area has led to develop calibrated equations for weirs within control structures so far, but have resulted in different equations. The objective of this study was to develop appropriate weir equations for a 22.5° V- notch weir developed for a tubular water level control structure in a controlled drainage system (CD). The three sharpeness of V- notch weir, using typical slope angles of 30°, 45°, and 60°, were also conducted. The literature on V-notch weirs does not clearly specify which angle is the most appropriate in this case. However, according to many recommendations, this angle should not be less then 60°. Experiments were carried out in a laboratory rectangular flume with 4.2 m long, 0.30 m wide, 0.50 m deep and with a slope of 3‰. An ultrasonic flowmeter was used for flow measurement, with 2.5% accuracy. To determine the head of water inside the V-notch weir, the pressure transducer logger was used with accuracy of 0.05% Full Scale (FS). At the same time, a logger for atmospheric pressure with accuracy of 0.05 kPa was placed outside the flume. The air temperature during the research was fluctuated between 20 and 21.5°C, and the water temperature varied from 19.0 to 19.5°C. The laboratory tests show no significant differences in the fitted parameters across the three analyzed slope angles of edge. The least squares regression showed the strongest relationship between head and flow rate in the case of a slope of notch angle 45°(R-squared= 0.9981). In the other cases, R-squared was also high, with values of R^2= 0.9955 and R^2= 0.9980, respectively (for the 30° and 60° angle). The smallest RMSE was 0.255 $dm^3 \cdot min^{-1}$ for 44 flow rate calibration measurements (slope of crest angle 45°). In the other cases, the RMSE was higher by 36% and 30%, respectively (0.346 [30°] and 0.332 [60°] $dm^3 \cdot min^{-1}$). The flow for the best fitted equation was $Q = 0.2235H^{2.4182}$ with Q in liters per minute and H in centimeters. This equation can be used to measure flow through tubular controlled drainage structures.

Keywords: *controlled drainage (CD), drainage water management (DWM), V-notch weir, flow measurement, weir calibration*

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TREATED WASTEWATER AS A SOURCE OF IRRIGATION FOR AGRICULTURAL CROPS - ILLUSION OR NECESSITY

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The research project carried out at FCHPT STU Bratislava aimed to treat wastewater from the WWTP Trnava to the required quality class so that it meets the parameters according to EU Regulation 2020/741 and can be used for irrigation of agricultural crops. Another goal of the project was to define whether residual wastewater pollution (bacteria, micropollutants, etc.) will affect the quality of the tested crops from a microbiological, chemical or sensory point of view. For the needs of the project, the AS-MEMBR UF26 technological unit was leased from ASIO Brno for the period from March to September 2024. The operating flow rate of the device was 600 L/h, technologically it consisted of two ultrafiltration modules (20 nm pores), preceded by a disc filter and a coagulation tank. The effluent from the UF then passes through a reaction vessel with activated carbon (GAU) and a UV lamp for additional disinfection of the purified water. The pre-treated wastewater was accumulated in a retention tank (1 m^3), from where it was pumped to a test field measuring about 5 x 10 m. Here, water was regularly distributed to test crops – potatoes, parsley, carrots and onions – by drip irrigation. The test field was modified so that about 40-50 cm of soil in depth was replaced with real soil from the place where these crops are grown in the fields of Agromáčaj a.s. The test field was covered with a foil shelter to prevent massive rain from entering the field, but with some light transmission necessary for crop growth. The operation of the test field was identical in time to the operation of the treatment unit (March – September 2024. Identical crops were also grown in real fields, and were used as reference values in the project results. The UF26 purification device was able to reduce the basic parameters of the water to the required level (e.g. E.Coli – 0 CFU/100 ml). A significant reduction was also achieved in the concentrations of pharmaceuticals, but these are not yet legislatively limited in wastewater. Basic bacterial species, pharmaceuticals, drugs, heavy metals were monitored in a test field in the soil and in individual crops, and the results were compared with a reference field where these crops were grown commercially.

Key words*: disinfection, drought, irrigation, micropollutants, wastewater reuse*

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ORAL PRESENTATION

II. section

Biological, ecological, agricultural and technical measures in the landscape in connection with climate change

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ANALYSIS OF PRECIPITATION-RUNOFF PROCESSES AS A BASIS FOR DESIGNING STRIP CROP ROTATION

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One of the most significant limiting factors for the agricultural use of sloped land is the threat of water erosion. Extreme weather events, heavy rainfall in particular, during the recent decades, caused significant intensification of this soil degradation form. To mitigate the negative impacts of rainfall-runoff processes (including erosion), new technologies and effective anti-erosion measures, including strip cropping, have to be adopted. A crucial foundation for their proper design is high-quality topographic data (point cloud), obtained through modern, non-contact technologies such as aerial photogrammetry or airborne laser scanning. Subsequent processing of the point cloud within geographic information systems (GIS), specifically creating a hydrologically correct digital elevation model (DEM), enables precise hydrological modeling. This includes delineating contributing areas (watersheds) or erosion-prone units, as well as deriving concentrated flow paths based on terrain configuration (topographic relief). While elevation variability, such as normal curvature and slope, influences the width of strip cropping, its footprint must be defined according to the horizontal variability, i.e., contour curvature of the relief. Design of the strip cropping largely depends on "current" rainfall-runoff processes (direction and flow integration) with primary focus on mitigating negative impacts. This paper aims to present the preparatory procedures as essentials for the subsequent design of a strip cropping project. This paper is a part of the research projects 004SPU-4/2025, *"Monitoring of Agricultural Soil Erosion with Open Science Participation,"* supported by the Cultural and Educational Grant Agency of the Ministry of Education, Science, Research, and Sport of the Slovak Republic (KEGA), and APVV-23-0530, *"Strip Cropping Rotation in Combination with Agroforestry – An Innovative Soil Management System in the Context of Climate Change,"* sponsored by the Research and Development Support Agency of the Ministry of Education, Science, Research, and Sport of the Slovak Republic (APVV).

Key words: *digital elevation model (DEM), concentrated flow paths, water erosion, design of measures, strip cropping (SCP)*

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CLIMATE ASSESSMENT OF YEAR 2024

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Climate change is an undeniable fact, and each passing year is evaluated with concern regarding its impact and whether its manifestations have accelerated or maintained the current trend. The year 2024 once again confirmed the effects of climate change and their increasing severity. Extreme temperatures, droughts, floods and intense precipitation were just some of the climate-related events that occurred worldwide and in Slovakia. This article focuses on assessing climate developments globally, with a particular emphasis on Slovakia. Based on data continuously published by SHMÚ, it is evident that clear signs of climate change persisted in 2024. The concentration of CO_2 in the atmosphere reached 422 ppm, marking an increase from 2023 and the highest recorded level to date (Copernicus, 2025). According to global measurements, 2024 was the warmest year in history, with the average global temperature exceeding 15°C (Kajaba – Garčár - Makkerová, 2025). Copernicus (2025) data shows that 2024 became the first year in which the average global temperature clearly surpassed 1.5°C above pre-industrial levels—the threshold set by the Paris Agreement to mitigate climate risks and impacts. In Slovakia, 2024 was also an extreme year. The average air temperature reached a record high of 10.4°C. Above-average temperatures were recorded throughout the entire year, beginning in January. As a result, there was a significant lack of snow cover across Slovakia in 2024. The lowest number of days with snow cover was recorded, with only one day at the Bratislava station and just 32 days at the Poprad station (Kajaba – Garčár - Makkerová, 2025). Authors also reported that such warm weather led to an early onset of vegetation and allergens, with the first honeybee pollen detected as early as February. Precipitation patterns in Slovakia were also unusual in 2024. While the total annual precipitation was within a normal range spatially, its distribution throughout the year was highly irregular. Many months experienced below-average precipitation, while June and September saw extremely high rainfall. In June, precipitation levels in Nitra reached 231 mm, while in Záhorie, totals exceeded 400 mm in September. Conversely, three drought waves were recorded during the year. The first occurred in May, affecting more than 25% of the country's territory. The second wave hit in August and September, causing early yellowing and shedding of leaves, even in older forest stands. Unusually, drought conditions persisted at the end of the year in November and December. The year 2024 thus demonstrated a continuing trend of worsening climate change impacts. As a result, society—particularly landscape engineers and environmental policymakers—faces new and urgent challenges.

Key words: *climate assessment, precipitation, drought, 2024*

Acknowledgement: This study was supported by project VEGA 1/0021/22 - Possibilities of improving environmental and agronomic soil parameters by re-application of biochar.

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CROP YIELD RESPONSES OVER SIX YEARS FOLLOWING INITIAL BIOCHAR APPLICATION AND ITS REAPPLICATION IN SLOVAKIA

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Agriculture ensures food production while facing significant challenges, including climate change. Biochar soil application is studied globally as a potential mitigation strategy, but its effects on greenhouse gas emissions and soil properties are highly variable depending on soil type and climate conditions. To investigate these effects locally, a field experiment was established in 2014 on Haplic Luvisol in Nitra, Slovakia. Biochar was applied at rates of 0, 10, and 20 t/ha to the topsoil (0-10 cm). In 2018, biochar was reapplied at the same rate to halves of the original plots. The experiment also included three nitrogen (N) fertilization rates: N0 (control, no fertilizer), N1 (standard rate for average yield of grown crops), and N2 (increased rate). We hypothesized that biochar addition would improve soil properties, leading to increased crop productivity. This study presents crop yield results from 2014 to 2020, investigating the impact of single and repeated biochar applications, combined with N fertilization, on spring barley (2014, 2018), corn (2015, 2017, 2019), spring wheat (2016), and pea (2020). Crop yields exhibited high variability within treatments, with inconsistent trends across years and crops. In the first year (2014), spring barley yield increased by 42% with a single 10 t/ha biochar application without N fertilizer (N0). From 2015-2018, yield responses were generally minor (1-24% increase), most notably with 20 t/ha biochar combined with N fertilization; some non-significant yield decreases (up to 33%) were also observed in other biochar treatments. A significant yield increase (71% for corn) occurred only in 2019 under 20 t/ha biochar combined with N2 fertilization. Biochar reapplication did not significantly alter yields, possibly due to high within-treatment variability. Overall, the 20 t/ha biochar rate with N2 fertilization resulted in the highest cumulative yield gain; however, all biochar treatments were economically inefficient due to high input costs, particularly after reapplication. Despite documented positive impacts of biochar on soil properties at this site over the years, these improvements did not consistently translate into enhanced crop yields. These unclear yield trends might be attributed to site heterogeneity and annual climatic conditions deviating from long-term norms.

Key words: *economic efficiency, soil amendments, fertilization, field crops, biochar, crop yields, Haplic Luvisol*

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ECOLOGICAL PROBLEMS OF THE REVITALIZATION OF THE KLÁTOVSKÝ BRANCH

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We focused on evaluating the flow in shallows and overgrown parts of the riverbeds, as well as the thermal regime of the flow near bridges and obstacles to the flow. However, it is necessary to solve the fundamental problems of the territory. First of all, these are the fundamental impacts on the quality of water, which are also in the fact that all but one of the municipalities are not sewered and the handling of waste The Waters has fundamental shortcomings. The same is true in the solitudes that are directly on the riverbanks of the Klátovský Branch. The next necessary step is to settle the ownership of the stream and surrounding land. The only possible way is land development and the municipalities in the territory are not included in the list for solving land development in the coming years. The third basic flow is the access of residents to the 5th level of protection. Above all, the behavior when taking waste to the vicinity of the Branch and also the use of surrounding land. After all, there is also a need for a stronger anchoring of the protected territory in spatial plans or Plans for the economic and social development of municipalities. It is only listed there that The Territory is protected in the cadastre. Without active proposals for its protection. Our results will bring changes in the state of Klátovský Branch only in conjunction with the above-mentioned measures. The quality of water and the quality of stream bottom sediments is only a response to the use of the territory and also the mouth of the channels from the surrounding landscape. Solving the problems of Klátovský Branch is very topical and in addition to what was found and happened during the project, it is necessary to allocate the attention of the state and regional development to fulfilling the legislative conditions corresponding to the highest level of protection. During the solution, a reassessment of the levels of protection of the Branch and surrounding lands was also addressed. Time will show their justification. Similarly, time will show whether the implementation of the proposals for the solution of our study are implemented and bring changes in flow rates in the riverbed as well as an improvement in the quality of water. The quality of water creates conditions for the survival of protected species.

Key words: *Klatovský branch, protected areas, water management, bottom sediments, water quality*

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GREEN INFRASTRUCTURE IN THE TUKE CAMPUS

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A temperature rise due to climate change, it is becoming more important to add green infrastructure to cities to reduce negative effects on people, organisms and the environment. On the TUKE campus, several green infrastructures have been introduced, including extensive green roofs on the main building, vegetated facades and bio retention systems like retention ponds. The green infrastructures aim to boost water retention, helping to rehydrate the city and create a better microclimate. It reduces excessive sunlight, lower temperatures, absorb storm water, and minimize air and noise pollution. Extensive green roof is vegetated or living roof with shallow soil substrate (50-130mm) covered with plants [1]. It creates diverse ecosystems, recreation spaces, and opportunities for the urban agriculture but require less structural support and maintenance, which mean it stays in good condition without regular watering. It usually just needs to be checked once or twice a year to remove any unwanted plants and add fertilizer [2]. The use of extensive green roofs in urban planning is increasing, thanks to their low maintenance requirements as well as the economic benefits of European social climate funds, which emphasize on energy performance. It is well known that green roofs significantly reduce air temperature by 0.4 - 12°C, surface temperature by 8.5 - 34.1°C, heat flux by 10-37% during heating and 51-90% during cooling and energy consumption by 2.1-84% [3]. The new extensive green roof (see Fig. 1) on the largest building at TUKE campus features a combination of wooden walk able paths and vegetated non-walk able areas with environmental, aesthetic, and educative benefits. Vegetated areas are covered with easy to - maintain plants like grasses. Wooden terraces include features for relaxation and presentations, such as benches, advertising banners and Wi-Fi. The environmental effectiveness of extensive green roofs on building at the TUKE campus ensures energy efficiency, building and ecological sustainability. The main goal of educative benefits is to educate the general public by showing how modern technology can help fight climate change in the city. The Technical University of Kosice demonstrates its commitment to energy and environmental sustainability as a way to respond to rising temperatures. The green roof on the university building is a symbolic feature that encourages people to think about how technical solutions are used across different sectors of the economy.

Fig.1 The new extensive roof at TUKE campus

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From a technical point of view, vegetated facades are walls built with panels or flower pots, which are installed vertically above each other on the outer wall of a building. The vegetated facade is the basis of energy-conscious building design, which is used to protect the building from overheating in summer and cooling in winter. The vegetated exterior wall TUKE campus (see Fig. 2) is located on the CO storage facility with dimensions of approximately 4x4 m.

Fig.2 The vegetated facades at TUKE campus

Fig.3 Retention pond at TUKE campus

The green wall is designed on the principle of hydroponics. Hydroponics is the cultivation of plants without soil in a nutrient solution, which is applied both outdoors and indoors. Hydroponic cultivation eliminates the weight of the substrate and is therefore also suitable where it is necessary to pay attention to the statics or load-bearing capacity of structures. Retention pond at TUKE campus (see Fig.3) is a permanent pond designed with additional storage capacity to attenuate surface runoff during rainfall events. Retention pond is an impermeable pond with a smaller number of medium-sized fish placed throughout the year, which have created a suitable and clean environment for life. The immediate surroundings of the pond are supplemented with suitable aquatic plants; the paved areas themselves are filled with light quartz gravel faction 16 mm - 25 mm, which is separated from the subsoil by geotextiles. In recent years, cities have been getting hotter because they absorb more heat and lose green spaces. This heat is released into the air, making urban areas warmer. To help fix this and fight climate change, experts have suggested different environmental and technical solutions for cities and one of them are green roofs and vegetated facades, retention ponds. The TUKE campus green infrastructure is essential in crowded cities to reduce the negative effects of climate change as well as urbanization [4].

