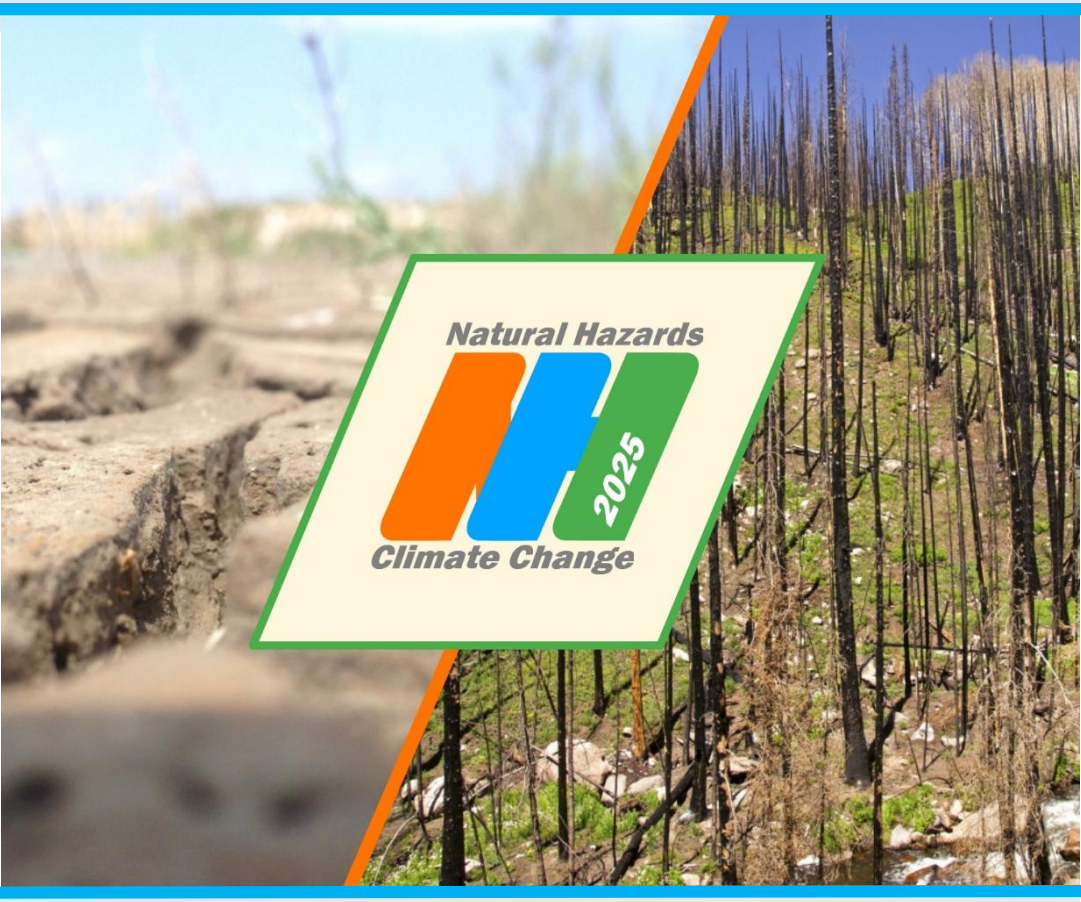
II. Natural Hazards and Climate Change Conference

International Conference for identifying and tackling challenges together

Book of Abstract



Szeged
21-23 May 2025

II. Natural Hazards and Climate Change

International Conference for identifying and tackling challenges together

Book of Abstracts

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NATIONAL RESEARCH, DEVELOPMENT AND INNOVATION OFFICE HUNGARY
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Evaluating unusual weather conditions in the past – a methodology and a visualisation platform

Márk Zoltán Mikes*, Roland Hollós, Zsuzsanna Dezső, Rita Pongrácz
Eötvös Loránd University, Institute of Geography and Earth Sciences, Department of Meteorology, Budapest, Hungary
*mikess@student.elte.hu

We present a methodology that can be used to evaluate past weather conditions and is based on the following principles: (1) the definitions of unusual phenomena must be based on relative thresholds and take into account seasonality; (2) the reference climatology must be spatially relevant; (3) the results should not be bound to specific calendar years or months; (4) unusual phenomena should be visualised simultaneously (to provide a compound framework). The expression “unusual” is used to describe anomalous values in contrast to the more commonly used “extreme”, because we aim to highlight periods with non-absolute weather extremes. As input, daily meteorological data available at 70 stations across Hungary from 2002 to 2024 are used to create the methodology, where a total of 9 unusual weather phenomena are defined using temperature, precipitation and wind gust as basic variables. The methodology serves as the meteorological basis for a science communication platform that combines complex information with simplicity through interactive visualisations. The described approach can serve as inspiration for further studies aiming to evaluate weather extremes in the past and for applications where specific information (regarding location or season) is required.

What can we learn about hail from laboratory studies?

Miklós Szakáll[1*], Alexander Theis[2]
[1]*University of Mainz, Germany;*
[2]*Max Planck Institute for Chemistry, Mainz, Germany*
[*]*szakall@uni-mainz.de*

Severe weather events including hail are responsible for damages in residential, industrial, and agricultural goods and cause hundreds of injuries and fatalities every year in Europe and worldwide. Furthermore, according to ICCP, extreme precipitation events are very likely to increase in rate and frequency in the next decades in Europe due to climate change. In spite of its importance, most of the atmospheric processes related to hail are not well understood. We have carried out laboratory studies in the vertical wind tunnel of the University of Mainz to explore the kinetics of hailstones and their melting behavior. Special focus was placed on the fall speed and its dependency on hailstone shape, size, and density. For that, a large set of hailstone replica of natural shapes has been printed out using 3D printing technique. Furthermore, the melting of hail was studied using spherical and natural hailstone shapes, which provided valuable information on whether hail reaches the ground in solid form or as rain.

Using ESA CCI Soil Moisture Data for Drought Characterization: Applications and Scientific Perspectives

Johanna Lems*, Pierre Laluet, Nirajan Luintel, Wouter Dorigo
Vienna University of Technology Department of Geodesy and Geoinformation, Vienna, Austria
**johanna.lems@geo.tuwien.ac.at*

Droughts are among the most challenging natural hazards to monitor, due to their slow onset, spatial heterogeneity, and far-reaching impacts across multiple sectors. Soil moisture is a key variable in understanding and detecting drought conditions, as it reflects the interplay between precipitation, evapotranspiration, and vegetation water uptake.

The ESA Climate Change Initiative (CCI) Soil Moisture dataset provides harmonized global observations dating back to 1978, derived from multiple passive and active microwave satellite sensors. It offers three main products—ACTIVE, PASSIVE, and COMBINED—each based on different sensor types and retrieval methods, and associated with specific uncertainty profiles. With daily observations at a 0.25° spatial resolution, it is a valuable and widely used resource for drought monitoring and analysis at multiple scales.

We have leveraged this dataset across several European reserch project, advancing both applied and methodological developments. Our findings demonstrate the strong potential of ESA CCI Soil Moisture data for drought research and early warning applications. However, challenges remain—particularly regarding spatial resolution and representativity in heterogeneous landscapes.

In our presentation, we provide an overview of the ESA CCI Soil Moisture product and show how it has been used in various drought applications developed at TU Wien, such as Clim4Cast. Additionally, we outline future developments aimed at aligning the dataset more closely with user needs, further enhancing its applicability for drought research.

OPTRAM model based plot-level soil moisture mapping using Sentinel-2 imagery

Gábor Mátyás Gubucz[1*], Boudewijn Van Leeuwen[2], Ferenc Kovács[1]
[1]*University of Szeged Department of Physical and Environmental Geography, Szeged, Hungary,*
[2]*Bay Zoltán Nonprofit Ltd. for Applied Research, Szeged, Hungary*
[*]*gubucz.gabor.matyas@stud.u-szeged.hu*

The OPTRAM (Optical Trapezoid Model) utilizes remotely sensed data to accurately deter-mine soil moisture by analyzing the linear relationship between the Normalized Difference Vegetation Index and transformed short-wave infrared values. Using this model, our aim was to map topsoil moisture at the plot-level on different soil surfaces. First, in situ measurements were carried out in spring 2020 with Spectrum FieldScout TDR 350 instrument on ground sur-faces at the same time of Landsat-8, Sentinel-2, PlanetScope satellite image acquisitions. The sentence related to the spectral indexes was adapted: Spectral index values were initially compared with in situ measurements collected concurrently to identify correlations and to determine the ratios of spectral bands for soil moisture estimation, but correlation coefficients were typically low (0.1-0.2), which indicates that none of the individual indices is sufficient for accurate soil moisture estimation. Using OPTRAM, the correlations significantly improved (0.7-0.8), particularly on bare soil surfaces. Model was then applied to Sentinel-2 data and compared with in situ data from three soil moisture monitoring stations in autumn 2023, re-sulting in a strong correlation (0.8-0.85). The OPTRAM based methodology demonstrates sig-nificant potential for remote sensing-based soil moisture determination and illustrates well time series variation improving the scalability and accuracy of drought monitoring while emphasizing the need for integrating soil properties context to enhance accuracy in plot-level analyses.

Impact of drought on the sustainable development of the border area of Serbia with Bulgaria

Marko Sedlak*, Nemanja Josifov, Vladimir Malinić
Faculty of Geography University of Belgrade, Belgrade, Serbia
**marko.sedlak@gef.bg.ac.rs*

The problem of drought is a big challenge and one of the problems, primarily in less developed and developing countries. The paper presents the theoretical framework of the effect of aridization on regional development, as well as the spatial aspect of its influence at the global level. The changes in the drought index and the differences in the border area between Serbia and Bulgaria were analyzed. In the paper, the methods of Lang's rain factor, De Marton's drought index and Pina combined index were used to obtain drought index values and identify regional differences based on available data at the meteorological stations of this territory (Negotin, Zaječar, Knjaževac, Pirot, Dimitrovgrad, Babušnica). The time frame of the research includes the period 1961–2020. By applying the standard deviation method, the ranking of dry and wet years was performed for each meteorological station individually. These data are related to the realization of certain goals of sustainable development: climate action (SDG 13), life on land (SDG 15), affordable and clean energy (SDG 7), zero hunger (SDG 2), good health and well-being (SDG 3), clean water and sanitation (SDG 6). In this context, their current and future impact on the economy, life and work of the population of this area was considered.

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Session 2 Environmental Stressors and Agricultural Sustainability

Rhizosphere under pressure: how plastics disrupt plant growth and soil health – *Gábor Feigl, Enikő Mészáros, Kamilla Kovács, Klaudia Hoffmann, Etelka Kovács, Katalin Perei, Attila Bodor*

Peptaibols: bioactive natural compounds with the potential to mitigate the adverse effects of climate change in agricultural crops – *Dóra Balázs, Chetna Tyagi, Tamás Marik, Gergő Terna, Fanni Kovács, Ákos Rozsnyói, András Szekeres, Mónika Varga, Csaba Vágvölgyi, Tamás Papp, László Kredics*

Exploring the role of microbial infections in walnut production decline – *Nóra Tünde Lange-Enyedi, Simang Champramary, Orsolya Kedves, Boris Indic, Attila Szűcs, Annamária Tüh, Árpád Bányi, Younes Rezaee Danesh, Omar Languar, Csaba Vágvölgyi, László Kredics, György Sipos*

The impact of global megatrends on microfungi in the Pannonian Biogeographical Region: a climate change perspective – *Donát Magyar, Zsófia Tischner, Anna Páldy, Sándor Kucsubé, Zsuzsanna Dancsházy, Ágnes Halász, László Kredics*

Black Soils of Eurasia: two-decade environmental analysis (2001-2022) – *Nándor Csikós, János Mészáros, Katalin Takács, Brigitta Szabó, Tamás Hermann, Éva Ivits, and Gergely Tóth*

Rhizosphere under pressure: how plastics disrupt plant growth and soil health

Gábor Feigl[1*], Enikő Mészáros[1], Kamilla Kovács[1], Klaudia Hoffmann[2], Etelka Kovács[2], Katalin Perei[2], Attila Bodor[2]
[1]*Department of Plant Biology, University of Szeged*
[2]*Department of Biotechnology and Microbiology, University of Szeged*
[*]*feigl.gabor@szte.hu*

Plastic pollution in terrestrial ecosystems is an emerging concern, particularly in agroecosystems where the rhizosphere – the narrow zone of soil surrounding plant roots – plays a central role in plant development, nutrient cycling, and microbial interactions. Despite the growing awareness of plastic contamination, the impacts of plastic particles on the early development of plants remain a relatively unexplored field, particularly with regard to species-specific responses and the physiological effects occurring at the level of the root. The objective of the research is to address a critical gap in understanding how both conventional and biodegradable plastic particles affect early plant growth and soil-related processes, with a focus on the biological consequences of plastic presence in the rhizosphere.

Using a semi-hydroponic screening system and soil-based rhizotrons, we investigated the effects of different types of plastic on several plant species. We quantified changes in germination rates and root elongation under different plastic fragment sizes and concentrations. The results show strong material- and species-dependent differences: certain plastics inhibited root growth in sensitive species such as radish, while others slightly stimulated root elongation in more tolerant species such as rapeseed. Biodegradable plastics were not necessarily harmless: in many cases, they exhibited inhibitory effects comparable to those of conventional polymers.

These findings suggest that plastic contamination may act as an abiotic stressor during early plant development, potentially affecting crop establishment and soil-plant-microbe interactions. As plastic inputs to soils continue to increase, from agricultural films to fragmented waste, their ecotoxicological impacts need to be integrated into sustainability frameworks for land management and agricultural policy. Our work highlights the urgent need for comprehensive risk assessments of both conventional and alternative plastics in soil ecosystems.

The project was supported by the National Research, Development and Innovation Office – NKFIH FK 142475. Project no. 2024-1.2.3-HU-RIZONT-2024-00010 has been implemented with the support provided by the Ministry of Culture and Innovation of Hungary from the National Research, Development and Innovation Fund, financed under the 2024-1.2.3-HU-RIZONT funding scheme.

Peptaibols: bioactive natural compounds with the potential to mitigate the adverse effects of climate change in agricultural crops

Dóra Balázs*, Chetna Tyagi, Tamás Marik, Gergő Terna, Fanni Kovács, Ákos Rozsnyói, András Szekeres, Mónika Varga, Csaba Vágvölgyi, Tamás Papp, László Kredics
University of Szeged Department of Biotechnology and Microbiology, Szeged, Hungary
dora.balazs91@gmail.com

Agriculture faces new challenges through increasing extreme weather conditions and the spread of new plant pathogenic microorganisms. The use of chemical pesticides can cause additional problems, thereby, new solutions are needed in biological plant protection. Trichoderma strains are already successfully used in practice. The raising temperature on agricultural fields due to climate change would require thermotolerant biocontrol strains of Trichoderma, however, this could result in the use of potential opportunistic human pathogens. To avoid this risk, bioactive compounds produced by thermotolerant Trichoderma strains could be used instead of the strains themselves. Peptaibols produced by them are small peptides characterized by variable amino acid composition and ion channel-forming ability. They have growth-inhibiting effects against several phytopathogenic bacteria and fungi, furthermore, they also exert beneficial effects on plants via induced systemic resistance. For future practical application of peptaibols it is also inevitable to gain a better understanding of their background mechanism of action by using computational molecular modeling techniques.

We investigated the peptaibol production of 12 Trichoderma strains using comprehensive methods. The produced peptaibols were determined using mass spectrometry. Peptaibol extracts were prepared using large-scale methods. The bioactivity of extracts was determined against 11 bacteria, as well as 6 phytopathogenic fungi. Structure of selected peptaibols produced in the largest percentages were investigated using accelerated molecular dynamics simulations. Comparing our laboratory and computational results revealed structure-activity relationships enabling to establish a rapid and targeted selection of bioactive peptaibol compounds. Our results may lay the foundation for the future practical application of peptaibol extracts, which can provide new alternatives in biological plant protection.

This work was supported by the Hungary–Serbia IPA Cross-border Co-operation Programme (project FERTILEAVES, HUSRB/23S/11/027) and by the Scholarship Program of the Ministry of Culture and Innovation, financed from the National Research, Development and Innovation Fund (EKÖP-24-4-SZTE-629 and EKÖP-24-4-SZTE-605).

Exploring the role of microbial infections in walnut production decline

Nóra Tünde Lange-Enyedi[1*], Simang Champramary[1], Orsolya Kedves[2], Boris Indic[1], Attila Szűcs[3], Annamária Tüh[4], Árpád Bányi[5], Younes Rezaee Danesh[6], Omar Languar[1], Csaba Vágvölgyi[2], László Kredics[2], György Sipos[1]

[1]Functional Genomics and Bioinformatics Group, University of Sopron, Hungary
[2]Department of Biotechnology and Microbiology, University of Szeged, Hungary
[3]Institute of Zoology, University of Innsbruck, Innsbruck, Austria
[4]Government Office of Zala County Plant Protection and Soil Conservation Unit, Zalaegerszeg, Hungary
[5]Pannon-Trade Ltd., Győr, Hungary
[6]Department of Plant Protection, Van Yuzuncu Yil University, Van, Turkey
[*]lange-enyedi.nora@uni-sopron.hu

Walnut (Juglans regia) production in Europe has declined in the recent years. Climate change and drought decrease the systemic stress response of plants and pose a synergistic effect on pathogen invasion. Several bacterial and fungal pathogens have emerged in Europe that damage walnut production, such as Xanthomonas arboricola pv. juglandis (bacterial blight, brown apical necrosis), Brenneria nigrifluens and B. rubrifaciens (canker), Ophiognomonia leptostyla (anthracnose), Fusarium, Alternaria (brown apical necrosis), Geosmithia morbida (thousand cankers disease), etc. Insects also play role in the transmission of infections as vector organisms. The aim of the study was to observe if there is a connection between the spreading of the pathogens and the walnut husk fly (Rhagoletis completa), the larvae of which hatch and develop inside the husk. The field samples were designed systematically to possibly uncover the primary microbial infectious process leading to the crucial weakening of the walnut tree resistance. To gain predictive insights, we collected infected walnuts from the trees, kept them on sterile, neutral soil, harvested the larvae and grew the flies. Furthermore, soil and phyllosphere samples from walnut plantations that were severely and less affected by walnut pathogens were collected in Hungary. 16S rRNA gene amplicon sequencing was performed on Oxford Nanopore MinIon platform showing that the bacterial community of the infected leaves and walnuts were shifted from unknown Cyanobacteriota (up to 100 %) to Pseudomonadota (up to 98.5 %). Stenotrophomonas and Pseudoxanthomonas had the highest relative abundance in the infected walnuts and these genera comprised the majority of the pupae grown in the lab, as well. The imagos' microbial communities showed higher diversity with abundant Brucella, Raoultella and Pseudomonas spp. Pseudomonas, Raoultella, Daeguia and Enterobacter were characteristic to the infected leaves.

This study was supported by the National Research, Development and Innovation Office (grant 2022-1.2.6-TÉT-IPARI-TR-2022-00009).

The impact of global megatrends on microfungi in the Pannonian Biogeographical Region: a climate change perspective

Donát Magyar[1*], Zsófia Tischner[2], Anna Páldy[1], Sándor Kucsubé[3], Zsuzsanna Dancsházy[5], Ágnes Halász[4], László Kredics[3]

[1]*National Public Health Center, Budapest, Hungary*

[2]*Hungarian University of Agriculture and Life Sciences, Department of Environmental Safety, Gödöllő, Hungary*

[3]*University of Szeged Department of Biotechnology and Microbiology Szeged, Hungary*

[4]*Ministry of Agriculture, Budapest, Hungary*

[5]*retired from National Food Chain Safety Office, Budapest, Hungary*

[*]*magyar.donat@gmail.com*

The European Environmental Agency (EEA) has set 11 global megatrends—slow processes that are hardly noticeable initially, but later cause long-term global effects—among which globalization, pandemics, technological advancements, and climate change exert major influence on microfungi in the vulnerable Pannonian Biogeographical Region. Globalization facilitates the introduction of fungal inocula through trade in tropical fruits, soil, and packaging materials, while technological developments create novel habitats for fungi in human surroundings, often under extreme environmental conditions. Climate change further accelerates the establishment of non-native fungal species in natural ecosystems, posing threats to human health, agriculture, and biodiversity.

To assess the effects of climate change on fungal communities, we conducted a controlled experiment exposing common fungal species—both endemic and introduced—to simulated heat waves under two climate scenarios: a moderate (RCP 4.5) and a strongly pessimistic (RCP 8.5) projection for July 2050. Results indicated that Aspergillus flavus, A. niger, A. tubingensis, and Fusarium spp., introduced from tropical regions, exhibited high heat tolerance, whereas native species such as Penicillium spp., Talaromyces spp., and Cladosporium spp. failed to grow under the extreme RCP 8.5 conditions.

Two years after this experiment, in 2024, airborne concentrations of A. flavus and A. niger in urban outdoor environments exceeded 3,000 and 5,000 CFU/m³, respectively. Additionally, a high prevalence of A. flavus and its mycotoxins was detected in cereal crops. These findings suggest that climate change-driven heat waves are facilitating the establishment and proliferation of invasive fungal species at an accelerated rate, underscoring the urgency of incorporating fungal risks into climate adaptation strategies.

Black Soils of Eurasia: two-decade environmental analysis (2001-2022)

Nándor Csikós[1*], János Mészáros[1], Katalin Takács[1], Brigitta Szabó[1], Tamás Hermann[2], Éva Ivits[3], Gergely Tóth[1,2]

[1]*Centre for Agricultural Research, Institute for Soil Sciences, Budapest, Hungary*

[2]*Institute of Advanced Studies, Kőszeg, Hungary*

[3]*European Environment Agency, LULUCF Data Integrition and Copernicus Land Monitoring, Copenhagen, Denmark*

[*]*csikos.nandor@atk.hun-ren.hu*

Black soils play crucial roles in maintaining global environmental and social systems, contributing significantly to world food production and balancing carbon in the earth-atmosphere system. Monitoring productivity and land cover changes in relation to other environmental variables is essential for understanding global processes and implementing timely actions.