Key words*: green roof, vegetated facades, retention ponds, TUKE campus*
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MANIPULATION OF THE CARBON SINK DYNAMICS AT THE FOREST/LANDSCAPE SCALE

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A very sensitive and widely discussed topic related to the issue of Global Climate Change (GCC) is the achievement of satisfactory way of GCC mitigation, which can be a crucial step for respective carbon neutrality reaching. The irreplaceable role of biological carbon pumps remains evident, as photosynthetic activity leads to the removal of CO_2 from the atmosphere. In this process of mitigating climate change, forests and agriculture system play a significant role. On a European scale, forest storage accounts for approximately 10% of total European emissions, with the potential to reach up to 22% by 2030. Unfortunately, data for agriculture are still lacking.. Currently agriculture is a net emitter of greenhouse gases (although a relatively small one): 0.03 t CO_2 eq. per hectare per year. At present time we are witnesses of the massive endeavour to introduce some forms of active management of carbon storage in agriculture, i.e. the management system named as Carbon Farming a (CFú re used. CF includes: The use of *no-till seeding* combined with species-rich cover crops can result in an average carbon sequestration of 6.6 tons of CO_2 per hectare per year, which corresponds to 12,355 CZK per hectare per year in emission allowances. Similarly, the *application of compost* offers even higher sequestration potential**,** with an average of 8.4 tons of CO_2 per hectare per year, equivalent to 15,725 CZK per hectare annually in emission credits. The mitigation role of forests is and will continue to be an exceptionally important "product" of the forestry sector for society. Forests and the use of forest products (especially wood) contribute to GHG mitigation in two ways: *sequestration* – This effect can be considered over a shorter time frame and is determined by biological processes (photosynthesis and respiration). *Substitution* – The long-term storage of carbon in wood-based products through the replacement of "fossil" materials. All these activities should be assessed and implemented with a focus on limiting carbon leakage from forests and enhancing their sequestration capacity. This presents a challenge for forestry practice as well — through the implementation of so-called *Climate-Smart Forestry* (CSF) approaches. These practical silvicultural techniques have the potential to repeatedly stimulate increased performance of the carbon pump in the canopy layer of forest stands. It seems that mentioned approaches in forestry and agriculture as well could in play important role in GCC mitigation.

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ORAL PRESENTATION

III. section

Current research and innovations in waste and circular economy

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NITROGEN AND PHOSPHORUS RECOVERY USING INNOVATIVE TECHNOLOGY IN SOFT CHEESE PRODUCTION: PRELIMINARY RESULTS FROM THE NENUPHAR PROJECT

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The Danube River Basin in Hungary has experienced considerable environmental pressure due to the continuously increasing volume of waste streams, primarily originating from agricultural and industrial activities. Among these, dairy wastewater has emerged as a major contributor to pollution. In particular, whey - traditionally considered a low-value by-product of cheese-making – has frequently been discharged with minimal treatment to reduce costs. However, the waste load of whey may be substantially higher than that of an equivalent volume of domestic wastewater. It is typically characterized by a high organic matter content, with chemical oxygen demand (COD) levels reaching up to 100,000 mg/L and biological oxygen demand (BOD) levels ranging from 27,000 to 60,000 mg/L. Furthermore, whey contains significant concentrations of nutrients, including nitrogen and phosphorus, which, if not properly treated, may contribute to eutrophication in receiving aquatic ecosystems. In this study, a novel approach was explored for the treatment of dairy industry wastewater. The developed technology integrates active oxidation with membrane filtration to maximize the retention of valuable substances while minimizing the negative environmental impact. This innovative technical solution was successfully implemented within an existing dairy production infrastructure. Laboratory experiments involved sampling at various stages of the treatment process, followed by comprehensive chemical and microbiological analyses. The effectiveness of this treatment was evaluated using standard photometric methods. Specifically, the COD, nitrogen, and phosphorus contents of samples treated with ozone and membrane filtration were analyzed. Preliminary results indicated that the retention of nitrogen and phosphorus ranged between 94.5% and 99.46%, while COD levels were reduced by 99.63% at just 10% output power of the ozone generator. The removal of pathogenic microorganisms was also nearly complete, with close to 100% retention.

Key words*: nutrient recovery, whey, dairy industry, wastewater, microorganisms*

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POSSIBILITIES FOR RECYCLING NUTRIENTS FROM FOOD INDUSTRY WASTEWATER FOR USE IN AGRICULTURE

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Nutrient recycling from dairy wastewater represents an innovative approach to addressing both agricultural sustainability and environmental concerns. Dairy wastewater is rich in nutrients, particularly nitrogen and phosphorus, which are essential for crop growth but can lead to severe ecological challenges, such as eutrophication, if not properly managed. The dairy industry is a significant contributor to nutrient loading, necessitating effective strategies to reclaim these nutrients for agricultural use, thereby minimizing the reliance on synthetic fertilizers and reducing environmental impacts. Consequently, the recycling of nutrients from dairy wastewater has gained attention as a vital practice that not only enhances soil fertility but also promotes sustainable agricultural practices by closing nutrient loops. Recent advances in technology have facilitated various methods for nutrient recovery, such as anaerobic digestion, solid-liquid separation, and electrodialysis, which have shown promise in improving the efficiency of nutrient extraction from dairy effluent. However, the adoption of these practices faces hurdles, including economic feasibility, regulatory constraints, and public perception issues concerning contaminants in recycled fertilizers. Addressing these challenges is crucial for broader acceptance and successful implementation of nutrient recycling strategies in the agricultural sector. Ongoing research and collaboration among producers, scientists, and policymakers are essential for advancing nutrient recovery technologies and fostering a more sustainable agricultural landscape. Within the NENUPHAR project, we are working with 20 foreign partners on the possibility of recycling wastewater from milk and dairy production into biomass that can be used as a bio-based fertiliser. The ongoing experiment shows us that the proposed technology with minimal energy requirements is well feasible with the resulting production of nutrient-rich biomass. The produced algal biomass is currently being tested for its fertilising properties in agricultural settings, focusing on its effect on plant growth and soil quality. In parallel, further analyses are being conducted to evaluate the presence of heavy metals and other potential contaminants. The aim is to confirm the safety and effectiveness of the recycled product. Results from pilot trials are promising, showing enhanced growth of leafy vegetables and improved soil nutrient levels. With further optimisation and monitoring, this circular approach may offer a viable alternative to conventional fertilisers.

Key words*: dairy industry, wastewater, nutrients, recycling, bio-based fertilizer*

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ORAL PRESENTATION

IV. section

Outlook and perspectives for the protection, planning and design of the urban environment

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DISTANCE MODEL OF CHANGES IN LAND USE AND COVER IN CENTRAL EUROPE

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The research focuses on developing a distance model of Land Use and Land Cover (LULC) changes for Central Europe for the years 1990-2018. The research uses pan-European spatial data from the Corine Land Cover (CLC) project of LULC changes in the years 1990-2000, 2000-2006, 2006-2012 and 2012-2018. The CLC Change dataset has a minimum mapping unit of 5 hectares and is available by Copernicus Land Monitoring Service. The analysis covers the areas of Poland, Czech Republic, Slovakia and Hungary. The developed distance model of changes is a linear model from the centre of the main cities of Central Europe included in the Urban Atlas project resolution 2018. The research covered 101 cities with a significant number of inhabitants and socio-economic importance (59 from Poland, 19 from Hungary, 15 from the Czech Republic and 8 from Slovakia). The average distance between the selected cities is approx. 45 km. The changes were assigned to cities by dividing the study area into Voronoi polygons, taking into account the administrative borders of the countries. The considerations taken pay special attention to the change in the distance of LULC changes from the centre of the main cities and their intensity. The developed model assumes a central growth of the city at the expense of the suburbs and the spread of urban development into suburban areas. Both regional and national models were developed to assess whether there are different spatial relationships of LULC change locations relative to major cities in the study countries. In connection with the above, the intensity and distance of LULC changes in relation to the boundaries of Functional Urban Areas (FUA) designated within the Urban Atlas project were also analysed. According to CLC data, a total of approximately 156.5 thousand LULC changes were detected in the study area in the years 1990-2018 (approx. 40 thousand in 1990-2000, approx. 36.9 thousand in 2000-2006, approx. 42 thousand in 2006-2012 and approx. 37.6 thousand in 2012-2018, respectively). An increasing trend in the number of LULC changes in Poland in the years 1990-2018 was observed, and at the same time a decreasing trend in the number of changes in the other countries analysed. A qualitative assessment of the changes was also made by determining the models of growth of urbanized areas and the loss of biologically active areas, as well as the growth of forests, depending on the distance from the city center. The developed model may be useful by decision-makers responsible for spatial policy and biodiversity protection in suburban areas.

Key words*: Functional Urban Areas, LUCC, Visegrad Group Countries, model of changes*

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OPTIMAL HEXAGONAL GRID SIZE FOR THE SPATIAL ENTROPY MAPPING AT LOCAL LEVEL

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In this study, the influence of the size of the basic spatial unit (BSU) on the value of spatial entropy determined at the local level was considered. Spatial entropy is a popular coefficient for determining the diversity of the spatial structure of land use and cover (LULC). Therefore, it is used to study the land use mix in cities and their commuting zones. The research used pan-European spatial data sets from the Copernicus Land Monitoring Service, i.e. CORINE Land Cover and Urban Atlas, for the years 2006, 2012 and 2018. Hexagon grids with sizes from 0.5 km^2 to 5 km^2 with a step of 0.5 km^2 were considered. The averages of local results were compared to the value characterizing the spatial entropy of the entire study area. The Functional Urban Area (FUA) of Warsaw (8265 km^2) and Prague (4786 km^2) was used as the study area. FUAs are an interesting area of research due to the fact that more than half of the human population lives in urbanized areas. Also, the FUAs around the capitals of Poland and the Czech Republic were selected for analysis because they are characterized by significant investment in the urban part and dynamic changes in the commuting zones. The average spatial entropy value characterizing the FUA determined from local spatial entropy values is variable and depends on the hexagon grid size used. The relationship between the average spatial entropy value and the hexagon size can be described by a logarithmic curve in such a way that the average entropy value increases with the hexagon size for both UA and CLC data. In the case of UA data, the average spatial entropy value reaches higher values than in the case of CLC data. The inflection point, after which the increase in the average spatial entropy value is smaller, can be noted for a hexagon size of 1 km^2 or 1.5 km^2, in all the cases considered. The entropy value in 2006 for the CLC data at first level of classes was 0.5810 for FUA Warsaw and 0.5606 for FUA Prague. Whereas in 2018 the spatial entropy value for FUA Warsaw was 0.5939 and 0.5731 for FUA Prague and the CLC data. Thus, an increase in spatial entropy was observed at the first level between 2006 and 2018. Similarly, spatial entropy increased at the first and second levels for the UA and CLC data. In turn, the value of the spatial average entropy closest to the value for the entire FUA, without division into a regular grid, occurs for a hexagon grid of above 450 km^2. Similar relationships were observed in the case of using the median.

Key words*: Functional Urban Areas, land use, land cover, spatial entropy*

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PLANTS AS AIR FILTERS: ASSESSING LEAF ACCUMULATION OF PARTICULATE MATTER, MICROPLASTICS AND TRACE ELEMENTS

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Urbanization and expanding road networks have significantly contributed to air pollution, particularly in densely populated regions. Particulate matter (PM), originating from fossil fuel combustion and industrial activities, is a major concern due to its ability to transport hazardous pollutants, including heavy metals (HMs) and microplastics (MPs). Green infrastructure, particularly trees, plays a crucial role in mitigating air pollution through phytoremediation, as leaves act as natural filters for airborne contaminants. This study examines the accumulation of PM, MPs, and HMs on plants leaves from urban areas. The primary aim was to assess spatial variations in pollutant retention and evaluate the effectiveness of trees in capturing airborne contaminants. PM deposition was analyzed in two forms: surface-PM (adhered to leaf surfaces) and in-wax PM (embedded in leaf cuticular waxes). PM was further categorized into coarse (10-100µm), fine (2.5-10µm), and ultrafine (0.2-2.5µm) fractions. Heavy metal concentrations were quantified using X-ray spectrometry, while microplastic contamination was assessed to determine its presence and distribution. Our findings revealed substantial variations in pollutant accumulation across regions, with the highest PM and HM levels detected on plants leaves from highly polluted cities, particularly in Europe and Asia. The accumulation of airborne contaminants correlated with local pollution levels, highlighting the role of trees in reducing urban air pollution. Notably, the capacity for PM capture varied by species, demonstrating the importance of selecting appropriate vegetation for urban air purification. Additionally, microplastics were detected in all sampled cities, indicating their widespread presence in urban environments. These results underscore the significance of urban greenery in air quality management. By acting as natural filters, trees contribute to mitigating air pollution and reducing the spread of hazardous pollutants. Implementing targeted green infrastructure strategies, such as species selection based on pollutant retention efficiency, can enhance the effectiveness of urban vegetation in improving public health and environmental quality.

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Key words: *particulate matter, microplastics, urban air pollution, phytoremediation*

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REVITALIZATION VS. EXPANSION: THE STRUCTURE OF SPATIAL DEVELOPMENT FROM THE PERSPECTIVE OF PLANNING DOCUMENTS

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Since humanity abandoned its nomadic way of life and began establishing permanent settlements—from small villages to large cities—the development of human habitats has followed a structured order. Throughout history, the expansion and transformation of the built environment have been shaped by economic, social, and political factors. Although modern urban and regional planning is based on legislative frameworks, these rules are often overlooked or applied selectively. Municipalities tend to prioritise expanding built-up areas onto undeveloped land over the interests of existing residents, environmental sustainability, and the stability of the local economy. One of the most pressing but often overlooked aspects of urban planning is the issue of redevelopment areas, particularly in the context of brownfields. These neglected locations degrade the aesthetic and functional quality of their surroundings and pose environmental and safety risks. Although various policies and incentives have been introduced to encourage their reuse, redevelopment is often hindered by financial constraints, legal complications, administrative barriers, or a simple lack of interest from the public. The challenge of decaying and abandoned buildings remains a key topic in municipal development strategies. Developers favour greenfield projects due to lower costs and fewer regulatory hurdles, while prospective residents often seek modern, quickly built, and more affordable solutions instead of renovating older buildings. This study aims to comprehensively analyse land-use planning policies related to redevelopment and urban expansion. Based on examining spatial planning documents and other publicly available materials, we assess the extent of the utilisation of existing areas suitable for redevelopment, analyse the spread of brownfields, and quantify the newly proposed buildable land in the studied municipalities. Furthermore, the study focuses on the classification and evaluation of buildable areas based on their planned use and provides an overview of current trends in land-use planning. For this analysis, fourteen municipalities from the South Bohemian Region were selected. These municipalities were selected based on their diverse characteristics, including differences in land area, population size, and overall attractiveness for residential and commercial development. The findings of this study contribute to a broader understanding of land-use planning trends and the challenges of balancing urban expansion with sustainable redevelopment practices. By highlighting the impacts of current planning decisions, we aim to support more informed policy-making and encourage a more strategic approach to land-use management in the Czech Republic.

Key words*: buildable areas, spatial planning, spatial development*

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ORAL PRESENTATION

V. section

Current research through creation and innovations in landscape architecture

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EXPERIMENTAL RESEARCH OF GREEN INFRASTRUCTURE IN THE LIVING LABORATORY OF GREEN INNOVATIONS IN LANDSCAPE ARCHITECTURE

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Green infrastructure, including nature-based solutions represent contemporary mitigation and adaptation strategies to address both climate change and biodiversity loss in urban environments. Within the project BIN SGS02_2021_013 *ReImaGIne: Research and Implementation of Green Innovations in Landscape Architecture* funded by Norway Grants (2022-2024), the *Living Laboratory of Green Innovations in Landscape Architecture* was established at the Institute of Landscape Architecture of the Slovak University of Agriculture in Nitra. It is situated at the main building of the Faculty of Horticulture and Landscape Engineering and includes an extensive green roof, four green walls, and two water-permeable hard surfaces with vegetation. The aim of the Living Lab is to integrate green innovations in landscape architecture through experimental research, research by design, and research-led teaching. The green roof with an overall surface of 84 square metres has a vegetation cover on 62 square metres. The basis of this cover consists of pre-cultivated stonecrop mats with a mixture of *Sedum* sp. (*Sedum album, Sedum reflexum, Sedum acre, Sedum spurium, Sedum floriferum, Sedum sexangulare*). Since the establishment of the green roof in April 2024, the thermal benefits of the green roof, as well as the growth dynamics of different Sedum species have been observed and measured. In October 2024, new plant species have been added to the green roof, including *Narcissus 'Tête-à-tête', Tulipa turkestanica,* and *Dianthus carthusianorum*, the first visual and compositional effects of which could be already observed in March-April 2025. The growth dynamics and the change in species composition and abundance have been observed and documented through on-site mapping and drone photogrammetry, the thermal benefits have been measured and documented using thermal cameras. The aim of this experimental research is to design, implement, test, and verify more diverse plant compositions for extensive green roofs. On four experimental green walls, several climbing plant species are being tested for their growth dynamics and their surface coverage potential, the tested species include *Lonicera henryi, Lonicera periclymenum, Akebia quinata, Parthenocissus quinquefolia, Hydrangea petiolaris, Schisandra chinensis,* and *Clematis x tellmanniana*. The water-permeable hard surfaces include the same *Sedum* sp. mixture used for the green roof, as well *Euphorbia myrsinites, Thymus serpyllum,* and *Thymus praecox* as a potential alternative to standard grass, while observing their growth dynamics, and their resilience to mechanical load and stress.

Key words*: climate change, green infrastructure, green roof, green wall, landscape architecture, living lab, stormwater retention*

Acknowledgements: This study is an outcome of the research projects BIN SGS02_2021_013; KEGA 004SPU-4/2023; 09I03-03-V05-00018; and 09I03-03-V02-00043.

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FIELDLAB PROJECT: PROMOTING BIODIVERSITY AND CLIMATE RESILIENCE IN URBAN SETTLEMENTS

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The development of biodiversity in urban settlements represents a key instrument of long-term sustainability. Species diversity supports ecosystem services, resilience to climate change, and contributes to improving the quality of human life. The FieldLAB project, a field laboratory, addresses the topic of biodiversity enhancement in urban environments and human-influenced landscapes. The project primarily focuses on expanding the diversity of tree species composition, which influences environmental conditions and creates habitats for other organisms. The target species – *Pyrus pyraster* (L.) Burgsd., *Sorbus domestica* L., and *Sorbus torminalis* (L.) Crantz – are relatively adaptable and naturally grow in habitats with negative water balance. Results of our experimental research have shown that even young individuals of these species are capable of surviving under drought conditions and employ various life strategies to overcome water stress. In 2017, a total of 192 saplings of *Sorbus domestica* and *Pyrus pyraster* were planted on a designated plot within the Botanical Garden of the Slovak University of Agriculture in Nitra. The saplings have a generative origin and were grown from seeds collected in various locations across Slovakia, which provides a high level of intraspecific variability. The research focuses on assessing growth models and dynamics of these species, which are not yet commonly used in targeted urban plantings. For screening growth and branching parameters, we apply terrestrial laser scanning (TLS) technology. Through the virtual platform FieldLAB [www.fieldlab.sk], developed since 2023, we present the characteristics and potential of native woody species, as well as their broader application in green infrastructure systems for the public. Students of landscape architecture and landscape engineering are actively involved in the project and, through the field laboratory, acquire skills and competencies in working with woody plants. The goal of the platform is to present non-traditional alley tree species, along with sharing practical experiences, expertise, and up-to-date knowledge on cultivating trees in permanent sites. The societal aspect of the project lies in raising awareness about the sustainable development of biodiversity.

Key words*: biodiversity, indigenous flora, urban trees, growth, modelling, experiential learning*

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IMPACT OF AN EXTENSIVE GREEN ROOF ON TEMPERATURE DYNAMICS IN ROOF LAYERING

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As urban areas continue to expand, the heat retention caused by conventional roofing contributes significantly to the urban heat island (UHI) effect. Extensive green roofs—lightweight systems with shallow substrates and low-maintenance vegetation—have emerged as an effective strategy to address this issue. Literature review showed the impact of extensive green roofs on temperature dynamics across roof layering systems, highlighting both environmental and economic benefits to be substantial. Multiple studies have shown that extensive green roofs reduce roof surface temperatures by 10°C to up to 40°C during summer, primarily through shading, evapotranspiration, and thermal buffering. These systems delay heat transfer through the roof layers, contributing to lower indoor temperatures and reducing the cooling load on buildings. While the thermal benefit during winter is less pronounced, green roofs can provide modest insulation depending on substrate moisture, snow cover, and overall design. Beyond temperature regulation, green roofs contribute to the longevity of the roofing membrane by shielding it from direct solar radiation, thermal cycling, and mechanical wear. This protective function can significantly extend the lifespan of the waterproofing layer, often more than doubling its expected service life. As a result, building owners benefit from reduced maintenance frequency and lower long-term repair and replacement costs. Thermal performance varies depending on factors such as substrate composition, vegetation type, and regional climate. While challenges remain in standardizing assessment methods, the existing body of research supports the integration of extensive green roofs as a sustainable building practice. In addition to mitigating UHI effects and improving energy efficiency, extensive green roofs offer long-term economic advantages through extended roof durability. These combined benefits make green roofs a compelling choice for cities aiming to enhance climate resilience, reduce building energy use, and lower infrastructure lifecycle costs. As a continuation of these findings, the Living Laboratory for Green Innovation at the Institute of Landscape Architecture, Faculty of Horticulture, Slovak University of Agriculture in Nitra, will host a new research-by-design experimental installation. This addition is specifically developed to monitor temperature fluxes of the waterproofing layer beneath an extensive green roof system. Equipped with temperature and humidity sensors designed for year-round data collection, the experiment aims to provide detailed insights into the thermal buffering capacity and long-term impacts of green roofs on underlying layers under varying climatic conditions. Another use of this installation will be comparative measurement of stormwater runoff. The project will contribute valuable empirical data to support design guidelines, enhance energy performance modeling, and further validate the economic and environmental benefits of extensive green roofs in Central European urban contexts.

Key words*: climate change, green infrastructure, green roof, thermal impact, landscape architecture, living lab, stormwater retention*

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SOCIOECONOMIC TRANSFORMATIONS AND LANDSCAPE FRAGMENTATION IN AGRICULTURAL REGIONS: A CASE STUDY OF SOUTH BOHEMIA, CZECH REPUBLIC

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Over the past century, agricultural landscapes in Central Europe have undergone profound transformations driven by socio-economic and political changes. This study explores the relationship between demographic shifts, employment trends, land ownership patterns, and landscape fragmentation in South Bohemia, Czech Republic. The research focuses on the long-term impacts of key historical events, including post-war resettlement, socialist collectivization, post-1990 land restitution, and European Union agricultural policies. These processes have significantly altered traditional land use practices, leading to landscape fragmentation, biodiversity shifts, and the restructuring of rural economies. Using a combination of historical cadastral maps, census records, and GIS-based spatial analysis, we assess how demographic changes—such as population decline, aging, and shifts in employment sectors—have influenced land use patterns over time. The results indicate a strong correlation between depopulation and landscape fragmentation, particularly in rural areas with high out-migration rates. Abandoned agricultural land has been gradually replaced by forests and unmanaged grasslands, leading to significant changes in biodiversity and ecosystem services. In contrast, regions with stable or growing populations exhibit more continuous land use patterns, with a prevalence of intensive farming and lower fragmentation levels. Statistical models confirm that socio-economic factors, including workforce shifts from agriculture to the service sector and urban migration, are key drivers of these transformations. Additionally, our findings reveal regional disparities in the extent of landscape change, with more dynamic shifts occurring in areas historically affected by forced resettlements and economic restructuring. Furthermore, we discuss the role of Common Agricultural Policy (CAP) subsidies in shaping land use decisions, highlighting both their stabilizing effects and unintended consequences on landscape structure. While CAP funding has supported agricultural production and helped maintain rural livelihoods, it has also contributed to land-use homogenization in certain areas and the neglect of marginal lands elsewhere. The study emphasizes the need for a more nuanced approach to rural policymaking, considering local socio-economic conditions and historical land use patterns. This study underscores the importance of integrating demographic and socio-economic perspectives into sustainable land management strategies. Addressing rural depopulation and its environmental consequences requires policy interventions that support multifunctional landscapes, combining agricultural production, ecological conservation, and rural development. The findings contribute to broader discussions on post-socialist land use transformations and provide valuable insights for policymakers, planners, and researchers working on sustainable rural development in Central Europe and beyond.

Key words: *Socioeconomic changes, Land use transformation, Rural depopulation, South Bohemia*

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ORAL PRESENTATION

VI. section

New approaches, methods and technologies for the planning, design, establishment and management of green infrastructure

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GEOSPATIAL METHOD FOR DETECTING URBAN EXPANSION: IMPLICATIONS FOR LANDSCAPE AND RESOURCE MANAGEMENT

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The ongoing urbanization process significantly affects landscape structure, the condition of natural resources, and the ways in which space is managed. The dynamic development of built-up areas, particularly on city outskirts and in peri-urban zones, poses new challenges in the fields of spatial planning, environmental protection, and the sustainable development of both urban and rural areas. To effectively respond to these challenges, it is essential to develop tools that allow for precise and up-to-date delineation of built-up areas. This paper presents an original standardized method for identifying built-up zones using GIS. The proposed approach is based on the use of threshold distances occurring within building clusters as the primary parameter for forming topological relationships. The developed algorithm uses the spatial location of objects as the sole parameter for identifying anthropogenic areas and distinguishing them from undeveloped land. The simplicity of the method allows for a clear distinction based on spatial configuration alone, without the need for land cover classification or thematic layers. The method was tested on a large area of Poland, characterized by diverse settlement patterns and varying forms of suburban development. The results confirmed a high level of accuracy in identifying built-up areas and demonstrated the method's applicability for temporal comparisons in multi-year monitoring. Another important dimension of the proposed methodology is the use of normalization as a foundational principle in the construction of spatial databases and geoprocessing routines. In the presented approach, normalization refers to the reduction of unnecessary or redundant complexity in data structures and analysis steps by focusing on a single, universal spatial parameter – the relative position and distance between built-up objects. This enables the development of spatial methods that are both transparent and easily replicable across different territories, reducing dependency on local semantic or classification schemes. Through this lens, normalization contributes not only to data integrity and model simplicity but also enhances the comparability and transferability of results. A key advantage of this approach is its scalability – it can be applied both at the local and regional levels without significant modifications. Potential applications include monitoring changes in the extent, density, dispersion, and irregularity of built-up areas; assessing the scale and dynamics of urban sprawl; modeling environmental risks associated with urbanization; and supporting planning processes aimed at maintaining ecological balance. The method may also provide insight into settlement structure evolution and serve as a basis for spatial analyses in territorial management. The proposed solution has strong potential to become a valuable tool supporting decision-makers and practitioners striving for more sustainable and responsible spatial development.

Key words: *built-up areas, built-up density, built-up dispersion and irregularity, geoprocessing standardization, spatial planning, suburbanization*

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TOWER WATER ENERGY STORAGE

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These structures may resemble the water towers known in the landscape. The difference is that they can support the process of collecting and producing electricity similarly to pumped-storage power plants. These structures are built from an upper (located on the top of the tower) and lower reservoir (located underground), and a pump and turbine station. Due to their smaller size and partial depression under the ground surface, they can be located near residential areas. The upper and lower reservoirs have a similar capacity. The height of the towers can reach souronding objects (buildings, trees...), while their diameter should correspond to local landscape as well as to the desired capacity. The location of the underground reservoir should should provide adequate volume for water collected in the upper tank. Due to the fact that potential energy is transformed into kinetic energy, the greatest possible drop should be achieved. There are other possible variants of such a facility:
1. Green towers - Green towers would be facilities in which the space under the reservoir would be used as a multi-level recreational space with shrubs, herbs and other plants. This facility could also be inhabited by birds. The water needed to irrigate the vegetation would partly come from rainwater and would be collected in separate water reservoirs or water supply systems.
2. Slope energy storage - There are many locations that are conducive to collecting water without building towers but using facilities located on slopes and having only an underground reservoir. Rainwater from higher-lying towns, instead of going to the rainwater sewage system, could be collected in pipelines and processed in hydropower units. In dry periods, it would be possible to pump water from the lower reservoir back to the pipelines. Only the excess water would flow into streams. In this way, large amounts of energy can be stored depending on the terrain conditions.
3. Combined water energy storage - Such facilities would have a system of pipelines and a tower at the top end of the upper water pipelines and an underground tank in the lowest part of the valley.

Key words: *towers, water energy storage, renewable energy sources, water management, green-blue infrastructure*

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ORAL PRESENTATION

VII. section

Environmentally friendly horticulture technologies

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INNOVATIVE CALIBRATION TECHNIQUES FOR LOW-COST AIR TEMPERATURE SENSORS IN SUSTAINABLE HORTICULTURE

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Deploying air temperature sensors in microclimates is crucial for acquiring accurate temperature data in irrigation systems, minimising water losses for farmers in the horticultural sectors. However, the high cost of commercial sensors makes them impractical for deployment in large numbers. Low-cost sensors offer an alternative solution due to their affordability but have reliability issues due to errors in their readings. Calibration can enhance their accuracy, yet fewer studies have investigated the reliability of calibration models and types of low-cost sensors. This study addresses this gap by conducting a performance analysis on three calibration models: Linear, Polynomial, and Power regressions. Aiming to analyse the uncertainties from this calibration models alongside identifying the main source of uncertainty.Additionally, the low-cost DHT22 sensor was investigated for accuracy and precision. The experiments were carried out in controlled climate chambers at multiple temperature steps starting from 5°C to 40°C in the laboratory. Eight DHT22 sensors were compared against the Testo 175 T2 temperature datalogger that acted as the reference instrument. Uncertainty analysis showed that the polynomial model had the lowest combined uncertainty, ranging between 0.24°C and 1.05°C, yielding an R^2 of 0.99. In contrast, the power model presented the highest uncertainties, ranging from 0.56°C to 33.68°C, with an R^2 between 0.05 and 0.99. Meanwhile, the linear model presented uncertainties ranging from 0.33°C to 0.89°C. It presented the lowest uncertainties at 40°C across all the models, yielding an R^2 of 0.97 to 0.98. The DHT22 sensor presented an average MAE of 1.89°C, with a mean error of 1.05°C. The sensor also showed performance reduction at 5°C, yielding mean error of averagely -3.128°C, MAE and RMSE were also observed to be highest at this point.Standard deviations across temperature steps were also noted in all sensors, with deviations also observed between sensors, emphasising the need for individual sensor calibration to ensure the accuracy and reliability of calibration data. Calibration proved to improve the sensor readings, but the choice of the calibration model will influence the outcome as proven by this study. These findings contribute to the growing body of research on sensor calibration by providing detailed calibration data, serving as a reference for researchers, practitioners, and other professionals working within the sustainable horticultural sector, enhancing understanding of sensor performance and improving irrigation practices.