In our study, we analysed environmental changes of Eurasian black soils from 2001 to 2021 using time series remote sensing-based datasets. The Eurasian region is vast and exhibits highly diverse environmental conditions across its different areas; therefore, we conducted our analysis by dividing the region into distinct bioregions. Understanding the factors influencing Gross Primary Productivity (GPP) is crucial for evaluating ecosystem health and productivity under changing environmental conditions. This study investigates the relationship between GPP and various environmental variables across multiple regions, focusing on spatial and temporal dynamics. We examined the following key variables: Fraction of Photosynthetically Active Radiation (FAPAR), Solar Radiation, Soil Water Content, Temperature, Evaporation, Precipitation, and Vegetation Period.

Results show productivity increases in Chinese and Mongolian black soils, contrasting with significant decreases in large areas of Kazakh black soils. Notably, among countries with extensive black soil coverage, Russia and Ukraine exhibit areas with both declining and increasing productivity trends, reflecting the complex interplay of environmental and agricultural factors within these regions

Our findings indicate that climatic factors predominantly influence both negative and positive productivity trends, while cultivation technology levels also contribute significantly in specific regions. Climate change emerges as the primary driver of land cover change on black soils, with the net loss of croplands being the most alarming trend. This loss displays a scattered spatial pattern across Eurasia but is most prominent in the drying regions of Kazakhstan and Russia.

Ensuring sustainable management of black soils is crucial for addressing food security, mitigating climate change, and promoting sustainable land use practices in the face of ongoing environmental challenges.

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Session 3 Climate-Health Nexus

Eco-Anxiety and Beyond: Understanding the Mental Health Dimensions of Climate Change – *Zsuzsanna Máté*

TÉR-EPI: a specialised spatial epidemiology system for monitoring population health at high resolution – *Attila Juhász, Csilla Nagy, Beatrix Oroszi*

Waterborne, water washed, water based and water-related diseases – *Barbara Nieradko-Iwanicka*

Climate change impacts on tourism in the 21st century: projections for Hungary and Szeged – *Attila Kovács, Gergely Molnár*

Consideration of climate change-related factors in vulnerability assessment frameworks for migrant health – *Zoltan Katz, Kia Goolesorkhi, Istvan Szilard, Erika Marek*

Artificial Intelligence and Machine Learning for Multi-Risk Assessment – *Adanu Peter Worlasi*

Eco-Anxiety and Beyond: Understanding the Mental Health Dimensions of Climate Change

Zsuzsanna Máté,
Department of Public Health, Albert Szent-Györgyi Medical School, University of Szeged, Szeged, Hungary
mate.zsuzsanna@med.u-szeged.hu

As climate change continues to reshape our world, its effects extend beyond environmental shifts, influencing public health in profound ways. One critical yet often overlooked aspect is the impact of climate change on mental health. Extreme weather events, displacement, and ecological disruption create a cascade of psychological challenges, from increased anxiety and depression to post-traumatic stress disorder (PTSD) in affected communities. The mental health consequences of climate change are particularly pronounced among vulnerable populations (children, the elderly, health care workers, etc.), who face disproportionate exposure to environmental stressors. There is increasing evidence that the climate crisis negatively affects mental health, leading to worse outcomes for individuals with pre-existing mental health conditions during climate-related disasters. This includes higher suicide rates and a general decline in mental well-being. People with conditions like schizophrenia and depression are at greater risk of dying during heatwaves. Additionally, some communities are facing ongoing grief and a heightened risk of disorders like post-traumatic stress disorder due to the frequency of extreme weather events. It is also of high importance shedding light on the rise in eco-anxiety—a growing phenomenon where individuals experience distress due to the uncertainty of the planet's future. There is a need for a multi-disciplinary approach in addressing these issues, with a focus on integrating mental health support into climate change adaptation and mitigation strategies. By prioritizing mental health in the climate change dialogue, we can foster more sustainable, adaptive societies that are better equipped to face the challenges of an increasingly unpredictable world.

TÉR-EPI: a specialised spatial epidemiology system for monitoring population health at high resolution

Attila Juhász*, Csilla Nagy, Beatrix Oroszi MD
National Laboratory for Health Security, Center for Epidemiology and Surveillance, Semmelweis University, Budapest, Hungary
*juhasz.attila@semmelweis.hu

Background: Systematic and ongoing collection, analysis, and interpretation of data on the population health status and its determinants is essential for the planning and evaluation of public health services and for health policy planning.
Results: Within the framework of the National Laboratory for Health Security, the Epidemiology and Surveillance Centre of Semmelweis University has developed and implemented the TÉR-EPI system to characterise and map the health status of the population, together with some determinants, by sex, age and study period, in a dynamic, interactive format. The spatial distribution of the selected indicators can be rapidly visualised at the county, district or municipality level, according to the user's needs (limited by data availability and statistical methodology).
The indicators are currently available in three modules: mortality; vital statistics, socio-economic status.
The map application shows the spatial distribution of indicators. It is complemented by a range of additional functions that allow users to examine the indicators for a given area and to track changes over time.
The profile function provides a quick summary of the health status of the population in a specified area for a selected group of indicators compared with the national average. In the case of mortality, the indicators have been aggregated over the last five years (by age group, sex, at the county, district, and municipality level), while in the case of vital statistics, indicators can be obtained for the last year available.
Summary: The TÉR-EPI has been developed to utilise the most recent geographic information systems and spatial epidemiological methods to describe and analyse the morbidity and mortality of the population at high resolution, with certain risk factors. TÉR-EPI can be used to develop local health plans and to monitor the effectiveness of interventions, including the evaluation of the medium- and long-term health impacts of the COVID-19 pandemic.

Waterborne, water washed, water based and water-related diseases

Barbara Nieradko-Iwanicka
Medical University od Lublin; Hygiene and Epidemiology Department, Lublin, Poland
barbara.nieradko-iwanicka@umlub.pl

Water is necessary for hygiene Water shortage and poor water quality cause waterborne diseases and water washed diseases. Floods and high humidity increase the risk for water-based diseases and water-related diseases. The aim of the presentation is to characterize the four groups of diseases. Waterborne diseases are transmitted through the direct drinking of water contaminated with pathogenic microorganisms. They are characterized by diarrhoea, often resulting to dehydration and possibly death. Water washed or water scarce diseases are those diseases which thrive in conditions with freshwater scarcity and poor sanitation. Control of water-washed diseases depends more on the quantity of water than the quality. Water washed diseases are: scabies, typhus, yaws, relapsing fever, impetigo, trachoma, conjunctivitis and skin ulcers. Four types of water-washed diseases are considered here: soil-transmitted helminthes, acute respiratory infections (ARI), skin and eye diseases, and diseases caused by fleas, lice, mites or ticks. Water-based diseases are infections caused by parasitic pathogens found in aquatic host organisms. These host organisms are: snails, fish, or other aquatic animal. Humans become infected by ingesting the infective forms or through skin penetration. Examples of water based diseases includes Schistosomiasis (cercariae released from snail, penetrate skin), Dracunculiasis (larvae ingested in crustacean), Paragonimiasis (metacercariae ingested in crab or crayfish) and Clonorchiasis (metacercariae ingested in fish). These diseases can be prevented through avoiding contact with contaminated water, or use of protective clothing or barrier creams. Insect vector-based diseases or water related diseases are caused by insect vectors which breed in or around water bodies. Humans become infected by being bitten by these insect vectors. However, consideration of vector control during the design, construction and operation of surface water reservoirs and canals can reduce the potential for water related disease transmission.

Climate change impacts on tourism in the 21st century: projections for Hungary and Szeged

Attila Kovács*, Gergely Molnár
Department of Atmospheric and Geospatial Data Sciences, University of Szeged, Szeged, Hungary
*kovacsattila@geo.u-szeged.hu

Climate change and associated natural hazards significantly impact the tourism and recreation sector, altering the suitability of locations and periods for various tourism activities. This study explores the future suitability of climate for outdoor tourism activities throughout the 21st century. The research focuses on analysing the impacts both at national (Hungary) and urban (Szeged) scale. Climatic conditions are assessed using two climate metrics that are relevant to tourism, and the spatial distribution of these indices is mapped on a monthly basis. For the analysis, outputs from various regional climate models, driven by different climate change scenarios, are utilized. Additionally, a high-resolution land surface model is employed for the urban-scale assessment. Future climatic conditions are described for the periods 2041–2070 and 2071–2100, with a reference period of 1971–2000.
The findings clearly show that climate change will significantly affect tourism potential in the studied regions. Specifically, from May to September, climatic conditions are expected to worsen, although the remaining months may offer more favourable conditions for tourism. A major contributing factor to the summer decline is the increasing occurrence of extreme daytime heat stress. Consequently, tourism strategies must account for this climatic hazard to a significant degree, independent of the scale under consideration.

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Consideration of climate change-related factors in vulnerability assessment frameworks for migrant health

Zoltan Katz*, Kia Goolesorkhi, Istvan Szilard, Erika Marek
Department of Public Health Medicine, University of Pécs, Pécs, Hungary
**katz.zoltan@pte.hu*

The negative impacts of global climate change are playing an increasingly important role in the global increase in refugee numbers. Complex environmental, economic and social impacts are increasing the propensity to migrate in many regions.

Climate refugees form a specific group of forced migrants. Although climate refugees are a non-existent legal category, but climate change has the potential to trigger or exacerbate the conflict situations responsible for displacement. Evidence-based action plans through international, multi-sectoral cooperation would be needed to mitigate the negative impacts.

The health and disease impacts of climate change have a multiple and excess burden on migrants. Migrants are the most vulnerable population, not only because of the increased disease burden due to climate change, but also because of the increased risk of diseases that already characterises certain phases of migration.

According to international recommendations, health and disease problems should be assessed on an individual basis before, during and after migration. For instance, different background may require different screening tests and vaccinations.

Although climate change does not provide a legal basis for climate refugees, a comprehensive picture requires the integration of climate-related factors into the vulnerability assessment frameworks for migrant health, since access to health and healthcare is a fundamental human right.

Our recommendations would be shared how the IOM's Determinants of Migrant Vulnerability Model, the UNHCR Screening Tool and the WHO Social Determinants of Health (SDH) Framework could be used to integrate climate change-related considerations and aspects.

Artificial Intelligence and Machine Learning for Multi-Risk Assessment

Adanu Peter Worlasi
Eötvös Loránd University, Department of Social and Economic Geography, Budapest, Hungary
peterworlasi@student.elte.hu

The increasing complexity of global risks spanning environmental hazards, healthcare uncertainties, financial instabilities, and cybersecurity threats requires innovative assessment methodologies. Artificial Intelligence (AI) and Machine Learning (ML) have emerged as transformative tools in multi-risk assessment, offering enhanced capabilities for predictive modeling, real-time monitoring, and automated decision-making. This paper explores the integration of AI and ML in risk assessment across various domains, including environmental management, healthcare systems, financial risk, and supply chain optimization. Using a systematic literature review approach, it evaluates the effectiveness of AI-driven solutions in improving risk prediction and management while addressing ethical considerations and challenges such as data bias, model interpretability, and regulatory compliance. Future recommendations emphasize advancements in explainable AI, improved data governance, and interdisciplinary collaborations to ensure the responsible and impactful application of AI and ML technologies.

II. Natural Hazards and Climate Change Conference

Session 4 Geohazards

Assessing luminescence sensitivity and ESR parameters as indicators of geomorphological processes in fluvial and aeolian settings – *Gergő Magyar, Alida Timar-Gabor, Aditi K. Dave, Dávid Filyó, Tamás Bartyik, Viktor Homolya, Gábor Bozsó, György Sipos*

Changes of the morphology of surface in the alluvial plane and loess plateau in the western part of Belgrade as a consequence of Pleistocene climate change and tectonic activity – *David Mitrinović, Marija Perović, Branislava Matić, Srđan Kovačević*

Sinkhole hazard in geoeducation: presentation of an online map – *Tamás Telbisz, László Mari*

Use of frequency ratio method and GIS for landslide susceptibility modeling: a case study in the South-Western part of Tajikistan – *Faizulloev Shohnavaz Abduqodirovich, Alamov Bekhruz Ahmadshoevich, Rahimbekova Manizha Rahmonbekovna*

The Influence of Mediterranean Hurricane Surges on Vertical Ground Motion Along the Southern Coast of Sicily, Italy – *FX Anjar Tri Laksono, János Kovács*

Paleotsunami records (?) and landscape reconstruction on the Western Black Sea coast (Mangalia) – *Alfred Vespremeanu-Stroe, Luminița Preoteasa, Mihai Ionescu, Laurențiu Țuțuianu, Mihaela Dobre, György Sipos*

Assessing luminescence sensitivity and ESR parameters as indicators of geomorphological processes in fluvial and aeolian settings

Gergő Magyar[1*], Alida Timar-Gabor[2,3], Aditi K. Dave[4], Dávid Filyó[1], Tamás Bartyik[5], Viktor Homolya[6], Gábor Bozsó[7], György Sipos[1]

[1]*Department of Physical and Environmental Geography, University of Szeged, Hungary*

[2]*Interdisciplinary Research Institute on Bio-Nano-Science, Babeş-Bolyai University, Cluj-Napoca, Romania*

[3]*Faculty of Environmental Sciences and Engineering, Babeş-Bolyai University, Cluj-Napoca, Romania*

[4]*Institute of Earth Surface Dynamics, University of Lausanne, Lausanne, Switzerland*

[5]*ELI-HU Nonprofit Kft., Szeged, Hungary*

[6]*Department of Computational Optimization, University of Szeged, Szeged, Hungary*

[7]*Department of Geology, University of Szeged, Szeged, Hungary*

[*]*magyar.gergo94@gmail.com*

In recent decades, electron spin resonance (ESR) and optically stimulated luminescence (OSL) methods have been increasingly applied to sediment provenance studies. While their combined use in age dating is common, the relationship between ESR and OSL parameters in provenance studies, particularly in comparing quartz grains across sediment types, remains understudied, as does the extent to which various factors influence these parameters. Here, the separability of sediments from different source areas and transport processes is investigated using parameters of the ESR (E'_1, Ti-h, peroxy, Al-h) and OSL (CW-OSL, Total LM-OSL, LM-OSL fast and medium component, 110°C TL) methods. Additionally, potential relationships between ESR and OSL parameters are explored to enhance the distinction of sediment samples based on their origin. Quartz grains from modern fluvial and paleo-aeolian sediments of the Pannonian Basin offer a valuable opportunity for these measurements.

Based on the measured samples, aeolian and fluvial sediments can be clearly distinguished by the mean values of E'_1, while the Ti-h parameter proved to be the most effective in differentiating between Danube and Tisza sediments. The strongest correlation between the two methods was observed between the E'_1 and the LM-OSL medium component. A linear downstream variation of the Al-h parameter is evident in both rivers, while a clear trend in the E'_1 and Ti-h parameters was observed only in the Tisza River. In the case of the luminescence parameters, in the upper Tisza, the LM-OSL fast component and CW-OSL sensitivity are similar to those of the Danube and lower than in the middle and lower sections. This downstream increase is driven by high-sensitivity quartz grains supplied by tributaries. In the case of the Danube a recurring increase can be observed instead. The observed variations in luminescence sensitivity are primarily attributed to erosion.

Keywords: luminescence sensitivity, sediment provenance, ESR parameters, coarse quartz grains

Changes of the morphology of surface in the alluvial plane and loess plateau in the western part of Belgrade as a consequence of Pleistocene climate change and tectonic activity

David Mitrinović[1*], Marija Perović[1], Branislava Matić[2], Srđan Kovačević[3]
[1]*Jaroslav Černi Water Institute, Belgrade, Serbia*
[2]*Educons University, Sremska Kamenica, Serbia*
[3]*Faculty of Technical Sciences, University of Novi Sad, Novi Sad, Serbia*
[*]*david.mitrinovic@jcerni.rs*

Within the Belgrade area north of Danube and Sava Rivers slow tectonic subsidence is accompanied by the fluvial, lacustrine and palustrine deposition. The constant tectonic lowering was accompanied by the fine floodplain material deposition during the period between two transitions, the thickness of which was increasing at the rate of tectonic lowering.

Their maximum surface elevation equals the river terrace along the alluvial plane of the Sava River near Belgrade – 73 m a.s.l. These deposits were fully or partially eroded down to the local base level (approximately 62 m a.s.l.) at the ends of glacial periods, and replaced to approximately 70 m a.s.l. by much coarser sediments – sandy gravel or sand. Cyclic climate changes caused the repeating of these processes, which together with tectonic lowering resulted in shortened cyclic deposits. The complete cycle is represented by Holocene sediments – last, youngest sedimentation cycle comprising floodplain silt and clay in the upper part, and well sorted riverbed sand at its lower part with the base at the elevation of approximately 62 m a.s.l., same as the elevation of the Sava River riverbed. In the tectonic block that stopped descending, on top of floodplain deposits, the aquatic loess-like sediments were deposited from 73 to 78 m a.s.l. forming the second terrace, or the base of loess.

Based on the results of absolute dating of aeolian, fluvial and glacial deposits a following sequence was derrived: before more than 700 ka a wide alluvial plain encompassed both Zemun and Batajnica areas west of Belgrade, then the tectonic blocks under Batajnica (farthest to the west) stopped subsiding at approximately 700 ka, the tectonic blocks under Zemun stopped lowering some 420 ka ago, with river staying within the subsiding blocks ever further to the east, in the ever-shrinking alluvial plane where new fluvial polycyclic sediments continued forming.

Sinkhole hazard in geoeducation: presentation of an online map

Tamás Telbisz*, László Mari
Department of Physical Geography, Eötvös Lorand University, Budapest, Hungary
**tamas.telbisz@ttk.elte.hu*

Most karst processes operate at a slow rate and have a long-term effect in creating the typical dissolution morphology including sinkholes (dolines) and subsurface features, such as caves. However, there are also some rapid processes, of which the most important are the collapse processes. It should also be mentioned that among the karstifying rocks, the dissolution of evaporites is an order of magnitude faster than that of carbonates. Due to the above factors, the most important geomorphological hazards associated with karsts are the formation of collapse sinkholes and the subsidence sinkholes typical of evaporite karsts. Nonetheless, hydrological hazards are also significant in karst areas, but this topic is not examined in this presentation. In addition to the above natural factors, human interventions (e.g. mining, dam construction) can also increase the karst hazards. In our study, a global database of hazards associated with the formation of sinkholes has been created based on the scientific literature and public media. Further on, an online map was created using this database. This map can be used in geoeducation, primarily in higher education, but due to its intuitive interface, it can provide any interested person with scientifically sound information and spatial knowledge on the issue of sinkhole hazard. In our presentation, we demonstrate the types of sinkhole hazards, present some type localities and show the characteristic geographical distribution of these phenomena.

Use of frequency ratio method and GIS for landslide susceptibility modeling: a case study in the South-Western part of Tajikistan

Faizulloev Shohnavaz Abduqodirovich*, Alamov Bekhruz Ahmadshoevich, Rahimbekova Manizha Rahmonbekovna
National academy science of Tajikistan Institute of Geology, Earthquake Engineering and Seismology, Dushanbe, Tajikistan
shohnavaz.faizulloev@mail.ru

South-Western part of Tajikistan is more propensity to landslide compared to other regions (North, North-East, Central and South-East). New land reclamation, housing and industrial construction in the landslide-prone areas require regional-scale landslide susceptibility mapping. A landslide susceptibility map illustrates future zones of potential landslide occurrence. Thus, predicting areas propensity to landslide, which has recently been accomplish through the landslide susceptibility modeling using the Geographic information system (GIS) technology, has become a fixture part of landslide risk reduction investigation. Taking into consideration information given above, the aim of this research is to conduct GIS-based landslide susceptibility modeling using the frequency ratio method. To carry out the landslide susceptibility assessment, a landslide inventory map containing 1024 landslide was composed through field investigation and the interpretation of Google Earth Pro satellite images. A digital elevation model extracted from USGS site and data from laboratory seismic hazard assessments were used to obtain landslide conditioning factors such as slope degree, slope aspect, curvature, precipitation, elevation, distance from river, distance from faults, PGA, TWI, SPI and distance from earthquake location to complete our resultant susceptibility map. It was explored that all the landslide causative factors have a spatial relation with training landslides. The landslide susceptibility map of the area interest was classified into five zones: very low, low, medium, high and very high. The quality of outcome map was assessed using ROC-curve, which calculates AUC (area under the curve) value. The results indicate an AUC of value 0,83, which according to the statistical characteristic of AUC, indicates very good model performance.