Key words: *uncertainty analysis, calibration models, low-cost sensors, air temperature, dht22, horticulture*

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INTERACTION OF LED LIGHT SPECTRA AND SUCROSE CONCENTRATION IN REGULATING GROWTH, PHOTOSYNTHETIC PIGMENTS, AND OXIDATIVE STRESS RESPONSE IN *CORNUS MAS* 'PODOLSKI'

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The influence of LED spectra and sucrose concentration in the culture medium on the growth, photosynthetic pigment content, and secondary metabolite accumulation of *Cornus mas* 'Podolski' was evaluated in an *in vitro* culture. Various light-emitting diode (LED) treatments were applied, including different dominating LED light spectra: White (W), Blue (B), Blue-Red (BR), and Red (R). Axillary shoots were cultured on Woody Plant Medium (WPM) supplemented with 20, 15, or 10 g/dm^{-3} sucrose, 5 ml dm^{-3} calcium nitrate, 8 g dm^{-3} BioAgar, 0.05 mg dm^{-3} thidiazuron (TDZ), 0.05 mg dm^{-3} naphthaleneacetic acid (NAA), and 0.5 mg dm^{-3} benzyladenine (BA). Cultures were maintained for three months in a phytotron at 23 ± 1°C under a 16-hour photoperiod with a light intensity of approximately 40 µmol m^{-2} s^{-1}. The study demonstrated that both LED light quality and sucrose concentration significantly influenced the biochemical and biometric parameters of *Cornus mas* 'Podolski'. Among the treatments, blue-red light combined with high sucrose concentration (20 g dm^{-3}) was the most effective in enhancing photosynthetic pigment biosynthesis, including total chlorophylls and carotenoids. In contrast, red light combined with high sucrose promoted the highest protein content, suggesting an active role of red spectra in protein metabolism. Red light treatments, regardless of sucrose concentration, stimulated the most vigorous shoot development, with the highest shoot number, elongation, and leaf formation, indicating its potential for micropropagation protocols. Furthermore, oxidative stress responses were modulated by both light and sucrose concentrations with red and blue-red light inducing the highest H_2O_2 accumulation and red light enhanced antioxidant activity through the highest amount of catalase activity.

Key words: *in vitro propagation, cornus mas, sucrose concentration, LED, shoot regeneration*

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LOCAL STUDY ON THE CULTIVATION OF DIFFERENT PEARL ONION (*ALLIUM CEPA* L.) VARIETIES FOR CANNING INDUSTRY AT EXPERIMENTAL SMART FARM IN MOSONMAGYARÓVÁR

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Pearl onions grown in Europe primarily consist of white-skinned, short-day varieties (*Allium cepa L.*) that typically range from 10 to 30 mm in diameter. The canning industry has set specific quality requirements, such as round shape, white colour, mild flavour, and sufficient hardness. This research aims to determine the optimal nitrogen fertilizer amount for producing pearl onions suitable for food processing, focusing on bulb size and hardness. To achieve this goal three varieties—Pompei, Barletta, and Fertődi Silver White—were tested in a randomised small plot experiment at the Experimental Smart Farm of Széchenyi István University in Mosonmagyaróvár. The study evaluated the impact of low, medium, and high nitrogen fertilizer doses on plant growth, specifically bulb size, and compared bulb hardness to current canning standards. A one-way analysis of variance (ANOVA) was performed at a significance level of $p \leq 0.05$, accompanied by Tukey's HSD post-hoc test to analyse the size of the vegetative organs. The results from the hardness tests included the calculation of arithmetic means and standard deviations, followed by an F-test and a t-test, were performed at a $p \leq 0.05$ significance level. The findings show that the Barletta and Fertődi onion cultivars treated with a low nitrogen dose produced bulbs that were significantly smaller in diameter compared to those grown with medium nitrogen doses. Interestingly, onions that received higher nitrogen doses did not result in larger bulbs. This suggests that increasing the nitrogen dose beyond a certain level does not have a beneficial effect. The results can help reduce fertilizer use and promote the development of sustainable and environmentally friendly fertilization practices. On the other hand, the Pompei cultivar, when treated with a high nitrogen dose, produced the smallest diameter bulbs, which were significantly smaller than those grown with medium nitrogen levels. This further demonstrates that the response to nitrogen fertilizer varies greatly between different cultivars, highlighting the need for further research in this area to ensure sustainable management and environmental protection. Hardness tests revealed that the Barletta cultivar treated with a high nitrogen dose and the Pompei cultivar at both medium and high doses did not show significant differences in hardness between canned and processed pearl onions. This indicates that their hardness levels were quite similar. Overall, the results indicated that Pompei bulbs treated with a high nitrogen dose are the most suitable for the canning industry. On average, they produced the smallest diameter bulbs and displayed hardness and characteristics comparable to those of pearl onions currently used for canning.

Key words: *pearl onion, nitrogen fertiliser, bulb hardness, barletta, pompei, fertődi silver white, canning*

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POSTER PRESENTATION

I. section

Water and soil management, perspectives for its protection and use

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2D LOWLAND RIVER FLOW CALIBRATION ON THE BASE OF IN-SITU MEASUREMENT DATA

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Currently, various types of numerical models are widely used in the open channel hydraulics. The most popular are 1D models where calculations are performed in cross-sections. They are most often used for the purpose of determining flood hazard zones. In modeling river processes, 2D models are widely used for establish morphological changes in river channel. Hydraulic calculations are performed in the grid nodes reflecting horizontal layout of the river. The calculation results are a two-dimensional distribution of hydraulic parameters (x and y components of velocities, water depth, shear stresses, local water level slope, Froude number, etc.). Models of this type are created for shorter river sections (up to several km). They do not allow for analyses of changes of hydraulic parameters in hydrometric profiles, but it is not a barrier for modeling the dynamics of river channels. Compering to 1D models they require much more data, including the river bed configuration and spatial distribution of roughness (size of sediment, bedforms and large-sized obstacles, vegetation, etc.). Despite the extention of the input data still the model results can be considered reliable only after the calibration process. This can be achieved by comparision the results of numerical modeling with field measurement data as well as information about historical floods. The paper presents the calibration process of the 2D numerical model of the Nida River based on field measurements of spatial distribution of velocities and depth. The calibration was performed in two steps: 1) comparison of the water surface elevation, 2) comparison of velocities distributions. The calibration results were then compared by calculating correlation coefficient R, modiffied correlation coefficient Rs and root mean square error RMSE.

Key words: *2D numerical modeling, calibration process*

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ANALYSIS OF PRECIPITATION AND RUNOFF IN CARPATHIAN CATCHMENTS USING THE SWAT MODEL

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Water resources are primarily created by precipitation. Their accumulation in the environment determines in the catchment the amount of surface and groundwater runoff. The most important factors influencing water are land relief, land use, and geological and soil conditions. Vegetation and soil cover play an important role. Forests, trees and shrubs, and grasses slow surface runoff, which improves water retention, as well as can limit the flow of pollutants into surface waters. Poland's water resources are mainly natural and quite small. The average specific outflow is smallest in the central lowland belt, larger in the uplands, and largest in the mountains. Unfortunately, the relationship between precipitation and runoff in Poland is not satisfactory. The average annual precipitation (about 600 mm), assuming that 50-60% of the precipitation is retained in the catchment and an outflow of 5.7 $dm^{3} \cdot s^{-1} \cdot km^{-2}$, gives an average theoretical proportion in the precipitation-outflow system for Poland of about 82%. This is, of course, an estimated value and averaged for the whole country, but it represents the hydrological risk for Poland. The aim of this study was to evaluate the relationship between precipitation and runoff in an exemplary Carpathian catchment using sublime analysis methods with the SWAT model. The results apply to a mountain catchment – the catchment of the Grajcarek stream located in the Małe Pieniny Mountains in the Polish Carpathians. The period 2018-2021 was studied. During the simulations, iterations were carried out with 50 numbers of simulations for each of the Biała Woda and Czarna Woda catchments. The following statistics were used to compare the model results: MAE, NSE, PBIAS, r and RMSE. The analysis showed multilevel parameter relationships between land use changes and their causal factors. The aforementioned methods of analysis highlighted the essence of these relationships. An important conclusion is that transformation towards arable land is practically non-existent. The influence of river sediment and surface runoff prevails here, which naturally links these two influencing factors. The statistical analyzes performed showed that the multiplicity and variability of the influence factors on structural transformation varies strongly. Methods of analysis (MAE, NSE, PBIAS and RMSE) showed that changes in use indicate natural or anthropogenic afforestation of arable land as grasslands, the main restructuring factors are sedimentation applied to the catchment, evapotranspiration, and water infiltration. This indicates a structural change towards a broadly greening of the catchment, resulting primarily from the extensification of agricultural production.

Key words: *SWAT model, MAE analysis, NSE analysis, PBIAS analysis, RMSE analysis, Western Carpathians, rainfall-runoff*

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APPLICATION OF UNMANNED AERIAL VEHICLES FOR GRAIN SIZE DISTRIBUTION ANALYSIS ON GRAVEL-BED RIVER CZARNY DUNAJEC

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The application of Unmanned Aerial Vehicles (UAVs) in fluvial geomorphology has enabled rapid, cost-effective, and high-resolution data acquisition for sedimentological analysis. This study investigates the potential of UAV-based imagery for characterizing surface grain size distribution on river bars of the Czarny Dunajec River in Chochołów. High-resolution aerial images were acquired using a UAV equipped with a high-precision optical sensor under controlled flight conditions. Images were captured from different altitudes ranging from 2 to 10 meters at 2-meter intervals. The collected orthophotos were processed and analyzed in BASEGRAIN software, which allows for the extraction of grain size distributions based on photogrammetric image analysis. The derived granulometric curves were then compared with those obtained from traditional sieving methods to evaluate the accuracy and reliability of the image-based approach. The research aims to determine the effectiveness of UAV-derived data for granulometric assessments and its applicability in river sediment monitoring. The expected outcomes include discrepancies between image-based and sieve-based methods and assessing the influence of factors such as scene size and sediment heterogeneity on granulometric results. The findings of this study contribute to improving remote sensing methodologies for river sediment analysis and may enhance the implementation of UAVs in geomorphological studies. Future research directions include refining image processing algorithms and integrating machine learning techniques to further optimize sediment classification accuracy.

Key words: *UAV photogrammetry, river sediment, grain size distribution, BASEGRAIN, Czarny Dunajec River, fluvial geomorphology, remote sensing*

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CHANGES IN THE CONCENTRATION OF BIOGENIC SUBSTANCES IN WATER BEFORE AND AFTER THE CONSTRUCTION OF A WATER RESERVOIR ON THE KORZEŃ STREAM

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The paper presents the results of 10-year long hydro-chemical studies on the Korzeń stream on which the "Skrzyszów" small storage reservoir was built. The Korzeń stream drainage basin is located in southern Poland, in the eastern part of the Małopolskie Voivodeship, in Tarnow Poviat (21°3'17"÷21°6'33" E, 49°56'28"÷49°58'57" N). The basin area is 9,65 km^2. The arable land, evenly distributed in the basin area, was the dominant land use form (a forest-agricultural catchment area with scattered buildings). Studies aimed at evaluating the impact of the reservoir on changes in the concentrations of the biogenic substances in water of a flysch stream. The analysis was based on the concentrations of four water quality parameters: ammonia nitrogen (N–NH_4^+), nitrite nitrogen (N–NO_2^-), nitrate nitrogen (N–NO_3^-) and phosphate phosphorus (P–PO_4^{3-}). Indicators were determined in one-month intervals in two periods: 2005–2009 (before the reservoir was built) and 2015–2019 (after the reservoir was built). The water samples were taken in one measuring point located at 1+520 km of the stream – in the first period from natural bed, and from the engineered bed downstream of the dam in the second period. The obtained results were subjected to a statistical analysis – basic descriptive statistics were calculated, the trend analysis of changes was performed using the Mann-Kendall test; significance of differences between indicator values from two periods was evaluated using the Mann-Whitney U test. In the period after the reservoir was built in relation to the period prior to the construction, the concentrations of N–NH_4^+ and N–NO_2^- were significantly higher, and concentrations of N–NO_3^- and P–PO_4^{3-} were lower. The favourable impact of the reservoir on water quality in the Korzeń stream lies mainly in a significant decreased concentrations of biogenic indicators causing eutrophication of waters. The concentration values of all biogenic indicators had a very high random variation (*CV*>60%). In the second period, the more differentiated values were for N–NO_3^- and P–PO_4^{3-}, and the concentration change dynamics for N–NH_4^+ and N–NO_2^- was lower. The values of analysed biogenic indicators from 2005–2009 showed a downward trend for one indicator only – N–NH_4^+. In case of remaining parameters the positive values of S statistics indicate upward trends. No statistically significant trends were observed in this period of study. After the reservoir was built, a favorable effect of the reservoir was appearance of a statistically significant downward trend for N–NO_2^- and N–NO_3^-. Similarly to the earlier period, a downward tendency found for N–NH_4^+ and an upward tendency for P–PO_4^{3-}.

Key words: *Mann–Kendall test, storage reservoir, trend and tendency of changes*

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CHARACTERIZATION AND ANALYSIS OF ENVIRONMENTAL FLOW AND RIVER MORPHOLOGY ON THE EXAMPLE OF THE SKAWA RIVER. OBSERVATION AND MEASUREMENT

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For the rational use of water resources, the environmental flow is determined, i.e. the minimum water flow in the river secured by the law for water habitats. The group of hydraulic methods for the determination of environmental flow includes the wetted perimeter method (WPM) and critical riffle analysis (CRA). These methods are related to the morphology of the riverbed - vertical and horizontal patterns. For maintaining the continuity of the river flow, the critical locations are cross-sections at a riffle crest. Hydraulic methods rely on the analysis of the critical cross-section, i.e. the cross-section with the smallest depth in the stream, most often it is the peak of the rapids, which is sensitive to changes in the flow rate. The aim of the study is to analyze the environmental flow (EF) changes along the The Skawa River (river length 97.8 km, catchment area A=1177.7 km^2). Determination of the hydralic parameters in the cross-section is based on Chezy's formula. The key factors used to calibrate the flow curve are the discharge, the granulometric composition of the bedload and the hydraulic gradient and where measured in the field. The properties of the bedload and its change along the length of the river have been correlated with the environmental flow. The flood in the year 2020 caused the changes (2019-2020) of The Skawa River riverbed morphology due to sediment transport, erosion and sedimentation and, consequently, the location and shape of the riffle crests. The riffle crests shift in both direction was noticed, i.e. upstream up to 73 m and downstream up to 15 m - the average was approx. 19 m. In one case, the riffle crest retained its location. The changes of the riffle crest location influenced the value of the environmental flow EF. The ratio of $EF_{WPM2020}$ / $EF_{WPM2019}$ values is in the range 77.2 % ÷ 124.0 % (103.7 % on average). In the upper and middle course of The Skawa River the relationship EF_{WPM}=f(A) is described by the equation $EF_{WPM}=0.0027\times A-0.2128$, ($R^2=0.95$). It was found that for The Skawa River, the tendency of the EF_{WPM} increase up to the catchment area of approx. 900 km^2 (75% of the total catchment area). In lower course, the relation EF_{WPM} = f(A) changes in to a decreasing trend. With some minor exemptions EF_{CRA} values were higher than EF_{WPM}.

Key words*: environmental flow, hydraulic methods, rifle-pool sequences, riffle crest, The Skawa River*

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HYDROMORPHOLOGICAL VALORIZATION, MACROPHYTE INVENTORY AND PHYSICOCHEMICAL ASSESSMENT OF WATER IN DRAINAGE CANALS AND REGULATED RIVERS IN THE POWIŚLE DĄBROWSKIE REGION (VISTULA LOWLAND, POLAND)

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Drainage canals and regulated rivers are an element of the agricultural landscape of Powiśle Dąbrowskie, located in the Vistula Lowland mesoregion. The study performed hydromorphological valorization, inventory of macrophytes and evaluation of selected physicochemical parameters of water in three regulated rivers and three drainage canals. The Polish Hydromorphological River Index (HIR) method was used in the field studies. The analysis included determining hydromorphological diversity and hydromorphological transformations, followed by calculation of the HIR multimetrics. The inventory of aquatic plants was made using the Macrophyte River Assessment Method (MMOR). In order to precisely inventory the species composition of indicator plants, field research was carried out on three dates (July 5, 2023; July 12, 2023; May 9, 2024). In 2024, the basic physicochemical elements of water assessment were examined, such as dissolved oxygen, electrolytic conductivity, dissolved substances, pH and water temperature. The studies showed the differentiation of hydromorphological elements of rivers and canals, but the final status/potential class assessments did not show any differentiation. Both rivers and canals were classified as class IV and V, meaning poor and bad ecological condition/potential, respectively. In all measurement sections, a total of 36 macrophyte species and 5 non-indicator plant species were inventoried. The studies carried out have shown that better conditions for the development of aquatic plants are created by drainage canals, which also performed better in terms of water assessment compared to regulated rivers. Moreover, based on the analysis of the environmental preferences of macrophyte species, it was found that the risk of eutrophication of canals is greater than that of regulated rivers. All measured physicochemical water indicators were higher in the water of regulated rivers: dissolved oxygen by 16%, electrolytic conductivity by 12%, dissolved substances by 15%, pH reaction by 5%, respectively. The average water temperature in both types of abiotic watercourses was similar.

Key words*: water monitoring, water quality, drainage channels, regulated rivers, macrophytes, hydromorphology*

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IMPACT OF CLIMATIC AND ANTHROPOGENIC FACTORS ON THE WATER MANAGEMENT CONDITION OF THE TALAS RIVER BASIN

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The Talas River Basin, located at the intersection of Kyrgyzstan and southwestern Kazakhstan, serves as a critical transboundary water resource in Central Asia. This basin is not only rich in diverse ecosystems, ranging from alpine meadows to semi-deserts, but it also faces significant challenges due to anthropogenic factors that adversely affect its water management and quality. The region's hydrology has been increasingly impacted by climate change, agricultural practices, inadequate infrastructure, and governance issues, necessitating a comprehensive approach to integrated water resource management (IWRM) to sustain its vital ecosystems and human needs. Key anthropogenic factors, including agricultural runoff and industrial discharges, contribute significantly to the basin's water quality degradation, with the indiscriminate use of agrochemicals leading to harmful levels of contamination in surface and groundwater sources. This pollution not only threatens local ecosystems but also poses substantial health risks to communities reliant on the river for drinking water and agricultural use. Effective management strategies, including improved governance and regional cooperation, are essential to mitigate these challenges and foster sustainable water resource use. Overall, the water management conditions of the Talas River Basin illustrate a complex interplay of environmental, political, and social factors. The necessity for a coordinated, multilateral approach to governance is critical in addressing the challenges posed by climate change, pollution in contemporary water resource management. The Talas River Basin is situated at the convergence of the Kyrgyz and Talas Ridges, with its sources located in Kyrgyzstan. The basin's lower section borders the Chu Depression in southwestern Kazakhstan, and the watershed is defined by various geographical features, including the Karatau Ridge to the south. The hydrology of the Talas River Basin is significantly influenced by climate change, which has been shown to affect the basin's hydrological processes. Water quality within the basin is also heavily impacted by the pollution levels of its tributaries and groundwater sources. Consequently, integrated water resource management practices are crucial for addressing the anthropogenic pressures faced by the basin's ecosystems, particularly given that some water management facilities are operated with the need for coordinated management strategies to protect and sustainably use the water resources it provides.

Key words: *Talas river, water management, water use, climate changer, international catchment*

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IMPACT OF SOIL MAINTENANCE REGIME IN A PEAR ORCHARD ON WATER RESOURCES

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The aim of the study was to assess the influence of the soil maintenance system on water resources in a brown leached soil developed from loess. The research was conducted at the Agricultural Experimental Station of the Department of Horticulture in Garlica Murowana near Krakow belonging to the Agricultural University of Krakow. The research was conducted in a pear orchard established in 2005 at three measurement points (in the orchard under tree crowns and in the orchard between tree rows) and in the garden of the agro-meteorological station located next to the orchard.Soil moisture measurements at depths of 10, 20, 30, 40, 60 and 100 cm were taken with the PR2/6 Delta - T Profile Probe at weekly intervals during the summer period (June-August) in 2019-2021. The results of the moisture content measurements in % VWC (volumetric moisture content) were converted to soil water reserves (Zw) in mm based on the following formula: Zw= (hi x W%/10) where hi - soil layer thickness, W%, - volumetric moisture content (%) i.e. forward reading from Profile Probe PR2/6. The results were statistically processed using Statistica 13.1. The hypothesis that there were differences in soil moisture content at 10, 20, 30, 40, 60 and 100 cm depths, between study years and points differing in soil maintenance, was verified using a non-parametric test of analysis of variance (Kruskal-Wallis median test).Statistical inference was carried out at a significance level of a=0.05. Based on the analysis of the results, the lowest soil water resource was found at the 10 cm level. There were no differences in water resources between the station location and in the orchard between the tree rows, but there were significant differences between soil moisture in the orchard under the trees and the other locations. In the orchard-under-trees water resources were higher (about 28 mm), while in the other locations they were lower and not statistically different (22 and 21mm). Deeper into the soil, water resources were correspondingly increasing and the differences between the measurement points were similar to the topsoil and occurred up to a depth of 40 cm, while deeper (60 and 100 cm) no significant differences were found according to soil maintenance. Based on the results of the Kruskal-Wallis median test, significant differences in soil water resources were also found between the study years, confirming the significant influence of the course of meteorological conditions on the formation of soil water resources.

Key words: *water resource, brown soil, Garlica Murowana, southern Poland*

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THE EFFECT OF GREEN MANURE ON SELECTED AGROCHEMICAL PARAMETERS OF SOIL IN KOHLRABI CULTIVATION

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During the year 2024, experiments with the application of green manure as a pre-crop for the culture of kohlrabi (*Brassica oleracea* Gongylodes group) were carried out at the Demonstration and Research Station in Prague Troja (detached workplace of the Department of Horticulture, Faculty of Agrobiology, Food and Natural Resources - Czech University of Life Sciences in Prague). White (Luna) and blue (Azur) varieties of kohlrabi were used. The crops selected for green manuring were *Pisum sativum* var. *arvense, Phacelia tanacetifolia* and *Raphanus sativus* var. *oleifera.* Small-plot field experiments were conducted in two periods:

Spring: sowing of green manure: October 2023 → its incorporation into the soil – March 2024/ Planting of kohlrabi - April 2024 → kohlrabi harvest and soil sample collection - June 2024.

Summer: Sowing of green manure: April 2024 → its incorporation into the soil - June 2024/ Planting of kohlrabi - July 2024 → kohlrabi harvest and soil sample collection 2024 – September 2024.

In the experiments, four replicates of each experimental variant were used, with 15 experimental plants in each replicate . During the growing season, standard agriculture techniques were used and, at the time of market maturity (June or September 2024), the kohlrabi tubers were harvested and, soil samples were also taken for subsequent analysis, which was carried out at the Research Institute for Soil and Water Conservation in Prague Zbraslav. The analysis included the following parameters: pH of the water leachate, nitrogen and carbon contents in soil using the Primacs method (Principle of Rapid In-Line Measurement of ammonium and carbon in soil), and P, K, Ca, Mg contents measured by the Mehlich III method. The application of all three types of green manure to the soil in spring 2024 resulted in an increase in soil pH from 6.6-6.8 to 7.0. Plant biomass of all green manures used decreased the total N content in the soil samples collected in spring 2024 (total N of about 0.10%). In samples collected in summer 2024 total N values were increased to reach about 0.14%. The decreased values of N/NO_3^- and N/NH_4^+ observed in the samples collected in summer 2024 probably reflected a slower mineralization of organic matter associated with a decrease in average daily temperatures at the end of the growing period. Green manures decreased N/NO_3^- levels observed in soil samples collected in both spring and summer growing periods. This effect was more pronounced in summer 2024 samples. Soil samples collected in summer 2024 showed slightly elevated oxidizable carbon (Cox) values for all green manure types. Green manure application had no pronounced effect on soil ion levels. Compared to the control there was a slight increase in the soil Ca and K levels after application of green manure and increased Mg levels in all soil samples collected in summer 2024. The content of P in soil was increased in all experimental variants in spring 2024 compared to the control unlike in the summer 2024 samples. No significant effect of the type of green manure used on the agrochemical parameters of soil was observed.

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Key words: *green manure, kohlrabi, soil pH, oxidizable carbon, soil nitrogen, soil minerals (P, K, Ca, Mg)*

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USE OF GEOCELLS FOR INCREASING OF STREAM BED STABILITY

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Increasing of river´s channel stability belongs among the common tasks in river engineering. They are ensuring a control of geomorphological state, increasing a protection of surrounding infrastructure and structures situated in the stream channel. The development of new ways of stream channel protection has evolved over time. At present, from the entire range of geosynthetics used in these works, the geocells stands out as an alternative that allows to combine the state of the art knowledge connected to stream bed stabilization with traditional materials to a hybrid form. Geocells are three-dimensional, honeycomb structures that provide affordable, flexible and reliable solution for stream channel stabilization. They are made from high-density polyethylene (HDPE) and represent a sustainable, effective method for enhancing of stream channel stability. The principle relies on use of a polymer in a three-dimensional shape filled with a granular non-cohesive material which shows properties to enable allowing to reduce the impacts of streambed erosion, resist to higher shear stress and higher flow velocities. Effectiveness of geocells use for increasing of stream bed stability was tested in a set of experiments in hydraulic flume. The experiments were focused on comparison of the permissible velocities of bed homogeneous material in the bed flume and bed material filled into geocells in the bed of flume under varying hydraulic conditions. A boundary conditions were set up within the range of longitudinal slopes from 0.5 % to 2 %, discharges from 5 to 39 $l.s^{-1}$ and mean profile velocities from 0.302 $m.s^{-1}$ to 1.124 $m.s^{-1}$. The results have showed increasing of permissible velocity in case of use of geocells have at the range from 13 to 33 %.

Key words*: geocells, river bed stability, channel revetment*

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APPLICATION OF REMOTE SENSING METHODS FOR HEAT ISLAND ANALYSIS AND OPTIMIZATION OF RAINFALL MANAGEMENT IN URBANIZED AREAS

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The present climate change is significantly affecting the thermal regime of urbanised areas, increasing the need for effective measures to regulate temperature parameters. The increase in extreme weather events, such as intense rainfall and heat waves, requires the implementation of strategies to optimise the use of rainwater to mitigate temperature fluctuations in urban environments. In this context, remote sensing (RS) methods, which use multispectral and thermal imaging to identify areas favourable or unfavourable for controlling the heat island effect, play a key role. Spectral indices such as the Normalized Difference Vegetation Index (NDVI), Land Surface Temperature (LST), or Normalized Difference Built-up Index (NDBI) allow a detailed analysis of the coverage of the urban environment by vegetation, impervious surfaces, and water bodies. The NDVI spectral index is one of the most widely used tools in vegetation analyses. This index uses the difference between red and near-infrared light to determine the amount and health of vegetation in each area. Higher NDVI values indicate abundant and healthy vegetation that has a high capacity to reduce environmental temperature due to its cooling and transpiration processes. In cities with a lower proportion of green vegetation, such as compact urban areas, the heat regulation effect is lower, leading to a higher intensity of heat islands. The NDBI spectral index, on the other hand, focuses on identifying impervious surfaces such as asphalt and concrete surfaces that contribute to overheating in urban areas. This index uses the difference between infrared and near-infrared light to detect urbanized and paved surfaces. High NDBI values indicate a high level of urbanization that is associated with an intense heat island. Combining NDBI with NDVI allows for more accurate identification of areas that need interventions to reduce heat stress, such as planting green areas or creating water areas. These methods provide valuable information on the distribution of different surfaces that influence urban temperature conditions. The combination of spectral indices with satellite imagery allows fast and efficient analysis even in large urban areas. The results of these analyses can be used as a basis for designing specific adaptation measures in cities, such as planting green areas, creating urban water bodies, and modifying impermeable surfaces. For further research, it is recommended that the methodology be extended by integrating high-resolution satellite imagery with in-situ measurements of surface temperature and humidity. At the same time, it is advisable to apply advanced heat flow modelling in urban environments, using a combination of RS data and hydrological models to optimise stormwater retention. This approach should enable more detailed modelling of the dynamics of temperature fluctuations and improve the prediction of climate change impacts in urbanised areas.

Key words*: climate change, heat islands, urbanised areas, blue-green infrastructure, remote sensing, spectral indices, temperature regulation*

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VARIATION IN RUNOFF IN POLAND IN RELATION TO PRECIPITATION AND AIR TEMPERATURE

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The study presents variation in river runoff in Poland depending on precipitation and air temperature. Data pertaining to runoff and pluviothermic conditions in Poland in the years 1971–2018 were used for the analysis. The annual runoff value was analysed in average years, warm wet years, warm dry years, cold dry years, and cold wet years, categorized on the basis of average annual values for air temperature and annual precipitation totals. In addition, a statistical mathematical model of annual runoff was developed in a function of input variables – temperature and precipitation in the warm half and cold half of the year, i.e. four independent variables. The model was developed using standard stepwise multiple regression statistical software from IBM. A quadratic model with interaction terms was adopted. The best form of the model was selected based on statistical tests: multiple correlation coefficient r, Fisher–Snedecor's F-test, and Student's t-test. Statistically significant differences were demonstrated between the runoff values for warm dry years, average years, and cold wet years. The calculations show that the relationship between the semi-annual values of meteorological parameters and the runoff value in the hydrological year is best described by the statistical mathematical model presented in the paper.

Key words*: precipitation; climatic water balance; runoff, Poland*

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POSTER PRESENTATION

II. section

Biological, ecological, agricultural and technical measures in the landscape in connection with climate change

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ANALYSIS OF CLIMATE CHANGE EFFECTS ON THE PHENOLOGICAL PHASES OF RED CURRANT (*RIBES RUBRUM*) IN THE BANSKÁ BYSTRICA AND ŽILINA REGIONS

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The year 2024 marks a significant milestone in climate history, with global average temperatures exceeding 1.5°C above pre-industrial levels for the first time. Air temperature, a key climatic factor, has a major influence on the timing of phenophases during the growing season. The climatic normal from 1991 to 2020 shows an exponential temperature rise, making it the warmest period in climatological history. In this scientific study, we focus on analysing the impact of climate change on selected phenological phases (full flowering – BBCH 65 and fruit begins to soften – BBCH 87) of red currant (*Ribes rubrum*) in the Banská Bystrica region (BBK) (southern region of the Slovak Republic) and Žilina region (ZAK) (northern region of the Slovak Republic). We compare the onset of phenophases in 2024 with the climatic normal 1991 – 2020. The results of the analysis, based on data from six meteorological stations in each region, localised to cover as much of the region as possible, indicate that the shift in selected phenophases occurs in both regions of the Slovak Republic. The onset of the full flowering phenophase in BBK in 2024 was observed from 6th April between altitude 380 and 510 m a.s.l. to 17th April (765 m a.s.l.). This represents an earlier onset by an average of 18.8 days compared to the 1991 – 2020 climatic reference period. The onset of the fruit begins to soften phenophase in 2024 was observed from 6th June between altitude 425 and 475 m a.s.l. to 14th July (765 m a.s.l.). This is an earlier onset by an average of 15.3 days compared to the climatic normal 1991 – 2020. In ZAK, the onset of the full flowering phenophase in 2024 was observed from 8th April between altitude 390 and 480 m a.s.l. to 8th May (700 m a.s.l.). This is an earlier onset by an average of 19.2 days compared to the climatic normal 1991 – 2020. The onset of the fruit begins to soften phenophase in 2024 was observed from 28th June between altitude 480 and 675 m a.s.l. to 08th July (457 m a.s.l.). This is an earlier onset by an average of 11.7 days compared to the 1991 – 2020 climatic normal. Due to the earlier onset of phenophases (1 to 2 decades depending on the region), full flowering should be planned in red currant plantations with technologies that minimise the negative impact of potential late spring frosts and summer drought, considering the specific local conditions given by the distinctive geomorphology of the Slovak territory.