The Influence of Mediterranean Hurricane Surges on Vertical Ground Motion Along the Southern Coast of Sicily, Italy

FX Anjar Tri Laksono*, János Kovács
University of Pécs Department of Geology and Meteorology, Pécs, Hungary
*anjar93@gamma.ttk.pte.hu

Vertical land movement is an important aspect of coastal dynamics along the Mediterranean, influenced by both natural and human activities. One natural factor affecting coastal stability is storm-induced wave inundation. Storms occur annually in the Mediterranean, with the highest intensity in autumn. Besides regular storms, the region also experiences Medicane storms, which bring high waves and occur almost once a year. Sicily is one of the areas frequently impacted by both types of storms. This study examines the impact of Medicanes on vertical land movement along the southern coast of Sicily. The research uses interferometric TOPSAR analysis with the Sentinel Application Platform SNAP 8.0 to process Sentinel-1 satellite images from 2015 to 2021. The study compares medium-term vertical land movement from 2015 to 2020, annual displacement from 2020 to 2021, and vertical changes before and after Medicane Zorbas in September 2018 and Medicane Apollo in October 2021. The results show that vertical motion over the medium term, annually, and after Medicane Zorbas generally trends toward uplift. However, after Medicane Apollo, the southern coast of Sicily experienced subsidence between 0.005 and 0.06 meters. The findings indicate a relationship between storm-induced flooding and coastal subsidence. The different vertical land movements following Medicane Zorbas and Medicane Apollo are likely due to variations in storm paths. Medicane Zorbas moved toward the Ionian Sea, avoiding direct impact on Sicily. In contrast, Medicane Apollo traveled from North Africa across Sicily to Europe, causing significant coastal subsidence.

Keywords: interferometric, Sentinel-1, SNAP, subsidence

Paleotsunami records (?) and landscape reconstruction on the Western Black Sea coast (Mangalia)

Alfred Vespremeanu-Stroe[1,2*], Luminița Preoteasa[1,3], Mihai Ionescu[4], Laurențiu Țuțuianu[1], Mihaela Dobre[1,2], György Sipos[5]

[1] *GEODAR Research Group for Geomorphology, Geoarchaeology and Paleo-Environments, Research Institute of the University of Bucharest, Bucharest, Romania*

[2] *Faculty of Geography, University of Bucharest, Bucharest, Romania*

[3] *Sfântu Gheorghe Marine and Fluvial Research Station, University of Bucharest, Faculty of Geography, Sf. Gheorghe (Tulcea), Romania*

[4] *Callatis Archaeological Museum, Mangalia, Romania*

[5]*Department of Physical and Environmental Geography, University of Szeged, Hungary*

[*]*fredi@geo.unibuc.ro*

We present the first integrated sedimentological, paleoecological, geochemical, geophysical, and geomorphological evidence supporting a new hypothesis of multiple tsunami events along the southern Romanian coast, near the ancient site of Callatis (modern-day Mangalia), a Greek colony founded in the 4th century BC. Our combined geo-bio-chronological dataset confirms and enriches existing records—such as historical accounts—of past seismic activity and associated marine disturbances affecting the western Black Sea shoreline.

A multi-layered sandy package (also containing pebbles and thin layers of silts) was initially identified in a 40 × 15 x 1.6 m trench, then verified and analyzed based on a network of 9 sediment cores (up to 6 m long). These were retrieved from an almost horizontal surface, currently located at 8.5-9 m *a.s.l.* and 140-300 m inland from the coastline, north of the Romano-Byzantine wall of Calatis. The sand pack stands between 4.5 and 8 m *a.s.l.*, discordantly overlaying a silt and clay deposit infilling a karstic depression (sinkhole). The multi-proxy analyses and robust chronology based on both OSL and 14C dating allowed discrimination between several phases of landscape transformation since Antiquity, from the foundation of the Greek colony of Calatis to the end of the 20th century.

II. Natural Hazards and Climate Change Conference

Session 5 Plant Communities in Transition

Community changes caused by an invasive alien C4 grass, and a promising biocontrol tool to suppress it – *Alida Anna Hábenczyus, Csaba Tölgyesi, Róbert Pál, András Kelemen, Zoltán Bátori, Judit Sonkoly, Fanni Molnár, Kata Anna Bán, Kata Frei, Ádám Lőrincz, László Erdős, Zalán Czékus, Attila Ördög, Klára Terézia Kovács, Edina Tóth, Péter Török, Péter Poór*

Climate change-related decline of Robinia Pseudoacacia forests in Hungary: a microbiome analysis – *Boris Indic, Nóra Tünde Lange-Enyedi, Simang Champramary, Omar Languar, Attila Szűcs, Orsolya Kedves, Csaba Vágvölgyi, László Kredics, György Sipos*

Mapping the occurrence of Asclepias syriaca using AI methods based on geotagged landscape photographs – *Georgina Veronika Visztra, Péter Balázs, Ádám Makai, Ádám Katona, Márton Bence Balogh, Zalán Tobak, Péter Szilassi*

Stable carbon and oxygen isotope ratios in Norway spruce (Picea abies (L.) Karst.) tree rings along an elevation gradient in the Rarău Mts (Romania) – *Daniela Maria Llanos-Campana, Zoltan Kern, Ionel Popa, Aurel Perșoiu*

Sown wildflower strips in urban areas–a strategy to enhance biodiversity of arthropods – *Botond Magyar, Anna Viola Nagy, Helga Simon, Attila Torma*

Community changes caused by an invasive alien C4 grass, and a promising biocontrol tool to suppress it

Alida Anna Hábenczyus[1*], Csaba Tölgyesi[1], Róbert Pál[2], András Kelemen[3], Zoltán Bátori[3], Judit Sonkoly[4], Fanni Molnár[3], Kata Anna Bán[3], Kata Frei[3], Ádám Lőrincz[3], László Erdős[4], Zalán Czékus[5], Attila Ördög [5], Klára Terézia Kovács[5], Edina Tóth[4], Péter Török[4], Péter Poór[5]

[1]MTA-SZTE 'Momentum' Applied Ecology Research Group, University of Szeged, Szeged, Hungary

[2]Department of Biological Sciences, Montana Technological University, Butte, Montana, USA

[3]Department of Ecology, University of Szeged, Szeged, Hungary

[4]HUN-REN-UD Functional and Restoration Ecology Research Group, Debrecen, Hungary

[5]Department of Plant Biology, University of Szeged, Szeged, Hungary

[*]alidaanna@gmail.com

Invasive alien species pose a dreadful threat to natural ecosystems and their ecological functions. In particular, invasions of C4 perennial grasses promoted by global warming are of outstanding hazard. Here we evaluated stands of Sporobolus cryptandrus in its native North American range and its non-native European range, where it is a recent invader. Our aim was to reveal how the species' increasing abundance affects functional diversity and the ecosystem service-provisioning capacities of plant communities in each range. We also tested the effects of Odontites luteus, a native European hemiparasite, on Sporobolus, as a potential biocontrol agent. We found that increasing Sporobolus cover resulted in a lower functional diversity and species richness, reduced average specific leaf area and increased the average height of the plant communities in both ranges but these effects were significantly stronger in the non-native stands. Sporobolus also negatively affected the cover of insect-pollinated plant species and the proportion of native perennials, switching the rest of the community from perennial-dominated to annual-dominated. Thus, the spread of Sporobolus, away from its native range, leads to the impoverishment of host communities and compromises the biomass and floral resource-provisioning capacity of the vegetation to pollinator communities. Our results also showed that Odontites considers Sporobolus a suitable host and reduces its biomass production (and potentially its competitive ability) by approx. 50%, equalling the effect on Festuca vaginata, i.e. the major native host of Odontites. However, Festuca showed severe metabolic impairment under hemiparasite pressure. So, the application of hemiparasites is a promising biocontrol tool against Sporobolus, but we cannot expect a full eradication of it. Rather, thinning monodominant Sporobolus stands to allow certain populations of native species to come back is a more realistic goal, leading to a partial recovery of the former species composition and an improvement of ecosystem functions.

Climate change-related decline of Robinia Pseudoacacia forests in Hungary: a microbiome analysis

Boris Indic[1*], Nóra Tünde Lange-Enyedi[1], Simang Champramary[1], Omar Languar[1,2], Attila Szűcs[3], Orsolya Kedves[2], Csaba Vágvölgyi[2], László Kredics[2], György Sipos[1]

[1]*University of Sopron, Functional Genomics and Bioinformatics Group, Sopron, Hungary;*

[2]*University of Szeged, Department of Biotechnology and Microbiology, Szeged, Hungary*

[3]*Institute of Zoology, University of Innsbruck, Innsbruck, Austria*

[*]*indic.boris@uni-sopron.hu*

Robinia pseudoacacia trees are a significant part of the forestry landscape in Europe, specifically in Hungary, where they cover some 23% of the forest area. They have significant economic and ecological roles, as they are important timber and fuelwood sources, crucial for honey production, while also aiding in nitrogen fixation and erosion control. However, a significant decline in tree health and productivity, possibly associated with climate changes, has been exhibited in recent years. This study investigates the potential biotic factors that could be contributing to this trend, focusing on the application of microbiome analysis in order to identify pathogenic agents. While the trees do not exhibit any external manifestations of disease, deeper investigations revealed internal trunk rot, thus suggesting a hidden pathology. To understand the full scope of fungal and bacterial communities within affected trees, high-throughput sequencing of the microbiome was employed. Specifically, samples were collected from both healthy and infected areas of Robinia pseudoacacia tree trunks, the center of the trunk and the underbark. DNA was extracted, and the 16S rRNA gene region was amplified and sequenced using Oxford Nanopore MinIon. The results showed generally low abundance of microbial communities in all samples except for the one coming from the center of the infected trunk. However, the primarily soil-dwelling bacteria, Alloacidobacterium, Bradyrhizobium, Paraburkholderia, were present across multiple samples regardless of infection status. In addition to these, several genera known to include potential plant pathogens were identified, such as Streptomyces, and Curtobacterium, primarily within the infected trunk center. These findings suggest a complex microbial community, with potential roles for both opportunistic and pathogenic bacteria in the observed decline. This approach, in conjunction with targeted sampling of healthy and infected trunk locations, aims to characterize the microbial communities associated with the observed decline and identify potential pathogenic agents.

Mapping the occurrence of Asclepias syriaca using AI methods based on geotagged landscape photographs

Georgina Veronika Visztra[1*], Péter Balázs[2], Ádám Makai[2], Ádám Katona[2], Márton Bence Balogh[1], Zalán Tobak[1], Péter Szilassi[1]

[1]*Department of Physical and Environmental Geography, University of Szeged, Szeged, Hungary*

[2]*Department of Image Processing and Computer Graphics, University of Szeged, Hungary*

[*]*myosotis.sylvatica12@gmail.com*

Invasive plant species are becoming increasingly widespread worldwide, making the mapping of their occurrence ever more important. However, collecting high-quality occurrence data presents a significant challenge, primarily due to the considerable time and financial resources required. Therefore, artificial intelligence- based image recognition models are gaining popularity for species identification from photographs. Nevertheless, it is essential to consider the diverse features of the images being analyzed and to select and train the image recognition model accordingly. The accuracy of photo recognition depends on various factors, including the dataset used for training, the quantity of available data, and its characteristics (e.g., a close-up photograph of the target species versus a landscape image).

In this study, we evaluated the efficiency of two AI-based image recognition models in identifying the invasive plant species Asclepias syriaca using the EUROSTAT Land Use and Coverage Area Frame Survey (LUCAS) image database. We developed a YOLO-based image recognition model, trained specifically on landscape photographs from the LUCAS database that had been pre-tagged with the target species. This model was compared to the Pl@ntNet image recognition model, which was trained on specifically targeted close-up photographs.

The results indicate that while the YOLO model recognizes Asclepias syriaca in landscape photographs with high efficiency, it also generates a high number of false positives. In contrast, the Pl@ntNet model shows lower efficiency, recognizes less instances of the target species but produces significantly fewer false detections. These findings suggest that while neither image recognition model can completely substitute human validation in landscape image selection, specialized models can significantly accelerate the process.

Stable carbon and oxygen isotope ratios in Norway spruce (Picea abies (L.) Karst.) tree rings along an elevation gradient in the Rarău Mts (Romania)

Daniela Maria Llanos-Campana[1*], Zoltán Kern[2], Ionel Popa[3,4], Aurel Perșoiu[5,6]
[1]*Doctoral School of Environmental Sciences, Eötvös Loránd University, Budapest, Hungary*
[2] *Institute for Geological and Geochemical Research, HUN-REN Research Centre for Astronomy and Earth Sciences, Budapest, Hungary*
[3] *National Institute for Research and Development in Forestry Marin Dracea, Campulung Moldovenesc, Romania*
[4] *Center of Mountain Economy -INCE - CE-MONT Vatra Dornei, Romania*
[5]*Emil Racoviţă Institute of Speleology, Romanian Academy, Cluj-Napoca, Romania*
[6]*Stable Isotope Laboratory, Ştefan cel Mare University, Suceava, Romania*
[*]*dani-llanos@student.elte.hu*

The application of stable isotopes such as δ13C and δ18O has opened new opportunities to expand our knowledge across various fields, including geochemistry, environmental sciences, paleoclimatology, ecology, and others. In paleoclimatology, these isotopes help to reveal climate data stored in proxies like tree rings.
Based on this, samples of Norway spruce (Picea abies (L.) Karst.) were collected along an altitudinal gradient in Rarău Mts in Romania to correlate the δ13C and δ18O signal in α-cellulose with Tmax, Tmin and precipitation amount. The aim of this study is to assess whether the plant physiological information documented in the isotopic composition of cellulose can provide insights into the environmental sensitivity of spruce populations, considering the local conditions at different altitudes.
After extracting α-cellulose from tree rings and measuring the isotopic composition, these data were correlated with environmental variables. The results from the individual series indicate a decrease trend in the mean δ18O value with increasing altitude, suggesting influences from factors such as source water composition, precipitation, and evaporative enrichment. However, mean δ13C values did not follow this trend, implying the impact of local factors like water stress and light exposure. Correlation analysis shows a negative relationship between δ18O value and summer precipitation which decreased with altitude, while the positive influence of growing season temperature increases at higher elevations, inferring that water availability becomes less important, and temperature plays a larger role near the timberline. A positive correction of δ13C and temperature during the growing season suggests stomatal conductance during dry conditions, while the negative correlation with temperature at higher altitudes may reflect relative humidity effects.
In conclusion, the findings emphasize the role of temperature and water availability in shaping the physiological responses of plants in response to climate variability, making it important to know how this could affects them.
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Sown wildflower strips in urban areas–a strategy to enhance biodiversity of arthropods

Botond Magyar[1*], Anna Viola Nagy[1], Helga Simon[1], Attila Torma[1,2]
[1]Department of Ecology, University of Szeged, Szeged, Hungary
[2]Lendület' Landscape and Conservation Ecology, Institute of Ecology and Botany, HUN-REN Centre for Ecological Research, Vácrátót, Hungary
[*]magyarbotond07@gmail.com

Urbanization is a global phenomenon which, through its many processes, can negatively alter urban ecosystems, with potential adverse effects on arthropod assemblages. Such effects include the fragmentation and degradation of natural and semi-natural habitats, the presence of various pollutants, the urban heat island effect (UHI). In addition, the high degree of built-up areas limits the arthropods movement between the remaining habitat patches, thus affecting many biotic interactions. A potential attempt to mitigate these negative effects is the establishment of sown flower strips, which through their diverse set of plant species, may help the survival of arthropods in these urban habitats. They can provide food base, shelter and overwintering sites to several arthropod groups, they also provide favorable microclimatic conditions through their shading activity, increasing connectivity between habitat patches.

In our current research, we investigated the extent to which these small habitats can support urban arthropod communities in twenty flower strips planted with a commercial seed mixture throughout the city of Szeged. Based on our preliminary results, we found significant differences in the number of species and individuals of pollinators and phytophagous insects between the flower strips and control sites, which clearly shows that these flower strips are indeed capable of maintaining a diverse arthropod community in urban environment.

II. Natural Hazards and Climate Change Conference

Session 6 Health, Hazards and Awareness

Role of public health in addressing emerging natural hazards – *Tamás Pándics*

Impact of Urban Green Spaces on Heatwave Mitigation in a Medium-Sized City – *Nóra Skarbit, János Unger, Tamás Gál*

Enhancing Climate Change Awareness in Medical Education: Assessing the Impact of CLIMATEMED Workshops in Serbia – *Darinka Korovljev, Bojana Harrison, Marijana Ranisavljev, Valdemar Stajer, Nikola Todorovic, Dragan Milosevic, Borislav Tapavički, Sergej M. Ostojic*

Impact of Seasonal Heating and the COVID-19 Pandemic on PM10 Levels in European Cities – *Seyedehmehrmanzar Sohrab, Péter Szilassi*

The Occupational Health and Safety of Climate Migrants through Accelerating Co-Innovation Capacity Building: A Conceptual Paper – *Kia Goolesorkhi, István Szilárd*

Non-Expert Understanding of Hazard Maps: An Eye-Tracking Study – *Solmaz Mohadjer, Gökce Ergün, Max Schneider, Tom Schürmann, Michael Pelzer, and Peter Dietrich*

Role of public health in addressing emerging natural hazards

Tamás Pándics
National Center for Public Health and Pharmacy / WHO Collaborating Center on Environmental Health Risk Management
pandics.tamas@nngyk.gov.hu

Environmental health is a multidisciplinary field addressing the health impact of physical, chemical and biological environmental stressors and the means of risk mitigation. Looking back to the past decades, the fundamental role of environmental health in improving health conditions of the population, increasing life expectancy is obvious. Drinking waterborne outbreaks have practically disappeared, toxic compounds, such as lead and other heavy metals or carcinogenic substances in retail products are strictly controlled and regulated and the quality of urban environments have also improved. In spite of stronger and wider environmental protection regulation, monitoring and large-scale environmental protection and remediation programs, the environmental burden of disease remains significant (approx. 12-20%). Among children (age group 0-18 years), one-third of the total disease burden is attributable to unsafe or unhealthy environment. The mandate of environmental health is unchanged, but the approach needs to change to address emerging challenges from the multifaced impacts of climate change to the geological hazards of water quality. Adequate response strategies to climate change include reducing excess morbidity and mortality of heatwaves through early warning and corresponding adaptation plans or reducing biological risk associated with ragweed pollen dispersion and other allergens. Combatting infectious diseases associated with climate change (e.g. vector-borne diseases) and the drinking water quality improvement programs targeting geological arsenic in many drinking water sources were and still are important means of health protection. Protection against natural hazards became an integrated part of public health action. The National Center for Public Health and Pharmacy has a coordinative role in this action, through providing guidance and support. The internationally recognized outstanding achievements of NCPHP lead to the establishment of the WHO Collaborating Centre on Environmental Health Risk Management under its auspices. The Collaborating Centre offers health protection strategies towards continuously changing and emerging challenges.

Impact of Urban Green Spaces on Heatwave Mitigation in a Medium-Sized City

Nóra Skarbit*, János Unger, Tamás Gál
University of Szeged, Department of Atmospheric and Geospatial Data Sciences, Szeged, Hungary
*skarbitn@geo.u-szeged.hu

In response to increasing urban populations and climate change, this study examines the role of urban green spaces in mitigating human heat stress during heatwaves in Szeged, Hungary. Utilizing the MUKLIMO_3 micro-scale climate model and the Klima-Michel model's perceived temperature (PT) result, the research evaluates the impact of diverse vegetation types, densities, and placements on thermal comfort. The analysis, grounded in the Local Climate Zone (LCZ) system, explores the effects of added vegetation and protective forests on daytime and nighttime thermal load. Findings reveal that strategically implemented dense urban greenery can significantly reduce PT, achieving cooling effects of 2-3 °C in localized areas during daytime heatwaves. However, the study also highlights the potential for dense vegetation to obstruct airflow, resulting in localized warming of 1-3 °C in downwind regions. Furthermore, the impact of green spaces on nighttime temperatures is complex, certain patterns may increase heat trapping. This research represents city-wide human comfort simulations, demonstrating the nuanced relationship between urban vegetation and thermal comfort. The findings underscore the importance of considering microclimatic factors, including regional wind patterns, during urban green space development. Strategic planning, coupled with appropriate access to green spaces, is crucial for enhancing city resilience to climate change and optimizing green infrastructure for maximum cooling benefits. This study contributes to a deeper understanding of urban greenery's microclimatic benefits, particularly in medium-sized cities, and provides a framework for future urban climate modeling using the LCZ system for thermal comfort optimization.

Enhancing Climate Change Awareness in Medical Education: Assessing the Impact of CLIMATEMED Workshops in Serbia

Darinka Korovljev[1,2*], Bojana Harrison[1,2] Marijana Ranisavljev[1,2], Valdemar Stajer[1,2], Nikola Todorovic[1,2], Dragan Milosevic[2,3], Borislav Tapavički[4], Sergej M. Ostojic[1,2]
[1]Faculty of Sport and Physical Education, University of Novi Sad, Serbia
[2]Center for Health, Exercise and Sport Science, Belgrade, Serbia
[3]Meteorology and Air Quality Section, Wageningen University & Research, Wageningen, Netherlands
[4]Faculty of Medicine, University of Novi Sad, Serbia
[*]darinka.korovljev@chess.edu.rs

Climate change presents a significant challenge in Serbia, particularly in the healthcare sector, where there is a notable gap in formal education about its impacts. This study aimed to enhance awareness and capacity regarding climate change through workshops across project partner countries, including Serbia. Methods: The study employed a mixed-methods approach, gathering qualitative data through World Café workshops with medical students, and academic staff from the University of Novi Sad, and practicing physicians from the Health Center of Novi Sad and quantitative data via online questionnaires from 150 participants (36 students, 23 academics, and 91 physicians). We assessed their awareness, existing knowledge, and attitudes towards integrating climate change into medical curricula. Results: Analysis revealed a significant awareness gap: 50% of medical students, 34.8% of academics, and 39.6% of physicians reported no formal education on climate change impacts. Students strongly advocated including climate-related topics in pre-clinical courses, favoring interactive workshops and fieldwork. Furthermore, academics and physicians emphasized the necessity for multidisciplinary collaboration and resource availability for effective curriculum reform. Discussion: These findings underscore the urgent need for comprehensive curriculum reform in medical education. The goal is to equip healthcare professionals with essential knowledge about climate change. Collaborative efforts between medical schools and climate experts are vital for developing high-quality educational resources. Conclusions: Integrating climate change education within medical curricula is crucial for preparing healthcare professionals to address emerging public health challenges. The CLIMATEMED initiative demonstrates effective collaborative learning and offers a promising pathway to enhance climate-related education in Serbia's healthcare system.

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Keywords: Climate change, health, medical education, Serbia, curriculum, healthcare professionals, knowledge gap, educational interventions.

Impact of Seasonal Heating and the COVID-19 Pandemic on PM_{10} Levels in European Cities

Seyedehmehrmanzar Sohrab[1,2*], Péter Szilassi[1]
[1]*Department of Physical and Environmental Geography, University of Szeged, Szeged, Hungary*
[2]*Department of Soil Mapping and Environmental Informatics, HUN-REN Centre for Agricultural Research Institute for Soil Sciences, Budapest, Hungary*
[*]*mehrmanzar_sohrab@geo.u-szeged.hu*

The COVID-19 pandemic significantly altered human activities, leading to substantial changes in air pollution levels worldwide. This study examines temporary variations in PM_{10} concentrations across three distinct periods: pre-COVID (2018–2019), Pandemic (2020–2021), and post-COVID (2022–2023), within different Heating Degree Day (HDD) groups (Cold, Mild, and Temperate). Utilizing the Kruskal-Wallis test, we identified statistically significant differences in PM_{10} levels across these periods for all HDD groups. Pairwise comparisons confirmed notable period-to-period variations, particularly in the Temperate HDD group, where air quality fluctuations were most pronounced. PM_{10} concentrations were analyzed by season, dividing the year into Heating and Non-Heating periods based on the heating (HDD)and Cooling (CDD) degree days. Cold countries, mainly developed countries such as Norway, Sweden, Finland, and Iceland, exhibited the lowest mean PM_{10} concentrations during Heating periods. This is likely due to advanced heating technologies, stricter environmental regulations, and the widespread use of cleaner energy sources. The Temperate HDD group, including countries such as Germany, Hungary, Poland, Romania, etc, exhibited the most pronounced fluctuations in PM_{10} levels, with a notably high effect size (η^2 = 1104), suggesting a heightened sensitivity to pandemic-induced activity shifts, including changes in industrial activities and mobility restrictions. These findings underscore the critical importance of robust air quality control, particularly in regions with higher heating demands.

Keywords: PM; Heating Degree Days, COVID-19, Air Quality, Seasonal Variations

The Occupational Health and Safety of Climate Migrants through Accelerating Co-Innovation Capacity Building: A Conceptual Paper

Kia Goolesorkhi*, István Szilárd
University of Pécs, Department of Public Health Medicine, Pécs, Hungary
**kia.goolesorkhi@aok.pte.hu*

The Occupational Health and Safety of Climate Induced Labor Migrants has been recognized as a main pillar of resiliency policy planning, underlining the need for newer ways of stakeholder collaboration. In line with same „research and academia" have contributed to the development of tools for assisting the „employers" and in many incidences the Migrant Workforce.
The current conceptual paper is an attempt to contribute to the on-going research through proposing newer methods of accelerating co-innovation across sectors in order to achieve resilience at the level of the labor, the employers and the community.
The study has used methods of Appreciative Inquiry, Circular Economy and the Quintuple Helix 6.0 for building Co-Innovation Platforms contributing to multi-task development using prediction tools.
Conclusions of the mentioned models show relevance in this field.

Non-Expert Understanding of Hazard Maps: An Eye-Tracking Study

Solmaz Mohadjer*, Gökce Ergün, Max Schneider, Tom Schürmann, Michael Pelzer, and Peter Dietrich
*solmaz.mohadjer@gmail.com

We investigate how well hazard maps are understood and interpreted by non-expert audiences. We tested two earthquake hazard maps of Germany that differ in color palettes (rainbow vs. colorblind-friendly and perception-optimized yellow-orange-red-brown color palettes) and data classification schemes (algorithmic Fisher vs. quasi-logarithmic classification schemes). We showed both maps to 18 non-expert participants during the 2024 Science & Innovation Days (a public engagement event) in Tübingen, Germany. Participants answered map-reading and hazard perception questions while their eye movements were monitored with eye-tracking software. The results indicate the following tendencies in the data: (1) the map reading accuracy appears to be higher for the redesigned map, (2) the redesigned map focuses the users' eye movements more on the high hazard zones and the corresponding values on map legend, and (3) both maps are indistinguishable in how they improve users' hazard perceptions. These tendencies encourage the repetition of the study with a larger sample size.

II. Natural Hazards and Climate Change Conference

Session 7 Challenges of Water Management in a Changing Climate

Simplicity or complexity? Identifying the optimal approach for flood hazard mapping – *Kaveh Ghahraman, Fatemeh Nooshin Nokhandan, Balazs Nagy*

Advanced Mapping and Integrity Assessment of Artificial Levees Using Machine Learning–Driven Electrical Resistivity Tomography for Natural Hazard Risk Analysis – *Diaa Sheishah, Enas Abdelsamei, Ahmed M. Ali, György Sipos*

Cross-comparison of national drought monitoring products in Central Europe using a new drought impact database – *Nirajan Luintel, Piet Emanuel Bueechi, Johanna Lems, Wouter Dorigo*

Inappropriate land use and vegetation cover: water scarcity in the climate-affected lowland regions of Hungary – *Benedek György Tóth, Zoltán Bátori, Alida Anna Hábenczyus, András Kelemen, Kata Frei, Orsolya Valkó, Balázs Deák, Csaba Tölgyesi*

The impact of climate change on the thermal stratification of a shallow polymictic lake – *Sebestyén Török, Péter Torma*

Droughts and floods: monitoring, prediction and artificial intelligence in the Hungarian Water Management – *Zoltan Liptay*

Simplicity or complexity? Identifying the optimal approach for flood hazard mapping

Kaveh Ghahraman*, Fatemeh Nooshin Nokhandan, Balazs Nagy
Department of Physical Geography, Eötvös Loránd University, Budapest, Hungary
**Kavehghahraman68@gmail.com*

Floods are among the most devastating natural hazards worldwide, and their frequency and intensity have increased due to climate change. Identifying flood-prone areas is crucial for effective risk mitigation and management. Various methodologies have been employed for flood hazard mapping, utilizing different types of data. In recent years, Synthetic Aperture Radar (SAR) data and machine learning algorithms have gained popularity due to their capability to analyze complex flood patterns. However, these approaches present significant challenges, including data preprocessing complexities and computational demands. Alternatively, simpler methods relying solely on Digital Elevation Models (DEMs) offer a more accessible means of flood hazard assessment. This study aims to compare three different approaches to flood-prone area identification, each with distinct data requirements: DEM-based analysis, SAR data utilization, and an integrated approach combining multiple data sources. By evaluating the strengths and limitations of each method, this research seeks to determine the most effective approach for flood hazard mapping, balancing accuracy, data availability, and computational efficiency. The findings will provide valuable insights for researchers and policymakers in selecting the most suitable methodology for flood risk assessment and management.

Advanced Mapping and Integrity Assessment of Artificial Levees Using Machine Learning–Driven Electrical Resistivity Tomography for Natural Hazard Risk Analysis

Diaa Sheishah*, Enas Abdelsamei, Ahmed M. Ali, György Sipos
Department of Physical and Environmental Geography, University of Szeged, Szeged, Hungary
**geo_diaa@nriag.sci.eg*

As climate change intensifies the frequency and severity of extreme weather events, the structural integrity of artificial levees has become increasingly critical for flood hazard mitigation. Many aging levee systems face deterioration, making reliable assessment of their condition a growing challenge—particularly due to the heterogeneous and complex nature of their construction materials. This study combines electrical resistivity tomography (ERT) with borehole (BH) data to explore the structure and materials of two levees, with the goal of better understanding how they perform during floods. The method improves the links between water content and other physical properties from borehole samples, while encouraging the use of non-destructive geophysical techniques—especially for estimating important factors like grain size (D50). This approach reduces reliance on conventional destructive testing. By using four machine learning models—Random Forest Regressor (RFR), Artificial Neural Network (ANN), Linear Regression (LR), and Support Vector Regression (SVR)—we found connections between resistivity from ERT, water content, and grain size. RFR yielded the highest predictive accuracy ($R^2 = 0.81$), outperforming ANN (0.74) and both LR and SVR (0.66). These results show that combining machine learning with ERT and BH data can better evaluate the state of levees, offering important information for flood risk assessments and improving strategies to deal with climate-related natural disasters.

Cross-comparison of national drought monitoring products in Central Europe using a new drought impact database

Nirajan Luintel*, Piet Emanuel Bueechi, Johanna Lems, Wouter Dorigo
Vienna University of Technology Department of Geodesy and Geoinformation, Vienna, Austria
*nirajan.luintel@tuwien.ac.at

Droughts have severe impacts on the environment and economy, particularly in regions with high water demand and low annual precipitation. Central Europe is one of those regions. We assessed six national drought monitoring products in Central Europe using a novel impact database developed within the Clim4Cast project (1). The database synthesizes reports in national newspapers, published between 2000 and 2023, on observed drought impacts on various sectors, including agriculture, hydrology, water management, economy and technology, and wildlife. The drought monitoring products comprise drought indicators such as standardized precipitation index (SPI), standardized precipitation evapotranspiration index (SPEI), and standardized soil moisture index with different aggregation periods. We evaluated the drought indicators using: 1) the area under the receiver operating characteristics curve (AUC) to assess their ability to detect drought, and 2) the correlation between drought index severity and the number of reported impacts to measure their ability to capture the impact severity.

The performance of the drought indicators varies by region and aggregation period. The AUC values for some drought indices exceed 0.8 for Czechia, Croatia, and Slovenia, while in Austria, the AUC values for most drought indicators remain below 0.7. Correlation values for many drought indicators remain below 0.6 in most countries, with correlations mostly below 0.3 in Slovakia, Slovenia, and Croatia. With an increasing aggregation period, the correlation generally decreased, while AUC values showed a more complex pattern, initially increasing, peaking at around 6-12 months, and then decreasing with longer aggregation periods. These results aid in understanding the strengths and weaknesses of drought monitoring products in each country and assist in developing a common drought monitoring framework for Central Europe.

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Inappropriate land use and vegetation cover: water scarcity in the climate-affected lowland regions of Hungary

Benedek György Tóth[1,2,3*], Zoltán Bátori[1,3], Alida Anna Hábenczyus[1,3], András Kelemen[2,3], Kata Frei[3], Orsolya Valkó[2], Balázs Deák[2], Csaba Tölgyesi[1,3]
[1]MTA-SZTE Applied Ecology Research Group, Szeged, Hungary,
[2]HUN-REN 'Lendület' Seed Ecology Research Group, Institute of Ecology and Botany, Centre for Ecological Research, Vácrátót, Hungary
[3]Department of Ecology, University of Szeged, Szeged, Hungary
[*]toth.benedek1001@gmail.com

Increasing temperatures and decreasing precipitation negatively affect underground water resources in the lowland regions of Hungary and have resulted in several meters of groundwater decline since the 1970s. Regional anthropogenic factors such as inappropriate landuse and vegetation cover may also have a role in the loss of groundwater resources. Here, we aimed to reveal the effects of afforestation and biological invasion as potential threats to the ground water recharge. We monitored vertical soil moisture dynamics in the most commonly planted forest types of lowland Hungary and compared them to neighboring grasslands. We found that plantations, particularly non-native pine stands, deplete the moisture content of unsaturated soil layers, preventing groundwater recharge throughout most of the year. We also studied the hydrologic effects of the most common invasive plant of the region, common milkweed (Asclepias syriaca). Despite being a herbaceous species, its large leaf area, deep roots and clonal growth form allows for a large evapotransipration capacity, potentially contributing to the depletion of soil moisture resources. With a removal experiment we could confirm this, as invaded areas had significantly lower soil moisture in the upper 1-m soil layer than uninvaded grasslands but by removing milkweed shoots, the moisture content in the soil could be restored within a year.

Our results suggest that inappropriate land use and vegetation cover can act synergistically with climate change in lowland Hungary and exacerbate water scarcity. We recommend the reconsideration of landuse strategies, and promoting grassland restoration as a nature-based solution for mitigating climite change effects, instead of establishing new forests. We also would like to draw the attention to the importance of milkweed suppression as it not only serves biodiversity protection but also water resource protection purposes.

The impact of climate change on the thermal stratification of a shallow polymictic lake

Sebestyén Török*, Péter Torma
Department of Hydraulic and Water Resources Engineering, Budapest University of Technology and Economics, Budapest, Hungary
*toroks@edu.bme.hu

Lakes are highly sensitive to climate change, which makes them important and efficient sentinels. Changes in meteorological factors, such as air temperature and wind, influence the mixing conditions of the lakes' while also altering their energy balance and thermal structure, which can directly affect their ecosystems. As a clear consequence, changes in the lakes' oxygen conditions can be observed, which have contributed to the increased frequency of algal blooms in recent years, such as the record-setting algae bloom in Lake Balaton in 2019, which occurred after more than 20 years of successful eutrophication management. Most studies focus on deep lakes, although shallow lakes are more exposed to internal or external changes due to their limited depth and water volume, making them respond more sensitively to the impact of climate change or anthropogenic effects. The long-term consequences of these changes are largely unexplored in shallow lakes. Therefore, this study examines the changes in the thermal structure of Lake Balaton, a large but shallow polymictic lake, over the past 40 years. The investigations are carried out using the one-dimensional General Ocean Turbulence Model (GOTM), which uses a k-ε turbulence model for vertical mixing, providing stratification results on a physical basis. The model was calibrated and validated for several years of in situ measurements, while for the past simulations, bias-corrected ECMWF ERA5 reanalysis time series were used. The study furthermore investigates the applicability of simple neural networks in calculating a shallow lake's thermal structure with strong daily cycles. The set-up neural network model was trained and validated using the same data as the one-dimensional model, with its results being compared against the GOTM, which served as the reference.

Droughts and floods: monitoring, prediction and artificial intelligence in the Hungarian Water Management

Zoltan Liptay
General Directorate of Water Management, Hungarian Hydrological Forecasting Service
liptay.zoltan@ovf.hu

In my presentation I will discuss the current status of the Hungarian draught monitoring and prediction system and how it is interconnected with the national hydrological forecasting system. I will also discuss the flood forecasting approach applied in Hungary through the current operational systems in both regional and local scales. Artificial intelligence type methods are becoming more and more widespread in the water management sector and there are also ongoing developments in Hungary in the field of hydrological forecasting and data management. Participation in global forecasting projects is new topic where we also represent the local knowledge and share our experiences with hydrologists all over the World

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Session 8 Resilient Landscapes and Water Systems

Changing sodic lakes under the threat of antropogenic and climate impacts in the Southern Great Plain, Hungary – *Zsuzsanna Ladányi, Zsolt Ladányi, Kitti Balog*

Grazing disturbance can override habitat effects in karst doline microrefugia – Attila Torma, István E. Maák, Kata Frei, Nikolett Gallé-Szpisjak, Jelena Šeat, Ádam Lőrincz, Gábor Lőrinczi, Zoltán Bátori

Natural Water Retention Measures contribution to flood risk management – *Branislava Matić, Barbara Karleuša, David Mitrinović*

Geospatial analysis of beaver built ecosystem dinamics in the High-Resolution Aerial Monitoring Network System – *Emese Zita Tóth, Zsolt Molnár, Gábor Bakó*

Human disturbances and refugial capacity: biodiversity in doline microrefugia – *Zoltán Bátori, Gábor Li, Kata Frei, Zsófia Krivács, Viktor Környei, Csaba Tölgyesi*

Application of the hydrogeomorphological index (IHG) and morphological quality index (MQI) in rivers of Timiş county and Romanian Banat region to assess their fluvial quality – *Daniel Ballarín, Fabian Timofte*

Changing sodic lakes under the threat of antropogenic and climate impacts in the Southern Great Plain, Hungary

Zsuzsanna Ladányi[1,2*], Zsolt Ladányi[2], Kitti Balog[1]
[1]*HUN-REN Centre for Agricultural Research, Institute for Soil Sciences, Department of Soil Mapping and Environmental Informatics*
[2]*University of Szeged, Department Physical and Environmental Geography*
[*]*ladanyi.zsuzsanna@atk.hun-ren.hu*

Wetlands, preserving a significant ecological value in the matrix of arable land in the Carpathian Basin, are threatened by anthropogenic processes and the effects of climate change, and their maintenance and restoration is therefore a priority for the conservation of the surrounding wildlife. There are many ecological wise management success stories in the Great Plain to restore more favourable water and salt regime, but there are examples of former wetlands located at higher altitudes where irreversible processes occur due to the lack of available groundwater resources. This study examines sodic lakes and their environments in the Southern Great Plain through snapshots of land use, habitat and soil where the well-known and documented groundwater level decline is not advanced, thus less effort has been and should be put into restoration, and where the degradation is mainly caused by anthropogenic activities. Results to date have confirmed that changing habitat patterns are determined by the spatial location and background factors. Habitat pattern monitoring is the most cost-effective method to monitor the changing condition, but soil and groundwater level should also be monitored to identify appropriate management options.

Grazing disturbance can override habitat effects in karst doline microrefugia

Attila Torma[1,2*], István E. Maák[1], Kata Frei[1], Nikolett Gallé-Szpisjak[2], Jelena Šeat[3], Ádam Lőrincz[1], Gábor Lőrinczi[1], Zoltán Bátori[1,3]

[1]*Department of Ecology, University of Szeged, Szeged, Hungary*

[2]*'Lendület' Landscape and Conservation Ecology, Institute of Ecology and Botany, Centre for Ecological Research, Vácrátót, Hungary*

[3]*MTA-SZTE 'Momentum' Applied Ecology Research Group, University of Szeged, Szeged, Hungary*

[*]*torma.attila@bio.u-szeged.hu*

Microrefugia are relatively small areas that are protected from climate-related disturbances, such as rising temperatures and severe drought. Several species can survive adverse climatic periods in these areas. The potential microrefugial role of karst dolines compared to the surrounding plateau areas has been demonstrated not only for vegetation but also for arthropod communities. However, anthropogenic disturbances, such as grazing by domestic animals, can affect their biodiversity. We aimed to determine how grazing affects the relationships between habitat conditions (i.e. topographic-driven differences in microclimate and plant species composition between doline vs. plateau), vegetation characteristics (structure and diversity) and arthropod communities (abundance and species richness) using structural equation modelling (SEM). We analysed the data from a grazed and a non-grazed year separately. In the non-grazed year, habitat (doline vs. plateau) influenced arthropods both directly and indirectly via vegetation structure. In the grazed year, grazing could also influence arthropod abundance and richness directly and indirectly via vegetation structure, overriding the effects of habitat. However, the pathways were particularly different for arthropod groups (true bugs, spiders, and ants). Understanding the mechanisms that influence the refugial capacity of dolines is essential for determining the appropriate management practices.

Natural Water Retention Measures contribution to flood risk management

Branislava Matić[1*], Barbara Karleuša[2], David Mitrinović[3]
[1]*Educons University, Sremska Kamenica, Serbia*
[2]*Faculty of Civil Engineering University of Rijeka, Rijeka, Croatia*
[3]*Jaroslav Černi Water Institute, Belgrade, Serbia*
[*]*branislava.matic@educons.edu.rs*

With observed and projected frequency and magnitude changes in hydrological and other water-related extreme events the great challenge is how to manage their risk. The most frequent hydrological hazards are floods (riverine-fluvial, pluvial, coastal, mountain torrents, urban. etc) and their occurrence depends on river basin retention capacity, precipitation, land use and cover etc. In recent decades flood risk management approach based on quickly water convey is shifted to approach that balance and integrate the restoration of natural features and processes with existing land uses to minimise loss of life and maximize benefits from nature (Natural Flood Management, Floodplain management, Integrated Flood Management, etc). The function and significance of drainage area retention capacity for water adverse effects mitigation is manifold and acknowledged in different concepts that slow runoff at source by mimicking natural processes. Natural Water Retention Measures (NWRM) as a multi-functional approach are recognized as a concept for flood risk management that provide synergy with environmental objectives of the EU Water Framework Directive and reduce trade-offs with other policies (Biodiversity, Habitat, Climate Change Adaptation, etc). Due to significant number of benefits (water storage and purification, sediment balance, groundwater recharge, etc) NWRM are incorporated in the Danube Flood Risk Management Plan (DFRMP) 2021. As presented in following, NWRM integration in DFRMP 2021 is elaborated and their implementation effects on synthetic unit hydrographs (SUH) and peak discharge rate for ungauged basin are presented in more details as a function of land cover, natural features and selected short-term heavy rainfall event.

Geospatial analysis of beaver built ecosystem dinamics in the High-Resolution Aerial Monitoring Network System

Emese Zita Tóth[1*], Zsolt Molnár[2], Gábor Bakó[2]
[1]*University of Pécs, Faculty of Sciences, Geoinformatics Master studies*
[2]*Interspect Ltd., Halásztelek*
[*]*t.zita2000@gmail.com*

The study presents a geoinformatic analysis of Eurasian beaver (Castor fiber) dam-building activities in Hungary, focusing on their role as ecosystem engineers. Following their reintroduction in the 1990s, beavers have significantly altered riparian habitats, resulting in both ecological benefits and human-wildlife conflicts. Since 2018, the High Resolution Aerial Monitoring Network (HRAMN) has been investigating areas significantly affected by beavers. Using photogrammetric methods, the research analyzes beaver-modified landscapes across diverse Hungarian terrains and habitats. The primary aim is to record the state of the studied territory with the multifaceted impacts of beaver activity on different ecosystems and to model water bodies dammed by their structures. Furthermore, to generate sample data from these case studies that can later be used in the High Resolution Aerial Monitoring Network project for training its AI-supported, partially automated evaluation procedures in monitoring. The study proposes an assessment tool and decision-support framework for stakeholders that recommends nature-based solutions – such as regulated modifications of dams (e.g., flow devices) instead of complete removal – to manage the risks of assets and infrastructure. At the same time, it must reliably demonstrate situations where existing beaver dams do not pose any risk to human life or the built environment. By synthesizing geospatial data, ecological monitoring, and legal perspectives, this study aims to demonstrate the role of beavers in water management and ecosystem restoration as a key tool for enhancing landscape resilience, while contributing to more evidence-based and sustainable conservation practices in Hungary.