Key words: *phenological phase, climate change, fruit farming, sustainability*

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ANTICONVULSIVE EFFECTS OF BIOLOGICALLY ACTIVE COMPOUNDS IN ESSENTIAL OILS OF SELECTED SPECIES FROM THE FAMILY MYRTACEAE

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Plants from the family Myrtaceae grow in the tropical zone, most abundantly in Australia and South America. Essential oils are secreted exotropically by secretory trichomes and endotropically in oil glands formed lysogenically. Essential oils produced by species of the genera *Eugenia*, *Marlierea*, *Callistemon*, and *Psidium* are known for their medicinal properties, including anticonvulsive effects. The aim of this study was to determine the anticonvulsive properties of essential oils produced by selected plant species from the family Myrtaceae. Clove oil obtained from the buds of *Eugenia caryophyllata* has been used in Iranian folk medicine as an antiepileptic agent. The chemical profile of clove oil is dominated by eugenol, carvacrol, β-caryophyllene, and α-humulene exhibiting a binding affinity for the GABA-benzodiazepine receptor. Clove oil reduced the intensity of tonic seizures and shortened the duration of seizure events due to the presence of eugenol and carvacrol with anti-stress, anaesthetic, and muscle relaxing properties. Essential oil extracted from *Marlierea eugeniopsoides* contained mainly α-pinene (54.6%) and β-pinene (32.4%). The mechanism of its anticonvulsant action was associated with the GABA neurotransmitter. *Callistemon citrinus* leaf oil shortened the duration of seizures by 69-81% depending on the dose. Similarly, essential oil from *Psidium persoonii* (*P. acutangulum*) leaves alleviated the severity of seizures, and the mechanism of its action involved endogenous adenosine. Essential oils regulate various neurotransmitter pathways. Further preclinical and clinical studies are advisable to investigate their effects. Additionally, development of methods for regulation of the generation of appropriate metabolites using genetic and metabolic engineering techniques is necessary to increase the yield and quality of phytochemicals with pro-health effects.

Key words: *Eugenia caryophyllata*, *Marlierea eugeniopsoides*, *Callistemon citrinus*, *Psidium persoonii,* neurotransmitter pathways, phytochemicals, phytotherapy

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CLASSIFICATION OF LANDSCAPE FEATURES USING THE EXAMPLE OF AGRICULTURAL COOPERATIVE HRIŇOVÁ

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The Agricultural Cooperative Hriňová enterprise is located in the Detva District, Banská Bystrica Region, Slovakia. It manages 5200 hectares of land, focusing primarily on crop production (including winter rapeseed, wheat, barley, oats, sorghum, and maize) as well as livestock production, specifically cattle and sheep breeding. A detailed field survey has been conducted. Initial focus was on documenting landscape features that are registered within the LPIS (Geospatial Aid Application System), i.e., where the entity is entitled for support in the form of direct payments and agri-environmental subsidies. The features have been categorized according to the subsidy criteria, including wooded patches, balks, windbreaks, wetlands, solitary trees, etc. Subsequently, other landscape features not included in subsidy schemes have been thoroughly documented, thereby getting a preliminary overview of the elements that are formally protected and supported through public funding, and those outside the scope of the subsidy mechanisms. Our findings indicate that although some landscape elements are integrated into the support system, many remain unregistered or are in a degraded state with significantly reduced ecological function. This augments the need for more accurate documentation, improved management, and a targeted approach to the protection and restoration of the elements. A particular attention shall be paid to landscape structures that do not fall under the formal definition of "landscape feature" by the legislation. Such entities are outside the LPIS system and thus are not subjects of legal protection or financial support, despite their importance for soil conservation, water retention, and biodiversity enhancement. Although the Common Agricultural Policy (CAP) formally supports conservation and development, practical implementations remain limited. Our results indicate that many landscape features are outside the LPIS system, as they do not meet the strictly defined technical and spatial criteria, even though their ecological value is indisputable. Moreover, there is a lack of reliable and up-to-date records complicating the integration into agri-environmental schemes. New landscape elements are missing, mostly due to unresolved land ownership issues, which hinder implementations of appropriate measures in practice. This paper presents particular examples of practical landscape features' protection and development within the agricultural cooperative.

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Key words: *LPIS, subsidy system, landscape features, ownership, protection, development*

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CORRECTION OF CROP WATER REQUIREMENT (V_c) ESTIMATION DUE TO CLIMATE CHANGE

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The determination of irrigation water requirements for special crops and vegetables, including their quantitative and temporal expression for planning, design, and operational purposes, represents a complex issue that is crucial for the effective design and operation of modern irrigation systems. The complexity of this issue is intensified by variable climatic conditions, the biological requirements of individual crops, and the demands of intensive agrotechnics. The study focuses on estimating crop water requirements (Vc) under Slovak conditions using biological curves and older methodologies, for the horizon of the year 2100, considering climate change scenarios in the phenological and meteorological context. The next part of the study analyzes the total crop evapotranspiration (ETc) according to the FAO methodology, applying modified climate scenarios GISSprep and CCCMprep for the time horizons of 2035, 2075, and 2100. Simulations were conducted for the location of Hurbanovo, which holds the longest series of meteorological observations in Slovakia and whose climatic conditions are representative of the irrigation regions in southern Slovakia. The results provide the first estimates of water requirements for selected special crops (fruit trees, hops, grapevines, and vegetables) under future climatic conditions and can serve as a basis for irrigation design, optimization of water management, and assessment of water resource capacity in changing conditions.

Keywords: *irrigation, evapotranspiration, climate change, crop water requirement, special crops, modelling, FAO methodology, Hurbanovo, future climate scenarios*

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IMPLEMENTATION OF HEDGELAYING METHODS IN THE AGRICULTURAL LANDSCAPES OF SLOVAKIA

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The aim of this contribution is to bring brief information about the possibilities of implementing hedgelaying techniques in the Slovakian agricultural landscape and their ecological benefits (increased biodiversity, improved soil health, decreasing erosion etc.). The second part describes the hedgelaying research plot established in March 2025.

Hedgelaying is a traditional technique for maintaining hedges on the borders of agricultural areas, mainly in the British Isles. This method is the art of shaping wood to create a dense, impenetrable barrier that brings various ecological benefits and can even create habitats for various vertebrates and invertebrates. This method of landscape maintenance contributes to a better functioning of ecosystems, has a low carbon footprint and acts against soil erosion. Hedgelaying is the process of partially cutting through and then bending the stems of a line of shrubs or small trees, near ground level, without breaking them, so as to encourage them to produce new growth from the base and create a living 'stock proof fence'. This contribution discusses a newly established layed hedge. Our model plot is located in the cadastre of the municipality of Opava on the border of agricultural land with a total length of 10 m. On the studied area there was spontaneous vegetation of the species *Prunus domestica* (87%), *Rubus fruticosus* agg. (7%), *Crataegus monogyna* (5%), *Rosa canina* (+%). We marked out the width and length of the imaginary hedge with a length of 10 m and a width of 1 m. We removed the other shrubs. Out of the total number of 120 shrubs, we left 44 *Prunus domestica* and 2 *Crataegus monogyna*. We folded the remaining trees using the standard method using a machete, axe and saw. When weaving the branches, we also used supporting poles. Where the fence was thinner, we added previously cleared trees in those places, to improve density. The hedgelaying process was carried out in the second week of March 2025. Subsequently, the survival of the trees, growth and wound healing will be evaluated during the vegetation. A zoological survey will also be included, with an emphasis on nesting in the folded fence and the occurrence of rare entomofauna, which may be associated with this type of habitat.

Key words *: hedgelaying, small landscape features, biodioversity, arboriculture, ornithology, entomology*

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POSTER PRESENTATION

III. section

Current research and innovations in waste and circular economy

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COMPOSITION ANALYSIS OF THE BIODEGRADABLE MUNICIPAL WASTE IN RURAL AREA

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Biodegradable municipal waste (BMW) is a highly heterogeneous mixture of different organic materials, which can be varied e.g. by the sorting criteria specified by the municipality, collection system (including types of collection bins), the efficiency of sorting by citizens, socioeconomic factors, etc. In order to meet the EU recycling target, municipalities are obligated to separate and recover BMW from gardens of family houses in Slovakia. BMW is then processed in the municipal composting plants, creating compost. The source segregation of BMW is recommended because of high probability of physical contamination in the municipal solid waste derived composts. Composting is a process highly valued in waste management, creating a valuable product with soil amendment potential. Our research was focused on the evaluation of the composition of the BMW sourced from family houses in two villages (Podhorany and Jelšovce) in rural areas. Both villages are part of the municipal association, which composts its waste in the village of Výčapy-Opatovce. The analyses were carried out on the ground of composting plant in the Nitra district in southwest Slovakia. The goal was to determine the proportion of unwanted impurities - such as plastics, metals, glass or other inorganic components - that reduce the quality of biological waste and complicate its further processing. Analyses of the composition of BMW from both municipalities were carried out in May 2024, September 2024 and March 2025. There was a total of 411.65 kg of waste from the municipality of Podhorany with an average pollution level of 3.54 % and 418.1 kg of waste from the municipality of Jelšovce with an average pollution level of 1.92 %. The knowledge gained and the results of the analyses serve as a basis for the proposal of specific measures that could contribute to the improvement of the existing system of waste management in rural municipalities. The proposed measures include both technical solutions (e.g. adjustment of the collection schedule, introduction of monitoring mechanisms), as well as proposals for streamlining communication with the public and raising awareness of the importance of proper waste sorting. The work also draws attention to the need for systematic education and motivation of the population as a necessary prerequisite for the successful functioning of the separate collection system. The research results can serve as a basis for further decision-making by local governments in the field of waste management and contribute to the sustainable development of municipalities in accordance with the principles of the circular economy and environmental responsibility.

Key words: *biodegradable waste, purity of separate waste, composting plant*

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EFFECT OF THE ADDITION OF DISPERSED REINFORCEMENT ON THE MECHANICAL PROPERTIES OF COHESIVE SOIL

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Mineral soils used in earthworks exhibit various mechanical properties that affect the bearing capacity, stability, and durability of engineering structures. It is generally accepted that the inclusion of dispersed reinforcement improves the strength parameters and reduces soil deformation under loading. The use of fibers also enhances soil resistance to erosion, which is particularly important in the context of protecting, for example, earth embankments against atmospheric influences and groundwater impact. The objective of the study was to determine the effect of dispersed reinforcement in the form of synthetic fibers – Fibermesh 300 and SicaCem Fiber 12 – added to clayey coarse silt on its compaction characteristics (optimum moisture content and maximum dry unit weight), shear strength parameters (angle of internal friction and cohesion), and bearing capacity index (CBR). Tests were conducted on unreinforced soil as well as on soil composites with 0.25% and 0.50% fiber content by dry weight of soil. The study also considered the influence of sample saturation during testing on the measured parameters. The addition of dispersed reinforcement in the form of synthetic fibers caused an increase in optimum moisture content and a decrease in the maximum bulk density of the soil skeleton. In the case of the internal friction angle and cohesion, an increase in their values was also obtained, with the composite of coarse silty dust with the addition of SicaCem fibers being characterized by higher shear strength parameters. Increasing the moisture content of the composite samples caused a decrease in the shear strength parameters. The addition of dispersed reinforcement also caused an increase in the bearing capacity index of the composite samples tested immediately after compaction. However, tests after 4 days of sample saturation showed a decrease in the bearing capacity index value.
Analysis of the test results confirmed that the application of dispersed reinforcement improved the mechanical properties of the tested soil. However, it should be clearly emphasized that the selection of the type and quantity of reinforcement should be tailored to the site-specific soil conditions and project requirements. In conclusion, the use of dispersed reinforcement for strengthening cohesive mineral soils proves to be an effective method for improving their mechanical properties, offering new design possibilities in geotechnical engineering and construction.

Key words*: clayey coarse silt, synthetic fiber, compaction parameters, angle of internal friction, cohesion, bearing capacity index*

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POSTER PRESENTATION

IV. section

Outlook and perspectives for the protection, planning and design of the urban environment

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ALIENATION OF LAND PLOTS IN THE URBAN ENVIRONMENT PLANNING IN UKRAINE

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The urban environment is a set of natural and artificially created material environments that arises as a result of the impact of urbanization processes on the natural environment.
Measures aimed at planning a quality urban environment include:

- location of residential development in favorable conditions depending on the sources of pollution;
- improvement of architectural and planning solutions;
- rational functional zoning of the city territory;
- improvement of engineering and transport infrastructure;
- improvement of the old buildings;
- formation of developed systems of cultural and household services for the population, greening and landscaping;
- relocation of hazardous enterprises outside the city or improvement of industrial production technologies.

It is important to meet the social needs of society aimed at creating the most favorable living conditions for people (work, life, recreation, cultural leisure and comprehensive development). One of the mechanisms that can ensure the planning of a high-quality urban environment in settlements is the introduction of a mechanism for alienating land plots to meet public needs. In Ukraine, these issues are regulated by the Law of Ukraine on the alienation of privately owned land plots and other real estate located on them for public needs or for reasons of public necessity. This law defines the object of alienation as a land plot (part of it), a residential building, other buildings, structures, and perennial plantations located on it, owned by individuals or legal entities. The list of public needs defined by this law includes those that can be ensured by urban environment planning, including: construction, overhaul, reconstruction and maintenance of linear facilities, transport and energy infrastructure facilities and facilities necessary for their operation, as well as the creation of city parks, construction of preschools, recreation areas, stadiums and cemeteries. The decision to apply the mechanism of land alienation should be made by the authorized bodies and only in cases of meeting public needs. The legislation defines the sequence of stages of the land alienation procedure and establishes the rules for calculating compensation to land owners and users when introducing the alienation procedure. The introduction of a mechanism for alienation of land plots to meet public needs can be quite effective in urban planning, especially in the process of negotiating with land owners and determining fair compensation for alienated property.

Key words: *alienation of land plot, urban environment, public needs, planning, compensation*

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PERCEPTION OF URBAN ADAPTATION TO CLIMATE CHANGE: INSIGHTS FROM SOCIAL MEDIA

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As climate change progresses, cities and their inhabitants are becoming increasingly threatened. Therefore, research on how to adapt cities to climate change is becoming important. It is also important to study the perception of these actions by city residents.
To respond to this call, our aim is to identify the main actions taken in Poland by cities and their inhabitants to adapt to climate change and to explore how these actions are perceived by the public. In order to guide the investigation and address the identified research gap, this study is structured around the following research questions:

RQ1: What actions are cities taking in Poland to adapt to climate change?
RQ2: How do city communities perceive these activities?

To answer the questions posed, posts dedicated to green cities were collected from social media. After collecting the posts, we decided on a quantitative method of analysis using text mining techniques. We examined the frequency of unigrams and n-grams and attempted to isolate the main topics in the collected posts. Thus, we answered the first research question.
To answer the second research question, we conducted a sentiment analysis and thus investigated the emotional nature of the collected posts. The results obtained were commented on from the perspective of stakeholder theory and institutional isomorphism theory. Our research can be useful for city residents and their city authorities to support actions that help increase the resilience of cities to climate change.

Key words*: adapting cities to climate change, social media, text mining*

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SOCIAL HOUSING AS A MEANS OF REDUCING URBANIZATION PRESSURE ON THE NATURAL ENVIRONMENT

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All human activity inherently exerts an impact on the natural environment. In the majority of cases, this impact is negative. One of the global phenomena resulting from the expansion of urban areas is urbanization. According to data published by the European Commission, buildings account for 40% of total energy consumption in the European Union and 36% of the EU's greenhouse gas emissions. Importantly, environmental impact occurs not only during the operational phase of buildings, but also throughout their entire life cycle, including the pre-construction and post-use stages. United Nations projections indicate that by 2050, the proportion of the world's population living in urban areas will increase from approximately 50% to nearly 70%. Moreover, half of the urban infrastructure required by mid-century has yet to be built. These figures illustrate that the coming quarter-century will be marked by growing urbanization pressure. This process is expected to lead to the gradual—and in some cases abrupt—transformation of non-urbanized areas, particularly peri-urban and rural zones. One of the primary drivers of this phenomenon is the shortage of housing, especially affordable rental housing. Therefore, social housing should not only respond to housing needs, but also actively mitigate negative environmental, spatial, and infrastructural impacts. Based on a comprehensive review of documents providing climate action guidelines related to spatial planning, urban design, and urban development management, the authors attempted to adapt selected best practices to the current legal and institutional framework in Poland. This analysis led to the formulation of a set of recommendations aimed at improving the implementation of sustainable development principles within the social housing sector. Special emphasis was placed on the need for legislative and systemic reforms that could facilitate housing investments minimizing urbanization pressure on the natural environment while simultaneously improving the efficiency of spatial management. The overarching objective of the proposed changes is to provide a set of actionable recommendations that can be integrated into legal regulations, housing policies, and public financing programs related to social housing. The application of these recommendations would enable the development of residential investments that reduce the negative effects of urbanization pressure and support more sustainable and resilient spatial development.