Human disturbances and refugial capacity: biodiversity in doline microrefugia

Zoltán Bátori*, Gábor Li, Kata Frei, Zsófia Krivács, Viktor Környei, Csaba Tölgyesi
Department of Ecology, University of Szeged, Szeged, Hungary
**zbatory@gmail.com*

Microrefugia are small areas that support the long-term survival of species during climate changes. Topographic depressions in karst landscapes (dolines) have the capacity to decouple their microclimate from regional climate changes, making them important 'safe havens' or microrefugia for biodiversity. Here we provide examples from European karst areas, where different types of anthropogenic disturbances have been shaping the vegetation for centuries, to illustrate the various effects of human activities on biodiversity in dolines. For instance, construction, lime burning, forestry activity, and biological invasion may significantly alter the capacity of dolines to support climate change vulnerable species, generally reducing the number of these species in doline microhabitats. However, in some cases, anthropogenic disturbances can also have positive consequences for biodiversity, supporting the populations of rare and endangered species in dolines. Therefore, the effects of various disturbances on biodiversity patterns in doline microrefugia must be carefully considered to determine the best management strategies.

Application of the hydrogeomorphological index (IHG) and morphological quality index (MQI) in rivers of Timiş county and Romanian Banat region to assess their fluvial quality

Daniel Ballarín[1*], Fabian Timofte[2]
[1]*University of Zaragoza Department of Geography and Territorial Planning, Zaragoza, Spain*
[2]*West University of Timişoara Department of Geography, Timişoara, Romania*
[*]*danielbf@unizar.es*

The hydrogeomorphological quality of European river watercourses has been regulated by the Water Framework Directive (EU) since 2000. Several methodologies have been developed to implement the Directive, as well as scientific works applied in Europe. In this work, two methodologies with a long history of application have been used: The Spanish hydrogeomorphological index (IHG) (Ollero et al., 2011) and the Italian morphological quality index (MQI) (Rinaldi et al., 2013b). Both methods have been compared in several rivers with a wide variety of river typologies of the Banat region, in the territory of Romania. The results of the application of both methodologies show a good correlation between the methods of analysis, correctly assessing the current state of the rivers. The hydrogeomorphological assessment makes it possible to establish a framework for action in the conservation and restoration policies of the most degraded watercourses, being able to act on them to improve their condition. In the current context of climate change, hydrogeomorphological status is closely related to flood risks, as a poorly assessed river can increase the risk by not functioning properly.

Keywords: hydrogeomorphological quality, Banat region, IHG, MQI

II. Natural Hazards and Climate Change Conference

Session 9 Towards Resilient Agroecosystems

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Large scale production of peptaibols for plant protection – *Gergő Terna, Bence Váczi, Dóra Balázs, Fanni Kovács, Chetna Tyagi, Ákos Rozsnyói, András Szekeres, Mónika Varga, Csaba Vágvölgyi, Tamás Papp, László Kredics, Tamás Marik*

Assessment of Vegetation Water Demand and Drought Index in Arid and Semi-Arid Regions Using Satellite Data and Plant Water Metabolism – *Mukesh Singh Boori,* Komal Choudhary

Microgreens and vertical farming- a sustainable tool for investigating plant salt stress responses

Ágnes Szepesi[1*], Andrea Rónavári[2], Adedokun Oluwatosin Peace[1], Batnasan Ganbold[1], Rebeka Karginov[1], Péter Pálfi[1], Zoltán Kónya[2,3]

[1]*Department of Plant Biology, University of Szeged, Szeged, Hungary*

[2]*Department of Applied and Environmental Chemistry, University of Szeged, Szeged, Hungary*

[3]*MTA-SZTE Reaction Kinetics and Surface Chemistry Research Group, Szeged, Hungary*

[*]*szepesi.agnes@szte.hu*

According to the report of FAO, more than 10 percent of the total global land area is affected by salinity and due to the climate crisis and human mismanagement, excessive salinization could risk an additional one billion hectares (FAO, 2024).

Controlled environment could offer a suitable strategy for investigating the salinity induced stress responses of plants. Two departments of University of Szeged (Department of Applied and Environmental Chemistry and Department of Plant Biology) established a controlled indoor greenhouse with precision technology in cooperation with industrial partners in the frame of GINOP project to install a modern vertical farm system with precision lightning system to study the plant metabolism. Our study focuses on investigating model plant species like Lepidium sativum and Lepidium crassifolium in order to compare their salt stress responses and decipher the mechanisms behind salt stress tolerance.

This sustainable and cost-effective manner for investigations could enhance our knowledge in salt stress-specific plant responses and contribute to make plants more tolerant to different stress conditions. In this study, an overview about the advantages and limitations of this strategy will be demonstrated.

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Using Earth Observation and AI for Irrigation Management Amidst Meteorological Hazards: A Case Study in Limpopo, South Africa

Nxumalo Gift Siphiwe[1,2*], Zsolt Feher[1,2], Ramabulana Tondani Sanah[3], Attila Nagy[1],
[1]*Institute of Water and Environmental Management, University of Debrecen, Debrecen, Hungary*
[2]*National Laboratory for Water Science and Water Safety, University of Debrecen, Debrecen, Hungary*
[3]*Institute of Geography and Earth Sciences, University of Pécs, Pécs, Hungary*
[*]*nxumalogiftsiphiwo@gmail.com*

Effective irrigation management is crucial in mitigating the impacts of meteorological hazards on agriculture. This study explores the integration of Earth Observation (EO) data—using both optical and radar sensors—with machine learning models and in situ meteorological data to enhance irrigation strategies in the Vhembe District, Limpopo, South Africa. Key parameters analyzed include crop drought prediction, major field crop delineation, soil moisture estimation, actual crop evapotranspiration (ETc), and secondary salinization classification.

To estimate reference evapotranspiration (ET_o), the Hargreaves (HG) method was employed, utilizing temperature-based meteorological inputs. Soil moisture was derived using Synthetic Aperture Radar (SAR) backscatter analysis, while ETc was retrieved through vegetation index-based approaches. Major crop delineation was performed using NDVI and regional yield data, applying classification algorithms to distinguish different crop types. Machine learning models, including random forests and deep learning approaches, were used for prediction and classification tasks, integrating ground-based meteorological data to refine model accuracy.

The novelty of this study lies in the synergistic use of multi-source EO data, AI-driven analytics, and a hybrid approach combining remote sensing and in situ data to optimize precision irrigation in a climate-vulnerable region. We introduce a novel approach to tracking soil salinity changes over time using SAR-based techniques, including polarimetric decomposition methods (the Freeman-Durden and Yamaguchi), multi-temporal coherence analysis, and interferometric SAR (InSAR) for soil structure changes. These techniques enable the detection of salinity-induced variations in soil dielectric properties and surface roughness, improving secondary salinization classification. The findings underscore the potential of these methodologies in improving irrigation strategies and enhancing climate resilience in agricultural systems.

Effect of irrigation with "greywater" on Triticum aestivum

Brigitta Roxána Horváthné Dani[1*], Martin Horváth[2], Anna Skribanek[2]
[1]*Eötvös Loránd University, Budapest, Hungary,*
[2]*Eötvös Loránd University, Szombathely, Hungary*
[*]*danibrigiroxi@gmail.com*

As a result of the increasing intense dry periods, irrigation with grey wastewater from washing and dishwashing is becoming more and more common practice worldwide. However, there are some ingredients in detergents that can pose a serious threat if released into the environment. Some of their components can be broken down by microbes under aerobic conditions, but no during anaerobic conditions or in several cases toxic substances are produced under anaerob conditions.

In our research, we irrigated Triticum aestivum organisms with a solution of three commercially available synthetic detergents and laundry soap (diluted 1:10) for two weeks.

Detergents caused severe drought stress for wheat crops. The moisture content of the organisms decreased sharply compared to the control crop, even though the soil moisture content was higher. In the 10-fold dilution of two tested synthetic detergents the shoot length of the plants decreased significantly compared to the solution of the laundry soap solution of the same concentration. Chlorophyll-a and total carotenoid content decreased in only one solution of synthetic detergent compared to the control (carotenoid content was reduced compared to the laundry soap solution), but the build-up of chlorophyll-b was inhibited by all synthetic detergents. The laundry soap solution did not inhibit the development of photosynthetic pigments. The activity of the enzyme guaiacol peroxidase, which is considered to be a stress enzyme, was significantly increased by one of the synthetic detergents, which characterizes the degree of stress exerted by detergents on plants. The laundry soap solution did not cause stress to the growth of wheat and its above-mentioned physiological parameters at the tested concentration.

Although our research examined the effects of solutions that are more concentrated than the concentrations that are realistically released into the environment after short-term exposure, based on our results, we conclude that long-term exposure can presumably cause detectable inhibition of Triticum aestivum even at lower concentrations of synthetic detergents.

This work was supported by the EKÖP-24 University Excellence Scholarship Program of the Ministry for Culture and Innovation from the Source of the National Research, Development and Innovation Fund.

The Role of Historical and Recent Land Use and Land Cover Changes in Promoting Biological Invasions in Hungary

Márton Bence Balogh[1*], Zalán Tobak[2], Dominik Kaim[3], Péter Szilassi[1]
[1]*University of Szeged, Department of Physical and Environmental Geography, Szeged, Hungary*
[2]*University of Szeged, Department of Atmospheric and Geospatial Data Science, Szeged, Hungary*
[3]*Jagellonian University of Kraków, Department of Institute of Geography and Spatial Management, Kraków, Poland*
[*]*balogh.marton.bence@gmail.com*

The dispersal of invasive plant species is influenced by a variety of geographic factors, including topography, climate, soil characteristics and hydrology. However, the significance of these factors varies according to the specific species in question. Another significant influencing factor that must be considered is historical and recent changes in Land Use and Land Cover (LULC). While LULC changes may facilitate the establishment of certain invasive species, the duration of their impact on biological invasions remains uncertain. This study assessed the potential relationships between historical LULC patterns over the past 200 years and the recent emergence of four common invasive plant species in Hungary: Ailanthus altissima (tree of heaven), Asclepias syriaca (common milkweed), Elaeagnus angustifolia (Russian olive) and Solidago spp. (goldenrod). The present study utilised Geographic Information System (GIS) data and statistical methodologies to undertake a comparative analysis of historical (1848–1990) and recent (1990–2018) changes in LULC with the contemporary distribution of the aforementioned invasive species in 2018. The results indicated that A. syriaca is more influenced by recent LULC changes, while A. altissima, E. angustifolia and Solidago spp. are more affected by historical LULC changes. A. altissima and E. angustifolia have been observed to thrive in areas of high land-use intensity. The analysis indicates that A. syriaca demonstrates a preference for areas characterised by mixed and decreasing land-use intensities, while Solidago spp. exhibits a preference for areas with continuously increasing and decreasing land-use intensities.

Large scale production of peptaibols for plant protection

Gergő Terna*, Bence Váczi, Dóra Balázs, Fanni Kovács, Chetna Tyagi, Ákos Rozsnyói, András Szekeres, Mónika Varga, Csaba Vágvölgyi, Tamás Papp, László Kredics, Tamás Marik
Department of Biotechnology and Microbiology, University of Szeged, Szeged, Hungary
**ternag1@gmail.com*

Chemicals used in today's agriculture harm the environment, therefore, there is an emerging need to replace them with efficient bioproducts. Members of the filamentous fungal genus Trichoderma are popular biocontrol organisms due to their rapid growth, intense sporulation, extracellular enzyme production and mycoparasitic behaviour. Certain Trichoderma species, which can grow at higher temperatures, could be used in agriculture under warmer conditions arising due to climate change, however, these species are also known as opportunistic pathogens in humans. The use of bioactive secondary metabolites produced by thermotolerant Trichoderma strains as biocontrol agents instead of using the strains themselves could minimize the risks arising from field application of potential opportunistic human pathogens.

Peptaibols are short, linear, helical antimicrobial peptides mostly produced by members of genus Trichoderma. Non proteinogenic amino acids such as α-aminoisobutyric acid (Aib) or D-isovaline are always present in their backbone, increasing the stability of peptaibols. They can form voltage-dependent ion-channels in cell membrane, especially in Gram-positive bacteria and filamentous fungi. Furthermore, peptaibol treatment of plants can induce systemic resistance in plants, through which they can act as biocontrol agents. We developed large-scale inexpensive and sustainable procedures to cultivate Trichoderma for peptaibol production. Two types of methods were established using certain grains and mycelia regrown several times on the same microbiological medium, and both methods significantly increased peptaibol production. The results of this study established the basis for commercial production of peptaibols, which is essential to introduce them in agriculture as biocontrol agents.

This work was supported by the Hungary–Serbia IPA Cross-border Co-operation Programme (project FERTILEAVES, HUSRB/23S/11/027) and by the Scholarship Program of the Ministry of Culture and Innovation, financed from the National Research, Development and Innovation Fund (EKÖP-24-4-SZTE-629, EKÖP-24-4-SZTE-605).

Assessment of Vegetation Water Demand and Drought Index in Arid and Semi-Arid Regions Using Satellite Data and Plant Water Metabolism

Mukesh Singh Boori[1*], Komal Choudhary[2]
[1]*University of Central Asia, Khorog, Tajikistan*
[2]*Aarhus University, Aarhus, Denmark*
[*]*mukesh.boori@ucentralasia.org*

This study presents an integrated approach to assess ecological water demand (EWD) and vegetation drought stress in arid and semi-arid regions. We introduce a novel method for evaluating threshold EWD, focusing on the Tarim River Basin over the past 30 years. By utilizing remote sensing data, we estimated evapotranspiration and analyzed the dynamics of minimum and optimum EWD. A new analytical framework, inspired by the concept of "latitude" from ecosystem resilience, was proposed to quantify vegetation's water demand effectively. Our findings showed average minimum and optimum EWD values of 105.45 mm and 135.53 mm, respectively, with variations among vegetation types such as woodland, grasslands, and high-coverage areas. In addition, we address the challenge of monitoring vegetation drought by introducing the standardized Vegetation Water Deficit Index (SVWDI). This index, based on the Remote-sensing-based Water Balance Assessment Tool model, tracks vegetation's water deficit and its drought response. We examined the spatiotemporal evolution of vegetation drought in the study area from 1995 to 2025. Our results reveal that drought conditions were severe during the first two decades but have been alleviated in recent years. SVWDI showed a significant correlation with vegetation health, particularly with the normalized difference vegetation index (NDVI), and exhibited improvement over time. This study offers valuable insights into the role of EWD in ecosystem management and provides guidance for climate adaptation strategies, such as vegetation restoration in the study area and sustainable water resource allocation in arid regions.

II. Natural Hazards and Climate Change Conference

Session 10 Environmental Hazards

Conservation potential of abandoned sand mines – *Szandra Sárszegi-Pék, Márton Szabó, Balázs Deák, Orsolya Kiss, Kristóf Süveges, Orsolya Valkó, András Kelemen*

The devastating impact of a landslide on a home (case study in Slovenia) – *Joze Janez, Nina Gognjavec, Vlasta Benedik*

Introducing the first ecovoltaic parks of Hungary: a reconciliation between solar development and nature conservation – *Csaba Tölgyesi, Botond Magyar, Kata Frei, Alida Anna Hábenczyus, Róbert Gallé*

From micropollutant removal to greenhouse gas monitoring: New challenges in the wastewater treatment sector – *Csenge Nagy-Mezei, Anikó Bezsenyi, Imre Gyarmati, Levente Kardos*

Microplastics in lakes and rivers – *Viktória Blanka-Végi, Alexia Balla, Tímea Kiss, Gabriella Hertelendy, Izabella Babcsányi*

The effect of water pollution caused by detergent residues on living aquatic organisms – *Brigitta Roxána Horváthné Dani, Martin Horváth, Anna Skribanek*

Conservation potential of abandoned sand mines

Szandra Sárszegi-Pék[1*], Márton Szabó[2,3], Balázs Deák[4], Orsolya Kiss[4], Kristóf Süveges[4], Orsolya Valkó[4], András Kelemen[1,4]

[1] *Department of Ecology, University of Szeged, Szeged, Hungary*

[2]*Hungarian University of Agriculture and Life Sciences, Gödöllő, Hungary*

[3]*HUN-REN Centre for Ecological research, Institute of Ecology and Botany, Lendület Landscape and Conservation Ecology Research Group, Vácrátot, Hungary*

[4]*HUN-REN Centre for Ecological research, Institute of Ecology and Botany, Lendület Seed Ecology Research Group, Vácrátót, Hungary*

[*]*p.sandra.sordes@gmail.com*

As a result of large-scale landscape aridification, moist habitat communities and species are increasingly declining. Interestingly, sand mining — driven by the growing demand of industry — can create conditions that support the formation of wetlands. Abandoned sand mines often offer suitable environments for rare and protected plant species that thrive in open or wet habitats. In our study, we examined 38 abandoned sand mines located in the Danube–Tisza Interfluve. We assessed the size of these sites, the time passed since abandonment, the groundwater level, and various soil parameters. Furthermore, we surveyed the presence and populations of rare and protected plant species within these sites. Our analysis focused on two main questions: (i) how the soil characteristics of abandoned mines differ from those of the surrounding landscape, and (ii) how factors such as previous land use (natural or agricultural), mine size, age, and groundwater level influence the occurrence of rare and protected species. Our findings revealed that soils in the abandoned mines have higher moisture content, lower nutrient levels, and lower pH compared to the surrounding areas. The previous land use and the age of abandonment did not significantly influence the number of rare and protected species present. In contrast, both the size of the mine and the groundwater level emerged as key determinants. We found that species richness increases with mine area, following a saturation curve, while the relationship between groundwater level and species richness shows an exponential decline. These findings highlight that abandoned sand mines can serve as important refuges for plant species affected by landscape changes such as aridification and land-use transformation. Therefore, incorporating abandoned sand mines into conservation strategies is essential — particularly for the protection of water-dependent species and habitats.

The devastating impact of a landslide on a home (case study in Slovenia)

Joze Janez*, Nina Gognjavec, Vlasta Benedik
Geologija d.o.o. Idrija, Slovenia
**joze.janez@geologija.si*

In August 2023, Slovenia experienced catastrophic floods affecting most of the country, marking the onset of recurring extreme torrential rainfall. This abstract presents a case study from June 2024, when residents of a house located on hilly terrain underlain by shale rocks (with a slope gradient of 19° to 38°) started noticing wall cracking of a few millimetres. Each rain event had made the situation more periling, prompting the local municipality to involve geologists to assess the situation. Our investigation identified the house's location on an active landslide, evidenced by larger cracks at the front of the building, indicating rotational movement downslope. Bedrock is overlain by a variable thickness of Quaternary silty clay with pieces of gravel. A nearby stream, situated approximately 50 m east, had been previously stabilized with transverse barriers.

Comprehensive terrain research was conducted, including geological mapping, dig pits, three boreholes, and inclinometer measurements. These revealed two distinct slip surfaces. Monitoring of groundwater levels further clarified subsurface conditions. Groundwater contributed to slope instability. Visible subsidence was also observed on the driveway, with pavement sinking near the garage.

The proposed mitigation plan included improving the drainage system behind the house, constructing a pile wall, and stabilizing the structure through Uretek expansion resins injection. However, before these measures could be implemented, the property deteriorated significantly, posing a serious threat to the safety of the inhabitants. Six months after the initial assessment, cracks in the walls widened to approximately 2 cm. Given the advanced damage and ongoing risk, residents were instructed to evacuate the house.

This case highlights the challenges of managing landslide-prone terrains under increasingly extreme weather conditions and the need for timely intervention.

Introducing the first ecovoltaic parks of Hungary: a reconciliation between solar development and nature conservation

Csaba Tölgyesi[1*], Botond Magyar[2], Kata Frei[2], Alida Anna Hábenczyus[1], Róbert Gallé[1,3]
[1]*MTA-SZTE Momentum Applied Ecology Research Group, University of Szeged, Szeged, Hungary*
[2]*Department of Ecology, University of Szeged, Szeged, Hungary*
[3]*Institute of Ecology and Botany, Centre for Ecological Research, Vácrátót, Hungary*
[*]*tolgyesi.csaba@bio.u-szeged.hu*

Solar energy is the most rapidly growing renewable globally, leading, as a side effect, to vast low-nature-value areas due to the high land requirement of ground-mounted solar panels. However, there may be ways to reconcile solar development with nature conservation. Ecological aspects can be considered during the planning, construction and management of the parks, and the resulting ecovoltaic park can bring various benefits to the owners. A major step in developing ecovoltaic parks is the creation of short but species-rich grassland ecosystem. Here, we set up an experimental design in three solar parks of Hungary, and sowed a mixture of 52 native species in one half of each park in 2022, while the other halves were left as control. In 2023, we surveyed the vegetation of the parks and adjacent old-growth grasslands (as references), and found that total species richness in the sown parts equalled that of the references, but the richness of grassland specialists remained lower (albeit higher than in the control). By 2024, grassland specialists in the sown parts reached the references, and we found no statistically significant difference between them. Regarding pollinators, we found higher species richness and Shannon diversity in the sown parts then in the reference grasslands, while control parts of the parks showed intermediate values. This can be explained by spillover from the sown parts, although flying pollinators might have also taken advantage of the windshade among the panels of the control parts, irrespective of food sources. Our findings suggest a rapid improvement of plant and pollinator assemblages after sowing native seed mixtures in solar parks. The resulting higher-nature-value grassland can have many co-benefits for the owners, as it requires lower management intensity, has the potential to offer high quality food for livestock or honey-bees, and lowers the widespread “not-in-my-backyard” syndrome of local people.

From micropollutant removal to greenhouse gas monitoring: New challenges in the wastewater treatment sector

Csenge Nagy-Mezei[1,2*], Anikó Bezsenyi[2], Imre Gyarmati[2], Levente Kardos[1]
[1]*Department of Agro-environmental Studies, Institute of Environmental Sciences, Hungarian University of Agriculture and Life Sciences, Budapest, Hungary*
[2]*South-Pest Wastewater Treatment Plant, Budapest Sewage Works Pte Ltd., Budapest, Hungary*
[*]*pribelszkycs@fcsm.hu*

In response to the current environmental, human health and economic problems, the amendment to the Urban Wastewater Treatment Directive (91/271/EEC) has been expanded with a number of new areas in November 2024. The wastewater treatment plants must deal with the development of treatment technology, the investigation and reduction of micropollutants and microplastics, the achievement of energy neutrality and the assessment of greenhouse gas emissions. Traditional wastewater treatment technology needs to be developed and expanded in treatment plants, which ensures compliance with increasingly stringent nitrogen and phosphorus emission limits values. One of the consequences of population growth and economic activity is the exponential growth of anthropogenic waste generation, which includes wastewater and sewage sludge generated during wastewater treatment. Most of the toxic substances in wastewater and sewage sludge are non-biodegradable and persistent compounds. Two groups of these are micropollutants (e.g. pharmaceutical active compounds, pesticides), which can have a harmful effect on human health and the ecosystem even at low concentrations (µg/L, ng/L), and microplastics, from which up to several million particles can be released with a single load of laundry. The investigation and monitoring of micropollutants and microplastics will become mandatory in treatment plants in the future, and their removal requires the installation of special technology, the so-called fourth stage of treatment. In addition to the proper treatment of wastewater and the removal and monitoring of the harmful substances contained in it, wastewater treatment plants must also achieve energy neutrality, which will be a real challenge due to the additional costs associated with the installation, operation and maintenance of the fourth stage. In the fight against global climate change, the new directive also requires the examination of greenhouse gases and gas emission points, and reducing emissions, with a special focus on nitrous oxide and carbon dioxide.

Microplastic Pollution in Hungarian Water Bodies: Urban Ponds and the Tisza River System

Viktória Blanka-Végi[1*], Alexia Balla[1], Tímea Kiss[2], Gabriella Hertelendy[1], Izabella Babcsányi[1]

[1]*Department of Physical and Environmental Geography, University of Szeged, Szeged, Hungary*

[2]*Independent Researcher, Mindszent, Hungary*

[*]*blankav@geo.u-szeged.hu*

Microplastic pollution (MP) in freshwater systems poses significant ecological risks as these persistent particles can adsorb harmful chemicals and serve as vectors for invasive species and pathogens. We have examined this issue from different perspectives in urban lakes and in the Tisza River system. MP pollution was investigated in Szeged, southeastern Hungary (population ~160,000), across four urban ponds with different land use characteristics in their watersheds. All ponds act as stormwater storage wetlands, urban runoff is directly discharged into the ponds through drainage channels. Samples were collected during both dry and wet periods in 2024/2025 to analyse MP concentrations in the water and sediments. In parallel, research along the Tisza River system examined the sink-source dynamics affecting MP transport and deposition in water and sediments between 2020 and 2023. The MP concentration varied between 730 ± 568 item/kg and 1737±889 item/kg in the sediments and from 19 ± 13.6 item/m^3 to 57 ± 44.8 item/m^3 in water samples (1, 2). Compared to the river, the MP concentration in urban ponds were 2 to 4 times higher in the sediments (~2100 item/kg during the dry and ~4200 item/kg in the wet period) and orders of magnitude higher in the water of the ponds (21 2 ± 22 item/L in the dry period, and 14 ± 10 item/L in the wet period). During the wet period, a significant accumulation of MPs (37 ± 16 item/L) was observed in the ice sheet of the ponds. In the river, MP pollution was strongly associated with wastewater discharges, indicated by fibers constituting 89.8-98.7% of MP types. In the ponds, the most probable sources of MPs are surface runoff through drainage channels and direct waste disposal. The concentration differences between the Tisza River and the urban ponds can be explained by their different dynamics. In the river systems, regular flood waves mobilise and transport the MPs downstream, while in the ponds, accumulation of the MPs is more dominant and controlled by the stormwater management practices.

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The effect of water pollution caused by detergent residues on living aquatic organisms

Brigitta Roxána Horváthné Dani[1*], Martin Horváth[2], Anna Skribanek[2]
[1]*Eötvös Loránd University, Doctoral School of Environmental Sciences, Budapest, Hungary*
[2]*Eötvös Loránd University, Savaria University Centre, Szombathely, Hungary*
[*]*danibrigiroxi@gmail.com*

Detergents and cleaning agents are substances used in large quantities in everyday life. However, no conventional wastewater treatment method can completely remove the residues of synthetic detergents and cleaning agents from wastewater, so they can be detected in living water and cause several problems. They change the pH and conductivity of waters and reduce the resistance of aquatic biota to environmental stress. Knowing all this, the need for solutions that do not burden the environment has become more and more increasing.

In our research, we investigated the ecotoxic effects of four commercially available detergents and laundry soap on Lemna minor at 10-, 50-fold and 100-fold dilutions of the detergent concentrations recommended by the manufacturers for washing. Synthetic detergents were diluted by 10 times the manufacturer's recommended concentration resulted in the death of the organisms. However, a significant reproduction was observed in the solution of laundry soap even at this concentration. The size, weight and protein content of the plants were reduced by detergents in 50-fold dilution, but laundry soap did not cause inhibition. The number of photosynthetic pigments was inhibited by synthetic detergents in a 50-fold dilution. The enzyme guaiacol peroxidase was significantly increased at this concentration for all detergents. With the increase of concentration, the enzyme activity in synthetic detergents solutions ceased, which mean the death of plants.

In solutions of synthetic detergents 100 times thinner than the concentration used during washing, the physiological parameters of Lemna minor were not significantly inhibited, but they were intensively reduced by increasing the concentration. However, even in its most concentrated solution, the laundry soap solution did not cause significant inhibition of the studied physiological parameters of Lemna minor.

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II. Natural Hazards and Climate Change Conference

Poster Session I

Agroclimatic Trends and Adaptation: Challenges and Future Perspectives in Hungary – *Erik Kovács, Balázs Zay, János Puskás*

Biodiversity of cultivable bacteria in the rhizosphere of industrial crop plants in Hungary – *Orsolya Kedves, Tamás Zsolt Polyák, Katalin Perei, Csaba Vágvölgyi, László Kredics*

Comparison of salt stress induced biochemical responses of *Lepidium sativum* (garden cress) and the salt tolerant *Lepidium crassifolium* – *Batnasan Ganbold, Adedokun Oluwatosin Peace, Rebeka Karginov, Ágnes Szepesi*

Development of a healthy casing alternative from spent mushroom compost – *Henrietta Allaga, Dóra Horkics, Ádám Bordé, András Varga, Rita Büchner, Terézia Kovács, András Misz, Csaba Csutorás, Judit Bajzát, Nóra Bakos-Barczi, Csaba Vágvölgyi, László Kredics*

Effect of plasma-activated water seed priming on the development of *Arabidopsis thaliana* seedlings in a drought stress model system – *Tamás Bodor, Gábor Fejes, Kinga Kutasi, Zsuzsanna Kolbert*

Future crop yield trends across Europe from past observations and ISIMIP climate scenarios – *Tobias Conrad*

Isolation, identification and characterisation of potential biocontrol agents of walnut pathogens in Turkey and Hungary – *Ahmet Akköprü, Younes Rezaee Danesh, Orsolya Kedves, Semra Demir, Emre Demirer Durak, Adnan Yaviç, Solmaz Najafi, Gokhan Boyno, Ceylan Pınar Uçar, Betül Yıldız Fırat, Árpád Bányi, Nóra Tünde Lange-Enyedi, Simang Champramary, Boris Indic, György Sipos, Csaba Vágvölgyi, László Kredics*

Osmotic stress-induced anatomical changes in pea (*Pisum sativum* L.) leaves – *Réka Szőllősi, Gábor Fejes, Tamás Bodor, Zsuzsanna Kolbert*

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Zinc Oxide Nanoparticles: Dual Effects on Broccoli Growth Under Nutrient and Salinity Stress – *Adedokun Oluwatosin Peace, Batnasan Ganbold, Rebeka Karginov, Andrea Rónavári, Ágnes Szepesi, Zoltán Kónya*

The role of climate microrefugia in shaping intraspecific trait variability in *Myrmica ruginodis – Bonita Ratkai, Kata Anna Bán, Kata Frei, Gergely Horváth, Gábor Li, Ádám Lőrincz, Gábor Lőrinczi, Fanni Pécsy, Zoltán Bátori, István Elek Maák*

Temperature and geographical location induced fluctuations of population density of European ground squirrels in Hungary – *Csongor Gedeon, Olivér Váczi, Felix Knauer, Mátyás Árvai, Franz Suchentrunk*

The accelerated spruce dieback in Central Europe is a warning sign of the climate change – *Zsuzsa Lisztes-Szabó, Mihály Braun, Albert Tóth, Elemér László, József Lennert, Anna F. Filep*

Extreme Dry Events in Vojvodina: Observations and Climate Change Projections - *Atila Bezdan, Jovana Bezdan*

Observed long-term trend in various extreme precipitation-related climate indices – *Csilla Simon, Mónika Lakatos, Olivér Szentes*

Eutrophication in Freshwater Ecosystems: Impacts of Nutrients, Groundwater, and Climate Change – *Marija Perović, Vesna Obradović, Mitrinović David*, *Mitrović Tatjana*

Agroclimatic Trends and Adaptation: Challenges and Future Perspectives in Hungary

Erik Kovács[1*], Balázs Zay[1], János Puskás[2]
[1]*Climate Policy Instiute, Mathias Corvinus Collegium, Budapest, Hungary*
[2]*Savaria University Centre,Eötvös Loránd University, Szombathely, Hungary*
[*]*kovacs.erik@mcc.hu*

Agriculture is one of the most exposed sectors to the increasing frequency of climate extremes caused by climate change. The intensification of temperature rise, droughts during the growing season, and significant modifications in extreme climatological and meteorological parameters have contributed to the deterioration of arable land conditions, yield reductions, and declining crop quality in recent years.

Following the historic drought of 2022, the Hungarian agricultural sector has undergone transformation, with increasing attention given to its vulnerabilities and the policy-driven adaptation responses available. Besides climate change, soil degradation, water management, and the European Union's Green Deal also pose significant challenges to the national agricultural sector.

In this research, we primarily focused on recent agroclimatic observations and future scenarios. The analysis was conducted using homogenized and interpolated agroclimatic databases and crop yield data, with special emphasis on temperature and precipitation indicators during the growing season.

A long-term climate analysis is necessary to understand the drought events of 2022 and 2024 and to ensure the success of future adaptation and mitigation strategies. The findings may assist stakeholders in the agricultural sector in effectively reducing the adverse impacts of climate change, thereby enhancing resilience to similar shocks and preventing increased vulnerability within the industry.

Biodiversity of cultivable bacteria in the rhizosphere of industrial crop plants in Hungary

Orsolya Kedves*, Tamás Zsolt Polyák, Katalin Perei, Csaba Vágvölgyi, László Kredics
Department of Biotechnology and Microbiology, Faculty of Science and Informatics, University of Szeged, Szeged, Hungary
kedvesorsolya91@gmail.com

The efficiency of agricultural production in temperate regions is increasingly threatened by rising average temperatures, desertification due to uneven distribution of precipitation, and the emergence of new pathogens linked to climate change. The widespread application of chemical pesticides, the appearance of their residues in the food chain, as well as the excessive use of fertilizers leading to eutrophication and nitrate pollution further exacerbate environmental concerns. Consequently, there is a growing demand for alternative, eco-friendly soil management strategies based on beneficial microorganisms that enhance plant growth and alleviate environmental stress. One of the primary challenges in utilizing beneficial microorganisms for agricultural purposes is the variability in their field efficacy. A promising approach to overcome this limitation is the development of soil inoculants that incorporate multiple beneficial microbial strains rather than relying on a single strain.

Our ultimate goal is the development of a complex, multi-microbial soil inoculant to mitigate the adverse effects of climate change in the cultivation of major crops such as soybean, maize, and sunflower. As a first step, we are assessing soil microbial biodiversity in the cultivation systems of these industrial plants.

Soil samples were collected from maize, sunflower, and soybean fields at three different locations. A total of 120 potential plant growth-promoting microorganisms were isolated. Based on existing literature, the isolated bacterial and fungal strains include several species with plant growth-promoting (e.g., Arthrobacter sp., Bacillus mojavensis, Epilithonimonas ginsengisoli, Priestia aryabhattai, Pseudomonas thivervalensis, Trichoderma sp.), biocontrol (e.g., Bacillus velezensis, Bacillus subtilis, Priestia megaterium, Pseudomonas koreensis, Trichoderma sp.), and bioremediation (e.g., Bacillus halotolerans, Pseudomonas frederiksbergensis) properties.

This research contributes to the development of sustainable agricultural practices by identifying microbial consortia that can enhance crop resilience to environmental stressors while reducing reliance on chemical inputs.

The study was supported by the Proof of Concept Fund of the University of Szeged.

Comparison of salt stress induced biochemical responses of *Lepidium sativum* (garden cress) and the salt tolerant Lepidium crassifolium

Batnasan Ganbold*, Adedokun Oluwatosin Peace, Rebeka Karginov, Ágnes Szepesi
Department of Plant Biology, University of Szeged, Szeged, Hungary
**ganboldbatnasan0322@gmail.com*

Brassicaceae family contains many valuable plant species with different medicinal compounds. Lepidium sativum (garden cress) a nutrient-rich plant species from this family with hepatoprotective, antioxidant, anticancer, antimicrobial, anti-inflammatory, hypoglycemic, diuretic, and antihypertensive effects. As functional food, it contains phenolics, flavonoids, essential fatty acids, γ-tocopherol, and phytosterols, and seeds are recognized with therapeutic applications for age-related diseases, immune support, and fracture healing. Compared to the well-studied garden cress, the biochemical responses of its salt tolerant relative, Lepidium crassifolium remain to be explored. Lepidium crassifolium (other scientific name Lepidium cartilagineum subsp. cartilagineum) is a halophyte plant species naturally occurring in sodic soils in Great Hungarian Plain. Our study reveals the main different biochemical responses of these two Lepidium species during salt stress in controlled vertical farming system and simulated salt treatment conditions using mild (100 mM) and severe (300 mM) NaCl concentrations. Our results decipher some species-dependent alterations in growth parameters and related stress markers. These investigations contribute to apply halophyte plant species for human health promotion in the future not only in our planet but also in the extraterrestrial conditions.

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Development of a healthy casing alternative from spent mushroom compost

Henrietta Allaga[1*], Dóra Horkics[1], Ádám Bordé[1], András Varga[1], Rita Büchner[1], Terézia Kovács[2], András Misz[3], Csaba Csutorás[3], Judit Bajzát[3], Nóra Bakos-Barczi[3], Csaba Vágvölgyi[1], László Kredics[1]

[1]Department of Biotechnology and Microbiology, University of Szeged, Szeged, Hungary

[2]Institute of Biochemistry, Biological Research Centre, Szeged, Hungary

[3]Új Champignons Ltd., Budapest, Hungary

[*]henrietta.allaga@gmail.com

During the cultivation of white button mushroom (Agaricus bisporus), the mostly peat-based casing material – which covers the compost colonized by mushroom mycelia – plays an important role in the formation of fruiting bodies and in high-water retention capacity. Today, the supply of casing material for champignon cultivation is a major problem, as peat mines are being exhausted, furthermore, peat mining is a destructive industry, as peatlands - the world's largest terrestrial carbon sink - represent one of the most significant tools of climate change mitigation. Thus, it is a burning problem to develop new and healthy casing layer alternatives to avoid environmental damages and pollution.

A good quality casing material contains variable microorganisms. Our aim was to develop a healthy casing alternative from spent mushroom compost. Occurrent microorganisms in the spent Agaricus compost include both beneficial and harmful bacteria (e.g., Bacillus, Pseudomonas, Microbacterium, Alcaligenes species) and fungi (e.g., Trichoderma, Hypomyces, Fusarium, Lecanicillium, Mortierella, Rhodotorula species). From the genera Bacillus, Pseudomonas, Phanerochaete and Rhodotorula, many representatives have beneficial properties. Microorganisms (bacteria and fungi) were isolated from spent mushroom compost samples taken during a natural recomposting process. The isolates were identified, characterized, and a consortium was established to help the natural recomposting process, which resulted in a peat-like material full of nutrients. Mushroom cultivation trials in bags revealed, that mixed with peat in a 90:10 ratio, the recomposted spent mushroom compost is excellent for use as casing, furthermore, it also has potential as plant growing medium, therefore it has the potential to become a succesful example of circular agriculture.

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Effect of plasma-activated water seed priming on the development of *Arabidopsis thaliana* seedlings in a drought stress model system

Tamás Bodor[1,2*], Gábor Fejes[1,2], Kinga Kutasi[3], Zsuzsanna Kolbert[2]
[1]*Doctoral School of Biology, Faculty of Science and Informatics, University of Szeged*
[2]*Department of Plant Biology, University of Szeged, Szeged, Hungary*
[3]*Complex Fluid Research Department, Institute for Solid State Physics and Optics, HUN-REN Wigner Research Centre for Physics, Budapest, Hungary*
[*]*szlon92@gmail.com*

In the contemporary context of global climate change, plants are increasingly subjected to significant environmental stressors. Among these, drought represents one of the principal abiotic challenges, severely restricting crop productivity on a global scale. Various strategies have been developed to address drought-induced stress, with seed priming being a prominent technique. It is a cost-effective and sustainable approach with potential to improve drought resistance and subsequently enhance crop yield.

Plasma-based technologies facilitate the production of priming agents that are not only cost-effective and efficient but also exhibit a minimal environmental impact. Plasma-activated water (PAW) is generated using cold plasma, which enhances the concentration of reactive oxygen and nitrogen species (RONS) within the treatment medium. The concentration of RONS can be stabilized through the incorporation of zinc (Zn) into the solution [1], potentially augmenting the effectiveness of PAW as a priming agent. Seeds of the wild type Arabidopsis thaliana L. (Col-0) were incubated in various treatment solutions [distilled water (HP), PAW, PA(W+Zn), PA(W+ZnO nanoparticle)] for 24 hours, in darkness, at 24 °C.

To simulate drought conditions, polyethylene glycol 8000 treatment was administered for three days following an initial cultivation period of four days on stress-free agar media. Data on seedling growth such as root length, hypocotyl length, cotyledon area, stomatal density were collected. Additionally, cell viability, in planta zinc level, and the levels of in planta RONS (e.g. nitric oxide, peroxynitrite, superoxide radical, hydrogen peroxide) were detected.

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Future crop yield trends across Europe from past observations and ISIMIP climate scenarios

Tobias Conrad
Potsdam Institute for Climate Impact Research, Potsdam, Germany
conradt@pik-potsdam.de

A statistical crop yield model developed by the author, ABSOLUT [1], is capable of identifying the time aggregates of meteorological variables or indices most relevant for agricultural yields. Using ISIMIP climate change scenarios as input to the model calibrated on recent weather and yield data future crop yields have been projected for the districts of Germany and for Europe's NUTS-2 regions.
Results show strong weather effects on green maize (high coefficients of determination in leave-one-out validation) and a generally negative outlook for the future: The median scenario under CMIP6 SSP370 climate, represented by ten bias-corrected model realizations, shows 5–15% declines in green maize yields for the years around 2050 compared to nowadays levels in most European regions. Southern France, Northern Italy, and Bulgaria are predicted to experience yield losses of even more than 20%, albeit with lower reliability. The Mediterranean countries however include also some regions with positive trends on low confidence levels. In a more distant future of the years around 2080 the spatial pattern remains unaltered, but the strength of the changes will have doubled.
For winter wheat the model performs better in the eastern parts of Europe. Only slight declines in yield of 0–10% are projected there for the 2050 time slice; for the years around 2080 losses of more than 25% have to be expected, though. Drastic losses of 20–50% and exceeding 50% in the more distant future threaten many Mediterranean regions. There is however also a stable outlook for Britain and Ireland, The Netherlands, Belgium, and the North-Western parts of France. Yield increases are projected for Southern Finland and the Baltic states. This regional exception to the general downward perspective is in good agreement with a map presented in the European Drought Risk Atlas [2] whose authors implemented a different modelling approach.