Key words*: urbanization pressure, social housing, natural environment, urbanization, sustainable development, housing policy*

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THE IMPORTANCE OF MARGINAL HABITATS IN THE AGRICULTURAL LANDSCAPE IN PRESERVING THE FLORISTIC DIVERSITY OF THE SOUTH PODLASIE LOWLAND

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Marginal habitats are a common element in the agricultural landscape of the South Podlasie Lowland. They play the phytocenotic role of in-field environmental islands. In the years 2015-2021, floristic studies were conducted in 120 marginal habitats, such as: sodden margins, shrub and wooded margins, strip woodlots, in-field roads, grassland areas, shrubs, tufted woodlots, in-field woodlots, surface woodlots and waterholes, and drying depressions, located among vast fields, diversified in terms of area and shape. The aim of the study was to conduct a comparative analysis and assess the role of marginal habitats in preserving the floristic diversity of the agricultural landscape. Vegetation studies in selected marginal habitats were conducted using the Braun-Blnquet method. A total of 750 phytosociological relevés and over 250 floristic censuses were taken. The diversity of the studied marginal habitats was determined using the Shannon and Simpson coefficients and the number of species and analyzed using the one-way analysis of variance method for a completely randomized design. A detailed comparison of means was made using Tukey's NIR at $p<0.01$ or $p<0.05$. Correlation analysis (Pearson's correlation coefficient) and regression analysis were used to assess the relationships between features. The similarity of the studied habitat types was determined based on multidimensional data analysis using the Ward agglomeration method. In total, 445 species of vascular plants belonging to 68 families and 250 botanical genera were recorded in all environmental islands. The area of marginal habitats was an important factor differentiating its floristic richness. The greatest richness was observed in surface woodlots up to 1 ha and in-field woodlots up to 0.5 ha, respectively 202 and 166 species. Rich phytocenoses also occurred in water bodies and depressions of 160 species. On the other hand, the poorest were recorded in small objects such as single trees and shrubs of 80 and 71 species. Analysis of the biodiversity of communities developing on individual types of marginal habitats using the Shannon biodiversity index (H') showed that the highest average values were achieved in the communities of water bodies and drying depressions of the terrain (11) – H'= 2.98, on grasslands H'= 2.90 and in strip woodlots (H'= 2.82), and the lowest in the communities of field roads H'= 1.04). The dominance index in the analyzed marginal habitats was less diverse, its average values were high and similar for communities developing in all types of habitats 0.69-0.91. The similarity of the studied sites determined by multidimensional cluster analysis using Ward's method, based on the number of species, the naturalness index and the total synanthropization index showed two groups of similarities. The sites from the first group were characterized by a small area and an average number of species - 97, and a high synanthropization coefficient - 94.5. On the other hand, the sites classified in the second group were large-area, on which an average of 161 species occurred, and the synanthropization coefficient was lower and amounted to 83.3.

Key words: *agricultural landscape, marginal habitats, floristic diversity*

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POSTER PRESENTATION

V. section

Current research through creation and innovations in landscape architecture

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LANDSCAPE ARCHITECTURAL POTENTIAL OF THE OPEN PUBLIC SPACES OF THE HOUSING ESTATE IN DUBNICA NAD VÁHOM

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Green infrastructure should be considered as an organic part of the residential areas, because its absence cannot be replaced by any artificial equipment. Urban greenery should form an integral system of interconnected areas, taking into account the trends of urban development and respecting the indicators of sustainability of the city, while reflecting the adaptation to climate changes. Abstract presents the landscape architectural proposal of the chosen segment of housing estate in Dubnica and Váhom. There were elaborated analyses of the area, including detailed inventory of the trees, analyses of the urban structure, traffic connections, equipment and functions of the space. As a source maps were used: Urban plan of the city and portals: Open Street Map and ZBGIS. Dubnica nad Váhom is located in the central part of Považie region. It is located in the valley of the river Váh and its altitude is 242 m above sea level. The average annual temperature is from 8.5 degrees Celsius upwards. The annual precipitation is on average 600-800 mm. Housing estate Pod hájom is located in southeastern part of the city. The chosen area has seven pedestrian entrances. It is surrounded by 7 and 8 – floors residential buildings. There were inventoried 101 trees (90 deciduous trees and 11 coniferous trees). According to the biological age of the trees, most of them were adult (46%) and senescent (37%), only 17% represent new planting. There are concrete playing field, concrete areas with benches and pedestrian road. The equipment of the space is insufficient. Relaxation zones, seating areas for seniors and playground for children are missing. The landscape-architectural proposal divides the open space into three parts - an active zone, relaxation zone and representative part. The largest is the active zone. The relaxation zone was allocated on less steep terrain. Each segment has section dedicated to different ages category (zone for children, zone for adolescents, zone for family and zone for seniors). These zones are intertwined with each other. During the design process adaptation measures of the changing climate conditions were taken into account. We have proposed: rain garden (which will capture water from the surrounding sidewalks), retention strip (designed along the entire inner block) and flower meadows (to support the biodiversity). There have been proposed trees as: *Acer platanoides, Acer campestre* ´Elegant´*, Amelanchier lamarckii. Corylus maxima* 'Purpurea'*, Prunus padus, Tilia cordata* 'Greenspire' *– all in total 106 pieces.*

Key words*: landscape architecture, housing estate, public open spaces, recreation, Dubnica and Váhom*

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LANDSCAPE ARCHITECTURE AS A STRATEGY OF TACTICAL URBANISM: TRANSFORMING URBAN VOIDS

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The urban environment is increasingly facing challenges related to underutilized, neglected, or dysfunctional spaces that arise due to urban planning changes or suburbanization. Urban voids represent significant potential for the renewal and adaptation of the city to meet the current needs of its residents. This study focuses on exploring tactical urbanism as a progressive approach to urban space revitalization and the role of landscape architecture in this process. Tactical urbanism refers to a set of low-cost, flexible, or temporary interventions that can quickly and effectively change the character of the urban environment. This has a direct impact on both the residents and the development of urbanism. Landscape architecture plays a key role in finding sustainable uses for urban voids—whether it involves creating green areas, temporary cultural, or social spaces. The aim of this study is to connect the possibilities of landscape architecture and tactical urbanism for the development and transformation of underused urban spaces into vibrant and functional areas that contribute to social inclusion, ecological sustainability, and overall urban quality of life. The research draws on case studies and the methodology of pixel analysis and the application of green and blue infrastructure elements. This study highlights the challenges of urban planning and landscape architectural interventions in the urban environment when forming effective strategies for transforming vacant urban spaces. Tactical urbanism offers innovative and participatory solutions that allow for quick responses to the changing needs of the city and its inhabitants. The integration of landscape architecture into this approach enables not only aesthetic, but also ecological and functional uses of these spaces. The potential of such initiatives can enhance the quality of life for residents and contribute to the long-term sustainability of the urban environment.

Key words *: tactical urbanism, landscape architecture, ecological sustainability, urban voids*

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STRATEGIES FOR REINTEGRATING MARGINALIZED AREAS INTO THE URBAN FABRIC

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The reintegration of marginalized areas into the urban fabric represents both a critical challenge and a significant opportunity for contemporary urban planning, architecture, and socio-economic development. This research investigates comprehensive strategies aimed at transforming neglected, socially excluded, and physically deteriorated urban zones into dynamic, inclusive, and functional parts of the city. It explores the historical evolution of urban marginalization, identifying structural causes such as urban development, political or economic collapses, socio-economic inequality, flawed planning policies, urban sprawl, as well as natural disasters and errors in the spatial planning process. The study employs a multidisciplinary approach, drawing from urban design theory, participatory planning, social geography, and sustainable development principles. By analyzing successful case studies from diverse contexts, the research identifies key factors that promote successful reintegration, including community-driven initiatives, adaptive reuse of spaces, mixed-use developments, green infrastructure, and enhanced mobility networks. Special attention is given to participatory processes that empower local communities, integrating their needs and aspirations into the transformation process, thereby fostering a sense of ownership and social cohesion. Furthermore, the research critically examines policy frameworks, financial instruments, and governance models that have proven effective in overcoming systemic barriers to reintegration. Emphasis is placed on the role of strategic urban design interventions that create permeability, connectivity, and multifunctionality, while preserving cultural identities and addressing environmental sustainability. The research posits that reintegrating marginalized areas requires a holistic and iterative methodology, balancing top-down planning with bottom-up engagement, short-term actions with long-term visions, and spatial interventions with socio-economic programs. Ultimately, the study aims to contribute to the development of resilient, equitable, and vibrant cities by offering a set of adaptable strategies that practitioners, policymakers, and community leaders can apply across different urban contexts, thereby fostering a more inclusive urban future.

Key words: *Urban voids, Marginalized areas, Urban reintegration, Participatory planning, Spatial planning, Adaptive reuse, Urban resilience*

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VI. section

New approaches, methods and technologies for the planning, design, establishment and management of green infrastructure

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ASSESSMENT OF LAND CONSOLIDATION IMPACTS ON WATER EROSION: A CASE STUDY FROM SOUTHERN POLAND

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Land consolidation (LC) is a key tool for improving the spatial structure of rural areas, primarily aimed at reducing land fragmentation and enhancing agricultural land use. In addition to its technical and economic benefits, LC can have important environmental effects, including impacts on water erosion processes. These effects may be positive or negative, depending on how the consolidation is designed and implemented. Modifications in plot layout, access roads, and drainage infrastructure can influence erosion-related factors such as slope gradients, surface runoff, and water flow direction. This is especially relevant in areas with varied topography and long-standing erosion problems, where landscape changes can significantly affect soil stability.This study aimed to develop and apply a method for assessing the impact of LC on water erosion using a case study from southern Poland. The analyzed area, covering approximately 2000 hectares, includes the villages of Tczyca, Jelcza, and Wierzbie in the Charsznica commune, Miechów County. The region is characterized by significant elevation changes and severe erosion issues, making it a suitable site for examining the environmental consequences of LC. The analysis compared pre- and post-consolidation conditions using geospatial tools, environmental indicators, and terrain modeling. Key factors such as slope, land cover, and changes in infrastructure were evaluated to assess their influence on erosion risk. Results indicate that under the specific conditions of the study area, the overall effectiveness of LC in reducing water erosion was limited. While some local improvements were observed—such as better drainage and more erosion-resistant plot arrangements—significant reductions in erosion risk were achieved on less than a few percent of the total area. In many parts of the region, the changes introduced during the LC process did not lead to noticeable improvements in environmental resilience. In certain locations, newly constructed roads or reconfigured plots may have even increased surface runoff and localized erosion. These findings highlight the importance of integrating environmental considerations into the planning of LC projects, especially in erosion-prone regions. Approaches such as vegetative buffers, contour-aligned plots, and erosion-resistant road design should be more systematically incorporated into future consolidation efforts. Overall, the case study contributes to a deeper understanding of the environmental dimensions of land consolidation and emphasizes the need for aligning agricultural planning with long-term soil and landscape sustainability goals.

Key words: *land consolidation, water erosion, soil protection, spatial planning*

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LEGISLATIVE OVERVIEW OF GLOBAL AND NATIONAL LANDSCAPE EVENTS, AGREEMENTS, CONVENTIONS AND LAWS

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Nature conservation and landscape planning are essential for sustainable rural development. Over the last fifty years, significant legislative changes have addressed the need to balance environmental, social and economic interests. Land use regulation has become key to addressing issues such as agricultural land loss, climate change, biodiversity conservation and the challenges of urbanisation. These regulations have been shaped by both national policies and international agreements, as well as European legislation, to ensure effective land management. Contribution aims to provide an overview of the development of land protection and planning legislation. It analyses key legal frameworks, both national and international, and their impact on current practices. International agreements and conventions are crucial for environmental protection and sustainable development. Since the 1970s, major global environmental commitments have shaped the approach to biodiversity, climate and natural resource protection. The 1972 UN Conference on the Human Environment in Stockholm established principles for sustainable land use. The following decades saw the creation of key international conventions such as the Ramsar Convention, the UNESCO World Heritage Convention and the Bonn and Bern Convention. The Vienna Convention laid the foundations for emissions regulation. In 1992, the Rio Summit adopted the UN Framework Convention on Climate Change and the Convention on Biological Diversity. This was followed by the Kyoto Protocol and the Paris Agreement on climate change. European initiatives such as the Landscape Convention and the European Green Deal focus on regional heritage and carbon neutrality by 2050. The first legislative measures in the field of landscape protection were adopted in Slovakia in the 1970s. The LANDEP methodology (1982) played an important role, providing the basis for landscape-ecological planning. After 2004, Slovak legislation was harmonised with European standards and new tools for landscape planning and management were introduced. With the adoption of the Council of Europe's Landscape Convention in 2005, landscape planning became part of the Slovak legal framework and landscape protection was integrated into the Slovak spatial development concept. In 2023, the Ministry of the Environment of the Slovak Republic introduced the first ever Landscape Planning Act to ensure integrated landscape management and prepare Slovakia for the negative impacts of climate change. The law proposed the introduction of landscape plans as a basis for spatial planning, with the aim of protecting natural resources, ecological stability and landscape character. Despite being approved by the government in 2024, the draft law was subsequently withdrawn. Currently, landscape planning is integrated into the Concept of Spatial Development of Slovakia, which outlines the main directions for sustainable territorial development and landscape protection. This summary provides an overview of the main environmental agreements and their impact on global and regional environmental policy. It identifies the main challenges in implementing these commitments and highlights the need for effective international cooperation to protect the planet for future generations.

Key words: *legislative regulations, landscape, sustainability, protection*

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VII. section

Environmentally friendly horticulture technologies

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CHANGES IN THE FLOWERING PATTERN OF A FLORIFEROUS HERBACEOUS MIXTURE IN A FRUIT ORCHARD

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Exploitation of herbaceous mixtures in fruit orchards and vineyards has become an integral part of a growing technology in Central and North-Western Europe in recent decades making it more environmentally friendly compared to the traditional fallowing soil management system. Apart from increasing the organic matter in the soil, higher abundance of soil microorganisms and edaphon, increasing water soaking ability and preventing soil erosion, and positive changes in availability of some nutrients, enhanced biological immobilization of Nitrogen, lower soil compaction, floriferous herbaceous mixtures in orchards are valuable food sources for various insect species including pollinators, thus enhancing diversity in fruit orchards. Different floriferous mixtures are available on the market composed of different numbers of herb species and share of individual groups of species e.g. grasses, legumes and non-legume herbs. The behaviour of plant components of the mixture reflects specific, and variable conditions in different localities, and their importance as a food source for insects is variable. Changes in the flowering pattern of a floriferous mixture were observed in the 2023 – 2023 period in the fruit orchard of the SUA in Nitra where old apple tree varieties were planted. The mixture was sown in spring 2022 and commercially supplied floriferous mixture GreenMix Economy. The soil at the locality was gley fluvial with organic matter content higher than 3,0 %, Ph/KCl 6,9 and medium-high (P), high (K, Ca) to very high (Mg) supply of nutrients. The sown herbaceous mixture consisted of 10 species – *Festuca ovina* L., *Festuca rubra* L. (grasses), *Anthyllis vulneraria* L., Onobrychis viciifolia Scop., Trifolium incarnatum L., Trifolium repens L., Trifolium pratense L. (legumes), *Camelina sativa* (L.) Crantz, *Fagopyrum eculentum* Moench, and *Phacelia tanacetifolia* Benth. (non-legume annuals). The experimental orchard was irrigated with the use of drip irrigation within tree rows, and the green mixture was mulched (2023) or mown (2024) in the first half of July. Observations of the plants growing in the orchard were performed in 1-week intervals in both seasons and the presence of flowering species was recorded. There were found differences in species spectrum at the observed area (40 m^2) over the total experimental period – of the original mixture all non-legume annuals were extinct after the first year, and 21 new species of all 3 plant groups appeared in 2023, while in 2024 another 2 species (legumes) of the original mixture extinct, 2 new grass species, and 5 new non-legume annual and perennial species appeared. The longest flowering period was found in *Trifolium repens* L., *Lotus corniculatus* L., and *Onobrychis viciifolius* Scop., and a spectrum of non-legume species and their role as a food source for insects increased with time. The obtained results imply various recommendations for practical orchard management.
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Key words: *floriferous mixture, flowering, fruit orchard, plant groups, pollinators*

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COMPARISON OF THREE ESSENTIAL OIL FROM BRAZILIAN PLANTS WITH ESSENTIAL OIL FROM *ORIGANUM VULGARE* FOR THEIR HERBICIDAL PROPERTIES

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Origanum vulgare L. is a common species from the family Lamiaceae. It is an aromatic plant used in traditional Mediterranean cuisine as well as in folk medicine. In recent decades, research has revealed that the essential oil, with a dominant content of thymol and carvacrol, also possesses phytotoxic effects. These properties are beneficial for agriculture, as they suggest potential for use as natural (eco-friendly) herbicides. The presented study was built to compare the biological activity of essential oils from plant species *Lippia alba* (Mill.) N.E.Br. ex Britton & P.Wilson, *Lippia sidoides* Cham. (Verbenaceae), and *Ocimum gratissimum* L. (Lamiaceae) from Brazil with the well-known *Origanum vulgare* essential oil. *Lippia* spp. are native to the American continent, ranging from Texas to Bolivia and Brazil. In addition to their culinary use, they have numerous medicinal benefits. Their essential oils have been successfully tested for antiparasitic and pesticidal properties. The oils are rich in monoterpenes such as thymol and carvacrol, similarly to *Origanum vulgare,* which makes them candidates for comparative studies on phytotoxic activity. *Ocimum gratissimum*, also known as clove basil, is naturalized in South America and is commonly used as a culinary herb. Its essential oil contains a high concentration of eugenol, a phenolic compound with documented antibacterial, antiparasitic, repellent, and food-preserving properties. The study was conducted using an in-vitro method based on the application of different concentrations of essential oils (EOs) on selected plant seeds. Four model plant species were used to represent monocots and dicots: monocotyledons - *Triticum aestivum* (wheat) and *Hordeum vulgare* (barley), and dicotyledons - *Trifolium repens* (white clover) and *Brassica napus* (rapeseed). The number of germinated seeds and the length of primary roots were measured after seven days of cultivation in a phytochamber under controlled temperature and photoperiod conditions. The results were compared with control groups grown in distilled water without EO application. Statistical analyses (ANOVA followed by Tukey's test) were performed to verify the significance of the observed biological activities. The data showed significant inhibition of both germination rate and root elongation in treatments with essential oils, particularly those rich in thymol and carvacrol, confirming their phytotoxic potential. Positive results from such bioassays are of interest not only for the agricultural industry seeking alternatives to synthetic herbicides but also from an ecological and sustainability point of view. Research into essential oils as eco-friendly herbicides aligns with long-term goals such as reducing chemical inputs, minimizing pollution, and enhancing soil and water health. These natural compounds offer a promising avenue for integrated pest and weed management practices.

Key words*: agriculture, aromatic plants, eco-friendly herbicide, essential oils, in-vitro, phytotoxic effect, secondary metabolites, model plants*

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MICROGREENS CULTIVATION OF PURSLANE: A SUPERFOOD FOR FUTURE FOOD PRODUCTION

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Purslane (*Portulaca oleracea*) is a succulent plant known for its resilience to extreme conditions such as high temperatures, drought, and saline soils. Widely distributed across the globe, it is considered an invasive weed in some areas but is cultivated as a valuable vegetable in others. It has exceptional nutritional properties, containing omega-3 fatty acids, vitamins (A, C, B), minerals (iron, calcium), and bioactive compounds like flavonoids and polyphenols, which offer health benefits, including anti-inflammatory and antioxidant effects. Purslane is currently being researched as a potential crop for sustainable agriculture and functional food production. Given its ability to thrive in challenging conditions, it is considered a promising crop that could help ensure future food security. The aim of this study was to evaluate qualitative and quantitative parameters of two purslane genotypes (commercial variety and a naturally occurring accession) cultivated as microgreens in controlled conditions and compare two different substrates - commercial rockwool and unconventional agar-perlite mixture substrate (10 % perlite). Seeds were pre-soaked, sown on top of the substrate, and cultivated in a phytotron chamber with controlled temperature, humidity, and lighting. Microgreens were harvested at the cotyledon stage (12 days post-sowing) by cutting the plants above the substrate. Fresh and dry biomass were measured, and the drying ratio. Length of aboveground part of the plants and root length was evaluated. Qualitative analysis included chlorophyll *a* and *b* quantification and total carotenoid content using spectrophotometry. Antioxidant activity of purslane microgreen plants was evaluated using three methods: DPPH, ABTS and FRAP assays. Results of the study demonstrate that the growth characteristics of purslane vary significantly based on the growing medium and genotype. Commercial purslane exhibited higher yields, drying ratios and longer aboveground part compared to wild purslane. Plants grown on agar-perlite substrate showed longer overall plant length and enhanced root development compared to rock wool. The highest levels of chlorophyll *a*, chlorophyll *b*, and total carotenoids were observed in wild-growing purslane cultivated on the agar-perlite substrate. Furthermore, the highest antioxidant activity was recorded in the commercially available purslane grown on the same substrate, although wild purslane on this substrate showed the lowest antioxidant activity. These findings suggest that substrate composition plays a crucial role in optimizing both the nutritional and antioxidant properties of purslane, with implications for its cultivation in functional food production and sustainable agriculture.

Key words: *purslane, microgreens, rockwool, agar, perlite, yield, quality*

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MINERAL COMPOUNDS IN BASIL SEEDS AS A FUNCTIONAL FOOD IN THE CONTEXT OF CLIMATE CHANGE AND SELENIUM BIOFORTIFICATION

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Climate change, particularly the gradual rise in temperatures, is creating new opportunities for cultivating thermophilic crops in the conditions of the Slovak Republic. One such example is basil (*Ocimum spp*.), which has traditionally been grown for its herbaceous parts. In recent years, however, favourable climatic conditions have enabled the plants to reach full seed maturity, making seed production viable. At the same time, basil seeds are gaining recognition as a functional food due to their content of biologically active compounds with proven medicinal and nutritional benefits. The present study was conducted as a one-year field trial at the Institute of Horticulture, Botanical Garden of the Slovak University of Agriculture in Nitra. The aim was to evaluate the effect of genotype and foliar selenium application (as sodium selenate, 50 g Se·ha^{-1}) on the content of selenium and selected macro- and microelements in the seeds of three basil genotypes: *Ocimum basilicum* 'Dark Green', *Ocimum basilicum* 'Cinamonette', and *Ocimum tenuiflorum* – Tulsi. The cultivation of plant material was carried out in accordance with modern agrotechnical practices of basil cultivation, with planting arranged in three rows of 10 plants per variety × variant (spacing 0.35 × 0.40 m); the plants were subsequently trimmed to promote the formation of multiple inflorescences and irrigated. The analysis of selected element concentrations was performed using inductively coupled plasma optical emission spectrometry (ICP-OES) on a dual-view iCAP7600 instrument (Thermo Scientific, USA). The study focused on selenium biofortification potential as well as its interaction with other nutritionally important minerals. Selenium fortification had a positive significant effect ($p > 0.05$) on increasing the selenium content in basil seeds. The highest increase was observed in the 'Dark Green' variety, with selenium content rising from 0.078 to 0.823 mg·kg^{-1}. The content of macronutrients in the seeds ranged as follows: calcium (Ca) 1459.8–1914.2 mg/100 g, potassium (K) 818.8–1267.8 mg/100 g, magnesium (Mg) 460.0–571.2 mg/100 g, and sodium (Na) 13.76–16.91 mg/100 g. Regarding micronutrients, iron (Fe) ranged from 5.5 to 22.1 mg/100 g, and zinc (Zn) from 5.8 to 7.0 mg/100 g. Genotypic variability had a significant effect ($P < 0.05$) on the content of all evaluated elements. Selenium treatment significantly influenced ($P < 0.05$) the levels of Ca, K, and Na, though the direction and intensity of the effect varied depending on the genotype. The impact on Mg was statistically insignificant ($P > 0.05$). While selenium application did not significantly affect the overall content of micronutrients across genotypes, in the case of Tulsi, it caused a notable 34% reduction in iron content (from 22.09 to 14.85 mg/100 g) and a slight increase in zinc by 7.8% (from 5.53 to 6.29 mg/100 g). These results highlight the potential of combining agrotechnical interventions (biofortification) with the benefits of changing climatic conditions to enhance the nutritional value of locally grown crops.

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Key words: *Ocimum, seeds, macronutrients, micronutrients, selenization*

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MONITORING SELECTED PHYSIOLOGICAL PARAMETERS IN RESPONSE TO STRESS REDUCTION IN THE PLANT

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Plant biostimulants are natural or synthetic substances that, when applied to plants or soil, can enhance the plant's growth, health, and overall performance. They work by improving the plant's ability to withstand stress, enhance nutrient uptake, and boost resistance to diseases. Biostimulants are often used to supplement traditional fertilizers and pesticides, aiming to improve plant productivity and sustainability in agriculture and horticulture. Physiological indicators measured in grapevine leaves are important information about the level of stress in the plant. In plant physiology, the PRI (Photochemical Reflectance Index) is a remote sensing index that provides insights into the photosynthetic activity of plants. It specifically measures the efficiency of photosystem II (PS II), which is involved in the process of photosynthesis. PRI is often used in plant health and productivity studies, especially in relation to how plants respond to environmental conditions. The xanthophyll cycle, which involves the pigments like zeaxanthin, plays an important role in photoprotection during photosynthesis. When plants experience high light intensity or stress, carotenoids, specifically xanthophylls, undergo reversible changes to dissipate excess energy. This process is linked to changes in the PRI values. Higher PRI values typically suggest that the plant is in a state of optimal photosynthetic activity because PS II is operating efficiently. Lower PRI values often indicate stress, which can be caused by factors like drought, heat, or nutrient deficiencies, as it reflects reduced photosynthetic efficiency due to altered xanthophyll cycling or other physiological responses. In the experiment, we focused on the application of Tecamin plant biostimulants to the blue grape variety Torysa. In total, we performed 5 measurements in the period from May 2024 to the end of August 2024. The lowest measured values and the highest stress in leaves were in all measurements in the control variant (-0.037±0.023; -0.053±0.007; 0.002±0.014; -0.051±0.028; -0.127±0.029), on the contrary, the highest values and the lowest stress in leaves were measured in variant I (-0.010±0.001; -0.033±0.007; -0.190±0.014) and variant II (-0.033±0.007 ; 0.005±0.010). The results confirmed the positive impact of plant biostimulators on reducing plant stress and thus contributing to improved photosynthesis. In the future, we propose to expand the results of the study to include other physiological indicators such as NDVI (Normalized Difference Vegetation Index) and LAI (Leaf Area Index).

Key words: *plant biostimulants, grapevine, leaves, plant physiology*

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PERCEPTION OF ICT IN SUSTAINABLE HORTICULTURE: EXPLORING THE CONTENT OF MOBILE APP USERS

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In the era of climate change and the growing need for rational management of natural resources, information and communication technologies (ICT) are becoming a key tool supporting the development of sustainable horticulture. Therefore, research into which ICT solutions can effectively promote sustainable horticulture is gaining importance. It is also essential to examine how these technologies are perceived by users, as expressed in the public online space. To guide the study, the research is structured around the following research questions: RQ1: Which information and communication technologies (ICT) are emerging as key tools supporting the development of sustainable horticulture? RQ2: What opinions about mobile applications and sustainable horticulture are expressed by users of these applications in the public online space? The study includes a review of selected mobile applications that support sustainable horticulture, considering their popularity and range of functionalities. Identified applications include those that enable the operation of smart irrigation systems based on IoT sensors, monitoring of environmental conditions, plant disease identification using artificial intelligence, as well as applications offering educational features and crop planning tools. The main goal of the study was to analyze user-generated comments and reviews from around the world, available in public online sources, related to mobile applications supporting the development of sustainable horticulture. The analysis was carried out using text mining methods, including topic modeling (Latent Dirichlet Allocation – LDA). This allowed for the identification of dominant themes appearing in discussions, such as: application usefulness, interface intuitiveness, data reliability, impact on gardening efficiency, and users' environmental awareness. The study also identified leading trends in ICT development within the horticultural sector and outlined key thematic areas perceived by users of horticulture-related mobile applications. The findings indicate that users recognize the potential of mobile apps as tools supporting a conscious and sustainable approach to gardening, while also pointing out limitations related to technical quality, limited functionality in free versions, and lack of adaptation to local climatic and soil conditions. Moreover, the analysis revealed that ICT applications serve not only a practical role but also an educational and motivational one, increasing user engagement in pro-environmental activities. The findings presented in the study may serve as inspiration for the further development of mobile applications and smart, environmentally friendly horticultural practices, both in the production and recreational sectors.

Key words*: ICT, mobile apps, text mining, LDA*

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THE ANTIMICROBIAL ACTIVITY OF *SANTALUM SPICATUM* ESSENTIAL OIL AGAINST PHYTOPATHOGENIC MICROORGANISMS ON THE BEETROOT AND PEACH MODEL *IN SITU*

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Phytopathogenic bacteria and microscopic filamentous fungi are considered plant disease agents and cause various diseases in many crops. These microorganisms have historically been responsible for major famines and widespread human suffering. Essential oils (EOs) are among the most important natural products derived from plants due to their diverse biological properties and medicinal and nutritional applications. However, the excessive use of synthetic chemical pesticides in agriculture has led to increased risks for humans, flora, and fauna. Additionally, the indiscriminate use of chemical pesticides has contributed to the development of resistance in phytopathogenic microorganisms. The aim of this study was to determine the antimicrobial activity of *Santalum spicatum* essential oil in the vapor phase. The oil was obtained through steam distillation of crushed wood purchased from Hanus s.r.o. Its main components were α-santalol, β-santalol, farnesol, and trans-α-bergamotol. The antimicrobial activity of *S. spicatum* EO was tested against the plant pathogenic bacteria *Agrobacterium radiobacter, Pectobacterium carotovorum, Pseudomonas syringae,* and *Xanthomonas arboricola*, as well as the microscopic filamentous fungi *Botrytis cinerea, Fusarium solani,* and *Monilia fructigena*, using beetroot and pear as model systems under *in vitro* conditions. The antimicrobial activity was assessed at concentrations of 500, 250, 125, and 62.5 µg/L. The highest inhibition among bacteria was observed against *X. arboricola* (95.67 %) on the beetroot model, while *B. cinerea* exhibited the highest susceptibility among fungi (89.76 %) at the lowest concentration. In the peach model, the strongest antimicrobial effect was recorded against *P. carotovorum* (94.53 %) and *B. cinerea* (91.26 %), mirroring the results observed in the beetroot model. The use of natural products or eco-friendly biopesticides offers a promising alternative to synthetic pesticides, reducing harmful impacts on human health and the environment. The transition to green chemistry processes, along with the continuous need to develop novel crop protection tools with unique mechanisms of action, has led to a growing interest in the discovery and commercialization of natural products as green pesticides. This approach is not only scientifically valuable but also commercially viable, highlighting significant opportunities for innovation in the field. In addition to their role as biopesticides, essential oils can also help extend the shelf life of cut fruits and vegetables.

Key words*: antimicrobial activity, phytopathogenic microorganisms, essential oil, vapor phase*

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