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Isolation, identification and characterisation of potential biocontrol agents of walnut pathogens in Turkey and Hungary

Ahmet Akköprü[1], Younes Rezaee Danesh[1], Orsolya Kedves[2], Semra Demir[1], Emre Demirer Durak[1], Adnan Yaviç[3], Solmaz Najafi[4], Gokhan Boyno[1], Ceylan Pınar Uçar[5], Betül Yıldız Fırat[5], Árpád Bányi[6], Nóra Tünde Lange-Enyedi[7], Simang Champramary[7], Boris Indic[7], György Sipos[7], Csaba Vágvölgyi[2], László Kredics[2*]

[1]*Department of Plant Protection, Van Yuzuncu Yil University, Van, Turkey*

[2]*Department of Biotechnology and Microbiology, University of Szeged, Szeged, Hungary*

[3]*Department of Horticulture, Van Yuzuncu Yil University, Van, Turkey*

[4]*Department of Field Crops, Van Yuzuncu Yil University, Van, Turkey*

[5]*Institute of Natural Sciences, Van Yuzuncu Yil University, Van, Turkey*

[6]*Pannon-Trade Ltd., Győr, Hungary*

[7]*Functional Genomics and Bioinformatics Group, University of Sopron, Hungary*

[*]*kredics@bio.u-szeged.hu*

Walnut (Juglans regia) is a commercially significant hardwood species. Both Turkish and Hungarian walnuts are highly sought in global markets. However, climate change-related challenges, including cultivation difficulties and plant health issues, have continuously declined walnut yield and quality.

The decline of walnut trees is caused by pests and various bacterial and fungal pathogens, which increasingly affect trees as their natural resistance weakens. Presently, chemical pesticides are the primary means of protection. However, the accumulation of chemical residues in the food chain rises environmental and health concerns, intensifying the demand for sustainable, eco-friendly alternatives such as biological control methods.

In Turkey, Anatolia, particularly the Van Lake Basin, is a key genetic center for walnut and an important region for its cultivation. We aimed to detect Xanthomonas arboricola pv. juglandis (Xaj), the causal agent of walnut bacterial blight, and to identify potential biocontrol agents. Surveys conducted in 2024 across Van, Hakkari, and Bitlis provinces found no evidence of Xaj or disease symptoms. Bacterial isolates were obtained from walnut leaves in surveyed orchards, yielding 47 candidate biocontrol agents. Screening for plant growth-promoting traits revealed that 19% of isolates solubilized phosphate, 87% produced indole-3-acetic acid (IAA), 76.5% exhibited siderophore production, and 27.6% demonstrated nitrogen fixation ability.

In Hungary, our research focused on the microbial diversity associated with walnut trees. Soil and phyllosphere samples were collected from orchards with varying degrees of disease severity. Alongside walnut pathogens (Pantoea agglomerans, Agrobacterium tumefaciens, Alternaria angustifolia, Neofusicoccum parvum, Nothophoma spiraeae, Aspergillus sp.), potential biocontrol agents, including

Trichoderma, Bacillus, Pseudomonas, Streptomyces, and Simplicillium species, were identified and are under detailed characterization.
Our findings provide foundation for future research on biocontrol strategies in walnut cultivation both in Turkey and Hungary.

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Osmotic stress-induced anatomical changes in pea (*Pisum sativum* L.) leaves

Réka Szőllősi[1,2*], Gábor Fejes[1,2,3], Tamás Bodor[1,2,3], Zsuzsanna Kolbert[1,2]
[1]*Department of Plant Biology, University of Szeged, Szeged, HUNGARY*
[2]*SZTE-MTA "Lendület" MOMENTUM Plant NaNObiology Research Group*
[3]*Doctoral School of Biology, Faculty of Science and Informatics, University of Szeged*
[*]*szoszo@bio.u-szeged.hu*

Due to the weather extremities and decreased amount of rainfall in the last few years, drought stress has become a threatening factor for the plants, mainly in the southern part of Hungary. In order to elucidate the potentially detrimental effects of osmotic stress on the anatomical traits of plants, we used pea plants as model. In our study, pea (Pisum sativum L. cv. Petit Provencal) seeds were primed (pre-treated) with distilled water (hydroprimed, HP) for 24 h, then plantlets were cultivated for 10 days, finally the half of the plants were exposed to osmotic (drought) stress for 3 days, using 20 w/v% polyethylene glycol (PEG8000; indicated as PEG20). Since PEG-treatment caused spectacular decay of the leaves, we compared the leaf structure of HP and PEG20 pea plants. Leaf segments were fixed and embedded in agarose to make cross sections by vibratome. Leaf sections were observed and photographed by light microscopy, and the following parameters were measured: leaf thickness, mesophyll thickness, the thickness and the ratio of palisade and spongy mesophyll. Our results showed that PEG-treatment resulted in not only fewer leaves with withered leaflets but it decreased the thickness of the leaf blade and the entire mesophyll, and mainly the amount of spongy mesophyll cells which seems to be a characteristic anatomical response for drought stress.

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Enhancing hydrocarbon biodegradation: Repeated application of extracellular organic matter from Micrococcus luteus in used lubricant oil-contaminated soils

Klaudia Hoffmann[1*], Enikő Mészáros[2], Gábor Feigl[2], Krisztián Laczi[1], Katalin Perei[1], Attila Bodor[1]

[1]*Department of Biotechnology and Microbiology, University of Szeged, Szeged, Hungary*

[2]*Department of Plant Biology, University of Szeged, Szeged, Hungary*

[*]*hoffmannklaudia99@gmail.com*

Used lubricant oils (ULOs) can accumulate various harmful compounds (e.g., heavy metals, polychlorinated or polyaromatic hydrocarbons) and cause persistent pollution in the soil environment, thereby disrupting its natural habitat functions or potential future use. Under such adverse conditions, microorganisms, including hydrocarbon degraders, can enter a low- or zero-activity viable but non-culturable (VBNC) state. Consequently, the success of biological rehabilitation techniques largely depends on maintaining microbial activity or reactivating VBNC cells through the application of biostimulant agents. Resuscitation-promoting factors (Rpfs) have been shown to be effective in the initial stages of bioremediation of ULO-contaminated soils. In this study, we aimed to extend the early phase stimulatory effect of Rpf-containing extracellular organic matter (EOM) from Micrococcus luteus to enhance ULO-biodegradation efficiency in polluted soils. ULO-contaminated ex situ soil microcosms were supplemented with EOM at the beginning of the experiment (Day 0) and again at the end of the first ULO-biodegradation phase (Day 20). By the end the 60-day incubation period, the initial concentration (30,300 mg/kg) of extractable petroleum hydrocarbons (EPHs) was reduced by 56% in the soil treated with repeated EOM application combined with biostimulation (BS+2xEOM), while single EOM dosing (BS+EOM) resulted in a significantly lower ULO-bioconversion of 46%. Moreover, BS+2×EOM significantly increased microbial colony-forming units (CFUs), respiration, and soil enzyme activities (dehydrogenase, catalase, sucrase, and fluorescein diacetate hydrolase) compared to the corresponding control treatments (natural attenuation, biostimulation, biostimulation+EOM). Although BS+2×EOM and BS+EOM showed the most effective bioremediation outcomes, the germination index of oilseed rape (Brassica napus L.) decreased to 43% and 42%, respectively, in the treated soils. Our results indicate that while microbial activities were stimulated and pollution levels reduced, these improvements do not necessarily translate to decreased soil phytotoxicity.

A Research Station Plan for the Global Challenges of the 21st Century

László Horváth[1*], Zoltán Bozóki[1,2], Edit Mikó[3]
[1]*HUN-REN-SZTE Research Group for Photoacoustic Monitoring of Environmental Processes, University of Szeged, Szeged, Hungary*
[2]*Department of Optics and Quantum Electronics, University of Szeged, Szeged, Hungary*
[3]*Institute of Animal Sciences and Wildlife Management, University of Szeged, Hódmezővásárhely, Hungary*
[*]*horvathl@titan.physx.u-szeged.hu*

In Hungary, global climate change is reflected in rising annual average temperatures and decreasing total precipitation. The consequences include heat and drought stress in plants, desertification, and soil degradation due to carbon loss. These changes threaten food security, reduce biodiversity, shift phenological phases, and cause a range of other environmental impacts.

To investigate these challenges, we have designed a complex environmental monitoring station on a 4-hectare semi-natural grassland located between the towns of Hódmezővásárhely and Szeged. The research focuses on the following key areas:

The risk of dry summers is among the highest in the Southern Great Plain region. Given the limitations of irrigation-based agriculture, it is crucial to emphasize improving the soil's water retention capacity. By measuring evapotranspiration, we aim to assess water retention and the improvements in water use efficiency resulting from no-till techniques in the Southern Great Plain.

Continuous monitoring of soil organic carbon content will help estimate the rate of carbon sequestration. Drought conditions negatively impact the soil's ability to store carbon, and there is a strong correlation between annual precipitation and net ecosystem carbon exchange. In years of low rainfall, net sequestration may reverse, leading to carbon loss.

Nitrogen loss due to fertilization and how it is influenced by climate change is another core objective. Globally, around half of all applied fertilizer is not utilized by crops, placing a significant burden on the environment. The consequences include soil acidification, depletion of the stratospheric ozone layer, an enhanced greenhouse effect, the spread of nitrophilous species, acid rain, smog formation, and health hazards. Measuring the flux of ammonia and nitrous oxide emitted into the atmosphere from fertilization using photoacoustic methods is also part of the research station's planned activities.

Plasma activated water-based seed pre-treatment affects the development, in planta reactive oxygen- and nitrogen species and photosynthetic activity of osmotic-stressed pea plants

Gábor Fejes[1,2,3*], Tamás Bodor[1,2,3], Réka Szőllősi[2,3], Kinga Kutasi[3,4], Zsuzsanna Kolbert[2,3]

[1]*Doctoral School of Biology, Faculty of Science and Informatics, University of Szeged*

[2]*Department of Plant Biology, University of Szeged, Szeged, Szeged, Hungary*

[3]*SZTE-MTA "Lendület" MOMENTUM Plant NaNObiology Research Group, Szeged, Hungary*

[4]*Institute for Solid State Physics and Optics, HUN-REN Wigner Research Centre for Physics, Budapest, Hungary*

[*]*gafej10@gmail.com*

Nowadays, drought has become a prominent problem. New methods resulting in healthier plants and better yields are needed to alleviate drought stress. The use of plasma activated fluids enables a new green and sustainable approach. Seed-pretreatment is a technique with which we can enhance the growth and resilience of plants leading to better germination, yield and stress response.

The aim of our model experiments is to study the effect of plasma-activated water (PAW) seed pre-treatment on osmotic stress tolerance. The ratio of reactive oxygen and nitrogen species (RONS) in PAW were modified by the addition of zinc ion (Zn). The following treatments were used for pea (Pisum sativum L. cv. Petit Provencal) seeds: distilled water (HP), PAW, PA(W+Zn) and Zn. After one day long seed treatment, the plants were grown for 10 days, followed by 72 h of osmotic stress treatment (20 w/v% polyethylene glycol, PEG8000). PEG8000 significantly reduced the stem length, primary and lateral root number, which could not be significantly improved by seed pre-treatments. In contrast, PEG8000-induced viability loss and hydrogen peroxide accumulation were reduced by PAW seed pre-treatment. Osmotic stress significantly increased in planta nitric oxide levels, which were not significantly affected by any of the seed treatments. In further studies, we detected levels of other RONS in root tips. PAW seed treatments improved leaf development, therefore photosynthetic parameters were investigated using porometer and OJIP (with FluorPen).

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Cellulose content in annual increments of Norway spruce (*Picea abies* (L.) Karst.) along an elevation gradient in the Rarău Mts (Romania)

Daniela Maria Llanos-Campana[1*], Zoltan Kern[2], Ionel Popa[3,4], Aurel Perșoiu[5,6]
[1]*Doctoral School of Environmental Sciences, Eötvös Loránd University, Budapest, Hungary*
[2]*Institute for Geological and Geochemical Research, HUN-REN Research Centre for Astronomy and Earth Sciences, Budapest, Hungary*
[3]*National Institute for Research and Development in Forestry Marin Dracea, Campulung Moldovenesc, Romania*
[4]*Center of Mountain Economy -INCE - CE-MONT Vatra Dornei, Romania*
[5]*Emil Racoviță Institute of Speleology, Romanian Academy, Cluj-Napoca, Romania*
[6]*Stable Isotope Laboratory, Ștefan cel Mare University, Suceava, Romania*
[*]*dani-llanos@student.elte.hu*

The studies on quantity of the cellulose content (CC%) of tree rings, calculated from the dry weight and the cellulose weight of a wood sample and its implication for dendroclimatological studies are quite scarce and even less is known about the influence of environmental conditions on the annual variability of the CC%.
CC% series from Norway spruce (Picea abies (L.) Karst.) was investigated in the Eastern Carpathians collected from three stands along an altitudinal gradient. Three individual trees were sampled in each stand and the α-cellulose of the annual increments laid between 1961 and 2020 have been extracted based on a modified Jayme–Wise procedure.
We hypothetized that (H1) positive correlation between CC% and mean summer temperature for the spruce stands; and (H2) CC% values can be lowest for high elevation tree-ring material, as a reflection of the colder conditions typically prevailing near the timberline.
The CC% series showed a significant increase in mean interseries correlation, such as low stand (r=0.1, p=0.4), middle (r=0.33, p=10-2), and high elevation (r=0.59, p=10-5) as moving toward the timberline. The mean CC% series showed positive correlation with thermal conditions of the growing seasons with a response peaking in the early growing season at the low elevation (rMay=0.27), and mainly in high summer at the middle (rMay-Aug=0.56), and high (rJul-Aug=0.65) elevation stands. These results from this pilot study support both hypotheses and encourage further testing of tree-ring cellulose content of Norway spruce as a supplementary proxy in dendroclimatology and dendroecology.

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Frost rings in Swiss Stone Pine (*Pinus cembra*) from Rodna Mts. (Romania) - Anatomical evidence of late spring frost in the past centuries

Eszter Mocsári*, Balazs Nagy[1], Ionel Popa[2], Matyas Arvai[3], Zoltan Kern[4]
[1]*Department of Physical Geography, Eötvös Lorand University, Budapest, Hungary*
[2]*National Institute for Research and Development in Forestry "Marin Drăcea", Câmpulung Moldovenesc, Romania*
[3]*Department of Soil Mapping and Environmental Informatics, HUN-REN Centre for Agricultural Research, Budapest, Hungary*
[4]*Institute for Geology and Geochemistry, HUN-REN Research Centre for Astronomy and Earth Sciences, Budapest, Hungary*
**mocs.eszti@gmail.com*

In this study, we analysed the tree ring features of Swiss Stone Pine (Pinus cembra L.) from the Zănoaga Valley, Rodna Mountains, Romania. The aim was to build a tree ring chronology and detect anatomical evidence associated with historical frost damage in the xylem. Tree-ring width were measured and checked using a LINTAB measuring table and the TSAPWin software. A total of six discs (dead trees) and four core samples (living trees) were analysed and the tree ring width chronology spans from 1551 to 2007 CE, covering nearly half a millennium. In every individual sample there is evidence of anatomical modification typical for frost damage. A total of 58 frost injuries were detected within the studied period. In the first half of the period represented by the disc samples, 47 frost damages were identified. However, after 1831 CE, these samples no longer showed any frost injuries. In the core samples, 11 damages were visible, with frost-related anomalies still present in the early 20th century. A significant frost event was recorded in 1876 CE, with its imprint observable in 75% of the core samples.
Some of the frost ring event detected in the Rodna Mts are found in the frost-ring chronologies of the Călimani Mts (~70 km SE direction) and the Retezat Mts (~280 km in SSW direction) suggesting regional spring frost events in the historical time affecting extended regions across Southeast Europe.

The impact of polyethylene-based plastics and heavy metals on rapeseed root growth

Kamilla Kovács*, Enikő Mészáros, Dorottya Hicz, Gábor Feigl
Department of Plant Biology, University of Szeged, Szeged, Hungary
**kambikov@gmail.com*

The efficient functioning of agriculture plays a vital role for society, so the study of abiotic stressors that threaten agricultural crops is particularly important. Artificial polymers, such as plastics, pose a serious environmental risk because they accumulate as waste, are fragmented and have the ability to bind pollutants such as heavy metals. In metal-polluted areas, where sewage is used as fertilizer, high concentrations of several metals often occur. When plastic pollution is also present, plants have to cope with multiple stressors during their development.

In the present study, we investigated the effect of three types of plastics, PE (polyethylene), LDPE (low-density polyethylene), LLDPE (linear low-density polyethylene), in the presence of solutions containing multiple heavy metals, on the early root growth of rapeseed (Brassica napus L.). During the experiment, 1 cm plastic fragments were soaked at different concentrations (0.5-1%) in distilled water and model wastewater containing heavy metals (Cd, Cr, Cu, Hg, Ni, Pb, and Zn) at the highest concentrations allowed by law.

The results show that plastics had a generally positive effect on rape root growth, while model wastewater treatment slightly reduced it. In most cases, the coexistence of plastics and heavy metals did not cause more stress than the combined heavy metal treatment. The presence of both contaminants together did not appear to significantly inhibit the early root development in rapeseed. A deeper understanding of the problem is of paramount importance for sustainable agriculture.

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The role of chitosan-encapsulated NO-donors in enhancing tomato resistance to fungal infections

Dóra Kondak*, Selahattin Kondak, Tamás Bodor, András Kukri, Réka Szőllősi, Zsuzsanna Kolbert
Department of Plant Biology, University of Szeged, Szeged, Hungary
**kondakdora@gmail.com*

Agricultural production worldwide is severely threatened by fungal pathogens, which are responsible for approximately 70-80% of plant diseases, causing significant economic losses (Zhang et al., 2023). Among these pathogens, Botrytis cinerea, a polyphagous, necrotrophic fungus, is particularly dangerous as it can infect all parts of tomato plants through direct contact or wounds (Sarven et al., 2020). This infection leads to direct losses such as yield reduction and unmarketable crops, as well as indirect damages, including quality deterioration and increased control costs, resulting in annual economic losses amounting to billions. One promising approach for sustainable plant protection is the application of nanotechnology-based strategies, particularly those utilizing nitric oxide (NO). NO is a key signaling molecule involved in plant growth regulation and stress tolerance, with increasing evidence supporting its role in plant defense against pathogens. Its reaction product, S-nitrosoglutathione (GSNO), serves as an effective NO donor that contributes to enhancing plant immunity. GSNO-based polymer nanodonors, encapsulated in biodegradable chitosan (CHT), enable targeted and sustainable NO delivery (Seabra et al., 2022). This approach can strengthen plant signaling and defense mechanisms, offering an effective alternative to conventional fungicides. In this study, Solanum lycopersicum L. cv. Money Maker tomato fruits were infected with B. cinerea B05.10 at a spore concentration of 10^6 spores/ml. Prior to infection, fruits were treated with free GSNO, chitosan-encapsulated GSNO, or empty CHT nanodonors at 5 mM concentrations, applying 1 ml per fruit via spraying. Infection symptoms were assessed three days post-inoculation. The results provide insights into the effectiveness of nanotechnology-based approaches in reducing fungal infections while evaluating their impact on fruit quality.

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In silico assessment of the ecotoxicological characteristics of terbuthylazine as a pollutant in surface waters

Tatjana Mitrović[1*], Darija Obradović[1], Saša Lazović[1], Marija Perović[2]
[1]*Institute of Physics Belgrade, University of Belgrade, Belgrade, Serbia*
[2]*Jaroslav Cerni Water Institute, Belgrade, Serbia*
[*]*tmitrovic@ipb.ac.rs*

Terbuthylazine (TBA), a triazine herbicide is commonly applied in agricultural activities to eliminate weed species and optimize crop yields. Following application, the accumulated TBA can persist in the environment and contaminate water sources via surface runoff and leaching. Consequently, human exposure to TBA through food chain may lead to a range of adverse health outcomes [1]. In our research, we applied various in silico methodologies to predict the biomimetic properties of TBA and evaluate its ecotoxicological impact on living organisms [2].

Preliminary studies (ADMETlab 3) indicate a significant toxicological profile such as cancerogenity and respiratore toxicity. Activity on liver enzymes (CYP2D6), passage through the blood-brain barrier and consequent neurotoxicity and endocrine toxicity can be expected as well (ProTox 3). The predicted bioconcentration factor (assesses the potential for secondary poisoning and the risk to human health via the food chain) is 0.946. The aquatic ecotoxicity is considered through values of LC50FM=5.30 (96-hour fathead minnow 50 % lethal concentration), and LC50DM=4.22 (48-hour daphnia magna 50 % lethal concentration). The predicted oral toxicity, LD50 for TBA is 750 mg/kg (Class 4). We assessed the impact on the human body of consuming one liter of water for measured 8.2 µg/l of TBA (OPERA). Predictions show that TBA will be mostly accumulated in the liver (7.8 µg/ml) and intestines (5.3 µg/ml) which can cause liver damage. Pharmacokinetic predictions indicate a high degree of human intestinal absorption (HIA=0.894), which further increases the toxic effect of its increased concentration in the intestines. In the case of a pregnant woman, it can be expected to cross the placenta and cause liver damage (36.38 µg/ml) and kidney damage (28.25 µg/ml). There is also accumulation in the thyroid gland (13.91 µg/ml) which may lead to delayed fetal development. The obtained data indicate an important ecotoxicological risk of TBA and the possibility of toxic effects including pregnant women.

Zinc Oxide Nanoparticles: Dual Effects on Broccoli Growth Under Nutrient and Salinity Stress

Adedokun Oluwatosin Peace[1], Batnasan Ganbold[1], Rebeka Karginov[1], Andrea Rónavári[2], Ágnes Szepesi[1*], Zoltán Kónya[2]
[1]*Department of Plant Biology, University of Szeged, Szeged, Hungary*
[2]*Department of Applied and Environmental Chemistry, University of Szeged, Szeged, Hungary*
[*]*szepesi.agnes@szte.hu*

As climate change intensifies, rising temperatures increase evaporation rates, leading to higher soil salinity. In addition, irrigation with saline water is becoming an increasing challenge for crop production in many regions. Understanding plant stress responses is essential for developing strategies that can improve plant stress tolerance. Nanoparticles may be good candidates for this purpose, but our current knowledge of the effects of these compounds is limited.

Zinc oxide nanoparticles (ZnO-NPs) have attracted attention in agriculture due to their potential to enhance plant growth, but their environmental impact remains a concern. The ability of ZnO-NPs to alleviate salt stress suggests that they may be able to maintain agricultural productivity under such conditions. In our controlled vertical farming system, we investigated how ZnO-NPs affect the growth of broccoli microgreens (Brassica oleracea) under different nutrient levels and salinity, assessing their role as growth modulators and potential stressors.

Under nutrient-rich conditions, higher ZnO-NP concentrations maintained or slightly improved plant growth, while lower concentrations were more beneficial in nutrient-limited environments. Under distilled water treatment, exposure to ZnO-NPs negatively affected plant development, suggesting potential toxicity in the absence of nutrients. However, under salinity stress, ZnO-NPs significantly improved fresh weight compared to untreated plants, highlighting their ability to reduce salt-induced growth inhibition.

Our efforts are needed to properly balance the benefits of nanoparticle applications with environmental considerations, ensuring resilient and sustainable crop production in the face of global climate challenges.

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The role of climate microrefugia in shaping intraspecific trait variability in *Myrmica ruginodis*

Bonita Ratkai[1,2*], Kata Anna Bán[1,2], Kata Frei[1,3], Gergely Horváth[4,5], Gábor Li[1,3], Ádám Lőrincz[1,2], Gábor Lőrinczi[1], Fanni Pécsy[1,3], Zoltán Bátori[1,6], István Elek Maák[1,7]

[1]*Department of Ecology, University of Szeged, Szeged, Hungary*

[2]*Doctoral School of Biology, University of Szeged, Szeged, Hungary*

[3]*Doctoral School of Environmental Sciences, University of Szeged, Szeged, Hungary*

[4]*Department of Systematic Zoology and Ecology, Eötvös Loránd University, Budapest, Hungary*

[5]*HUN-REN-ELTE-MTM Integrative Ecology Group, Budapest, Hungary*

[6]*MTA-SZTE 'Lendület' Applied Ecology Research Group, University of Szeged, Szeged, Hungary*

[7]*Museum and Institute of Zoology, Polish Academy of Sciences, Warszawa, Poland*

[*]*bonitaratkai@gmail.com*

Climate change is transforming habitats worldwide, altering environmental conditions critical for species survival. Heterogeneous landscapes, such as sinkholes, are becoming increasingly important as they provide diverse microhabitats that support species with different ecological requirements. A distinctive characteristic of sinkholes is their significant microclimatic variation, particularly on north-facing slopes and bottoms, which are cooler and more humid than the surrounding plateaus. While previous studies suggest that sinkholes harbour species with distinct traits, little is known about their influence on intraspecific trait variation—specifically, how populations of the same species adapt to different environmental conditions. To address this knowledge gap, we investigated how sinkhole habitats affect the functional and behavioural traits of the ant species Myrmica ruginodis, which can significantly impact their fitness. Our results showed no significant differences in overall functional and behavioural trait patterns. However, sinkholes had a notable impact on certain functional and behavioural traits. Virgin queens were more abundant on the plateaus, while males were more numerous in sinkholes, although colony size did not differ significantly between the two microhabitats. Sinkholes contained more worker brood, suggesting a greater potential for colony growth. Notably, worker aggressiveness was more consistent, and worker size showed greater variability in sinkholes, emphasizing the distinct individual traits of these colonies. These findings highlight the role of small-scale habitat features in driving intraspecific trait variation and emphasize the potential of habitat islands like sinkholes to promote ecological and behavioural diversity. As climate change continues to reshape ecosystems, such microhabitats may become increasingly crucial in maintaining biodiversity.

Temperature and geographical location induced fluctuations of population density of European ground squirrels in Hungary

Csongor Gedeon[1*], Olivér Váczi[2], Felix Knauer[3], Mátyás Árvai[1], Franz Suchentrunk[3]
[1]*Department of Soil Mapping and Environmental Informatics, Institute for Soil Sciences, HUN-REN Centre for Agricultural Research, Budapest, Hungary*
[2]*Herman Ottó Institute Nonprofit Ltd., Budapest, Hungary*
[3]*Research Institute of Wildlife Ecology, University of Veterinary Medicine, Vienna, Austria*
[*]*gedeon.csongor@atk.hun-ren.hu*

Rodent populations often undergo demographic fluctuations and cycles, highlighting the need to understand the underlying factors for accurate predictions, especially for endangered species. We analyzed long-term data from the Hungarian Biodiversity Monitoring Scheme on European ground squirrel populations to assess abiotic factors influencing spatial and temporal dynamics in Hungary. Using generalized additive models with splines, we examined the relationship between relative population density—monitored annually since 2000—and environmental and weather variables. Our findings identified location, year, and winter temperatures as key determinants of ground squirrel density. Populations in central Hungary had higher densities, while those in the northern and southern regions were lower. Additionally, winter temperatures during hibernation contributed to density fluctuations. Given the overall decline, our results suggest that rising winter temperatures may negatively affect ground squirrel survival and population density.

The accelerated spruce dieback in Central Europe is a warning sign of the climate change

Zsuzsa Lisztes-Szabó[1*], Mihály Braun[1], Albert Tóth[1], Elemér László[1], József Lennert[2], Anna F. Filep[3]

[1]*HUN-REN Institute for Nuclear Research, Debrecen, Hungary*

[2]*HUN-REN Centre for Economic and Regional Studies, Budapest, Hungary*

[3]*Pál Juhász-Nagy Doctoral School of Biology and Environmental Sciences, University of Debrecen, Debrecen, Hungary*

[*]*lsz.zsuzsa@atomki.hu*

The Norway spruce (Picea abies (L.) Karst) dominates the European boreal forests, subalpine areas in the Alps and the Carpathian Mountains. It is also widely planted outside its natural range and has considerable economic and ecological importance. In 2023, a remarkable summer heat struck many parts of the Earth, leading to considerable tree dieback. In addition to the data of the statistical office, we collected data from citizens of the Hungarian administrative units from the Carpathian Basin to assess the intensity and extent of planted spruce dieback. As a result, the spruce tree loss had an alarming rate in the last year (59.1±1.5 percent of planted spruce tree dieback was reported) indicating accelerated climate change. Our study draws attention to several conclusions derived from this. Extreme climate events (1) increase people's will to react, (2) can make the species' survival impossible on a regional scale even within a few years and (3) can cause unpredictable, cascade-like complex transformations in ecosystems and in the agriculture, for which environmental policy must be prepared in economic and social aspects. (4) Extreme climate events can more quickly make drastic changes than we have thought and (5) the signs of it appear in basin areas first.

Extreme Dry Events in Vojvodina: Observations and Climate Change Projections

Atila Bezdan*, Jovana Bezdan
Department of Water Management, Faculty of Agriculture, University of Novi Sad, Novi Sad, Serbia
*atila.bezdan@polj.edu.rs

As a result of climate change, the Vojvodina region in northern Serbia is witnessing more frequent extreme weather events. Considering the existing trends and future climate change projections, a wide range of impacts is anticipated on the agricultural sector. The Consecutive Dry Days (CDD) metric, commonly utilized in drought research, serves as an important indicator of drought severity by measuring the duration of dry spells. Understanding short-term droughts and their impact on agriculture and ecosystems is crucial. This research studied the occurrence and length of extreme CDDs during the growing season for historical (1950-2019) and future (2020-2100) periods in the Vojvodina region for 9 locations. This analysis utilized an ensemble of eight downscaled, bias-corrected regional climate models from the EURO-CORDEX database, focusing on the RCP8.5 scenario to assess future CDD events. The analysis of CDD events was conducted using the Threshold Level Method on precipitation data, defining extreme CDDs as periods of at least 15 consecutive days without rain. The adapted threshold was chosen as it is more relevant for agriculture, considering that field crops may suffer from water stress after 15 days without rain or irrigation. The research examined various aspects of the stochastic process for CDDs, focusing on the distribution patterns of three key elements: distribution of the number and duration of CDD events, and distribution of the longest CDD events. To determine if extreme CDDs events act as independent and identically distributed random variables, run tests at a 5% significance level were conducted for all nine locations, utilizing both historical data and the chosen ensemble of eight regional climate models. These run tests confirmed the randomness hypothesis. Additionally, serial correlation coefficients for the series of extreme CDD events were computed, and a significance test at the 5% probability level indicated the independence of these CDDs, revealing no notable serial correlation within the data. The Poisson distribution was used to model the number of extreme CDD events, the exponential distribution function was used to model the distribution of the duration of CDDs, and the Gumbel distribution was selected to model the durations of the longest CDD events. The results indicate an increased likelihood of more frequent and severe droughts in the future, compared to historical data. There is an expected rise in the probability of 3 to 6 dry periods in the growing season. Moreover, the lengths of the longest CDDs within a growing season are anticipated to extend, reaching up to 57 days for a 10-year return period and 83 days for a 100-year return period. This trend suggests a worsening in drought conditions, particularly in the eastern and northern areas of the Vojvodina region. These insights are valuable for predicting future agricultural drought scenarios, aiding decision-makers in adjusting agricultural practices to mitigate the adverse effects of climate change.

Observed long-term trend in various extreme precipitation-related climate indices

Csilla Simon[1,2*], Mónika Lakatos [1], Olivér Szentes [1,2]
[1]*Unit of Climate Research, HungaroMet Hungarian Meteorological Service, Budapest, Hungary*
[2]*ELTE Faculty of Science, Doctoral School of Earth Sciences, Budapest, Hungary*
[*]*simon.cs@met.hu*

Precipitation is one of the most important meteorological elements, and its absence can cause severe damage to the ecosystems, agriculture and forestry, on the other hand, intense rainfalls may also led to devastation, e.g. flash floods, which are one of the most dangerous natural hazards. Therefore, climate monitoring is very important, which allows us to detect the long-term changes of meteorological variables including precipitation. In addition, it can help us to prepare for the adaptation to the expected change in climate extremes.

To analyse the observed climate trends, using measurement-based, long data series of good quality is essential. At the Unit of Climate Research of the Hungarian Meteorological Service (HungaroMet) the MASH (Multiple Analysis of Series for Homogenization) software is used for producing homogenised, quality controlled, completed (free from missing data) station data series. After homogenization process, in order to obtain spatially representative data for Hungary, the homogenised station data series are interpolated onto a 0.1° horizontal grid using the MISH (Meteorological Interpolation based on Surface Homogenized Data Basis) method developed specifically for meteorological variables.

On the HungaroMet webpage, several extreme temperature climate indices are already available for 24 settlements, as well as for the nationwide average, dating back to 1901. As part of this research, precipitation indices will be created and analyzed for the period 1901–2024 using homogenised daily station data series to support local climate adaptation efforts. In this study, the results are presented for Szeged and Budapest for the following extreme precipitation-related climate indices: consecutive dry days, the highest daily precipitation sum and very heavy precipitation days (days with a precipitation sum of at least 20 mm). The indices are illustrated on a yearly basis using graphs. A linear trend model is fitted to the index values to assess the impact of climate change in observations.

Eutrophication in Freshwater Ecosystems: Impacts of Nutrients, Groundwater, and Climate Change

Marija Perović[1*], Vesna Obradović[1], Mitrinović David[1,2,] Tatjana Mitrović 2
[1]*Jaroslav Černi Water Institute, Belgrade, Serbia*
[2]*Institute of Physics, University of Belgrade, Belgrade, Serbia*
[*]*marija.perovic@jcerni.rs*

The eutrophication presents the natural response of freshwater ecosystems to increased nutrient inputs. It is noticed that uncontrolled algal growth is intensified by global warming, leading to deterioration of water quality. The sources of high nitrate and phosphate concentrations are usually caused by improper fertilization techniques, inadequate manure storage, and untreated wastewater impact. Due to increased content of organic matter in water bodies, its subsequent decomposition leads to oxygen depletion, pH decrease, and creates hypoxic or anoxic conditions, resulting in fish mortality and ecosystem destabilization. The phenomenon of blooming reduces light penetration, increases turbidity, and leads to layering of the water body, making it unsuitable for drinking or irrigation. In the case of harmful algal toxins appearance, the risks to aquatic life, livestock, and human health are significant. Although it is often acknowledged that surface nutrient loads are the primary causes of eutrophication, groundwater influx during surface water recharge should also be considered. The content of nitrogen and phosphorus can be further increased if the surface water recharges with nutrient-enriched groundwater, maintaining eutrophic conditions even during times when surface inputs are reduced. This kind of nutrient-loaded recharge can prolong algal blooms, disrupt natural self-purification processes, and decrease the effectiveness of lake management techniques like sediment management, biological restoration, nutrient load reduction, and algal bloom control. Sediment temperature has a significant impact on nutrient cycling. The temperature increase induces microbial activity, thus organic matter content and consequently releases phosphate (PO_4^{3-}) and ammonia (NH_4^+) from sediments. Because of longer stratification periods and higher microbial activity, summertime usually sees the most obvious nutrient release from sediments. The seasonal peaks are prolonged, and nutrient retention is increased by rising global temperatures. The intensification of eutrophication brought on by climate change reflects precipitation patterns, with heavy rains increasing nutrient-rich discharge and droughts lowering water exchange. Disturbed patterns of oxygen saturation, water layering and stratification impact biodiversity, and usability of water, emphasizing the need for climate-adaptive strategies to protect freshwater resources.

II. Natural Hazards and Climate Change Conference

Poster Session II

Biodegradable plastics: A growing concern for early plant development – *Enikő Mészáros, Kamilla Kovács, Gábor Feigl*

Lateral channel migration and riverbank degradation: A natural process or environmental threat? – *Marko Langović, Slavoljub Dragićević, Nenad Živković*

Urbanisation effect on the butterfly communities of river dikes – *Szabolcs Borbáth-Székely-Varga, Attila Torma*

1500 Years of Flooding in Romania: Climatic and Anthropogenic Influences – *Ioana Persoiu, Maria Radoane, Gabriela Florescu, Aurel Persoiu, Alexandru Hegyi*

Evaluating Levee Stability: Simulating Flood Scenarios Using Time-Lapse ERT for Improved Risk Mitigation – *Ahmed M. Ali, Attila Tímár, James Boyd, Enas Abdelsamei, Diaa Sheishah, Alexandru Hegyi, György Sipos*

Statistics on the frequency of rain and snow-rain floods on rivers of the Tisza basin within of Ukraine – *Stanislav Moskalenko*

Improving wind hazard assessment using high-resolution numerical weather prediction models and interpolation techniques in Hungary – *Kinga Bokros, Beatrix Izsák, Natália Szalontainé Gáspár, Dávid Lancz, Mónika Lakatos, Rita Pongrácz*

Natural Hazards and Society in Croatia: Impacts and Public Health Interventions – *Ivan Miskulin, Ivana Kotromanovic Simic, Nika Lovrincevic Pavlovic, Jelena Kovacevic, Maja Miskulin*

Investigating Mortality Trends in a Warming Climate with a special focus on urban population in Asia – *Sandugash Abisheva, Rita Pongrácz*

Biodegradable plastics: A growing concern for early plant development

Enikő Mészáros*, Kamilla Kovács, Gábor Feigl
Department of Plant Biology, University of Szeged, Hungary
**meszaroseniko29@gmail.com*

Plant growth and productivity are adversely affected by various biotic and abiotic environmental stressors. In addition to traditional stressors, plastic pollution is becoming an increasingly serious problem due to its long-term negative effects on plant growth and ecosystem health. The growing popularity of biodegradable plastics (BDPs) as a sustainable alternative to conventional polymers raises new questions about their environmental impact, in particular their effects on agricultural ecosystems.

This study investigated the effects of two types of BDPs, polylactic acid (PLA) and an agricultural mulch film composite, on the germination and early root development of 15 plant species from different taxonomic groups under in vitro conditions. During the experiments, we used plastic fragments of different sizes and concentrations (0.5-1%), simulating environmentally relevant plastic pollution. Our results show that different plant species and plastic types respond differently to the treatments, with PLA significantly inhibiting germination of monocots, especially sorghum (Sorghum bicolor L.), and reducing early root growth in radish (Raphanus sativus L.). The composite agricultural mulch film significantly reduced germination of radish and flax (Linum usitatissimum L.), while having minimal negative effects on sorghum root growth and even slightly stimulating root growth of white mustard (Sinapis alba L.).

The results indicate that BDPs cause stress to early plant development in several species, pointing to potential agricultural risks from BDP residues in the soil environment. Further research is needed to better understand their long-term effects, particularly on agricultural productivity and ecosystem health.

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Lateral channel migration and riverbank degradation: A natural process or environmental threat?

Marko Langović*, Slavoljub Dragićević, Nenad Živković
Faculty of Geography, University of Belgrade, Belgrade, Serbia
**marko.langovic@gef.bg.ac.rs*

Contemporary research on fluvial process involves a comprehensive examination of the increasingly complex interactions between natural forces and human activities. Riverbank erosion, as a component of lateral channel migration, is therefore characterized as a continuous and highly significant geomorphological process in floodplains. The lateral bank erosion of meandering rivers is responsible for extensive agricultural land loss and landscape degradation. The genesis, direction, and intensity of lateral river channel migration exert significant pressure on various environmental aspects—ecological, social, economic, and demographic. Environmental transformation is inevitable: bank degradation results in the loss of land along the concave side of the river, while, conversely, the accumulation of eroded material occurs on the convex sides. This paper aims to identify the main consequences of riverbank erosion and assess the intensity of this process on the environment. Accordingly, optimal measures and activities to mitigate these consequences are proposed. The South Morava River (Republic of Serbia) was used as a case study, where previous research has documented intensive lateral migration and riverbank erosion. The results indicate significant consequences, particularly in terms of agricultural land degradation, as well as secondary economic and financial impacts. These findings could serve as a foundation for further research in the field of riverbank erosion and environmental degradation.

Urbanisation effect on the butterfly communities of river dikes

Szabolcs Borbáth-Székely-Varga[1*], Attila Torma[1,2]
[1]*Department of Ecology, University of Szeged, Szeged, Hungary*
[2]*'Lendület' Landscape and Conservation Ecology, Institute of Ecology and Botany, HUN-REN Centre for Ecological Research, Vácrátót, Hungary*
[*]*szabolcs0.20@gmail.com*

Linear landscape elements (LLE), such as roads, ditches, and dikes, often have a vegetated part, which can support species-rich flora and fauna. These LLEs are becoming increasingly important for biodiversity conservation in human-modified, fragmented landscapes. In Hungary, species-rich meadows have developed on the slopes of river dikes over the last few centuries. These dike slope meadows provide valuable habitats for many insect groups, including butterflies. We aimed to study how urbanisation affects the butterfly communities of river dikes in four cities. Butterfly species abundance data were collected by visual observation along 300 m long dike sections in the center and at the edge of the cities and along reference dike sections outside the cities. We found differences in the abundance and species richness of butterflies between the center, edge and reference only in the largest city. In addition, among the studied species traits, the voultanism and host plant specificity of the species were influenced by urbanisation. We suggest that dikes have a great potential for biodiversity conservation.

1500 Years of Flooding in Romania: Climatic and Anthropogenic Influences

Ioana Persoiu[1*], Maria Radoane[1,2], Gabriela Florescu[1,2], Aurel Persoiu[3], Alexandru Hegyi[4]

[1]*Research Institute of the University of Bucharest, Bucharest, Romania*

[2]*Stefan cel Mare University, Suceava, Romania*

[3]*Emil Racovita Institute of Speleology, Romanian Academy, Bucharest, Romania*

[4]*West University of Timișoara, Timișoara, Romania*

[*]*ioanapersoiu@gmail.com*

This study integrates documentary, instrumental, archaeological, and sedimentological data to reconstruct periods of increased flooding in present-day Romania over the past 1500 years. The findings indicate a rise in flood frequency during the Medieval Climate Anomaly and towards the end of the Little Ice Age.

To explore the potential causes of these flooding events, reconstructions of seasonal air temperature, precipitation levels, and atmospheric circulation patterns were analyzed using various proxy records (stable isotopes from cave ice and speleothems, tree-ring proxies, etc.). The most extensive floods occurred between AD 1050 and 1250, primarily affecting the extra-Carpathian regions, and were linked to the influx of humid Eastern Mediterranean air masses. There is no definitive evidence regarding flood magnitude during the Migration Period; however, the limited available fluvial data suggests a lower intensity compared to the Medieval Climate Anomaly.

Over the past 500 years, the most geomorphologically impactful floods took place between 1770-1800 and 1880-1920, affecting the entire study area. These events were associated with an unstable climate, marked by intensified westerly Atlantic circulation and frequent northward incursions of Eastern Mediterranean cyclones. Recent floods (1990-present) have been primarily driven by warm, humid air masses from the Eastern Mediterranean and the strengthening of westerly Atlantic circulation at the onset of the Little Ice Age (1460-1470 and 1490-1530). In addition to climatic influences, floods in the last 500 years also exhibit a significant anthropogenic component, which has become more pronounced in the past 250 years.

Evaluating Levee Stability: Simulating Flood Scenarios Using Time-Lapse ERT for Improved Risk Mitigation

Ahmed M. Ali[1,2*], Attila Tímár[3], James Boyd[4], Enas Abdelsamei[1,2], Diaa Sheishah[1,2], Alexandru Hegyi[5], György Sipos[1]

[1]*Department of Physical and Environmental Geography, University of Szeged, Szeged, Hungary*

[2]*National Research Institute of Astronomy and Geophysics, Cairo, Egypt*

[3]*Department of Flood Protection and River Engineering, Körös District Water Directorate, Gyula, Hungary*

[4]*British Geological Survey, Keyworth, Nottingham, UK*

[5]*Department of Geography, Applied Geomorphology and Interdisciplinary Research Centre, West University of Timisoara, Timisoara, Romania*

[*]*ahmed.mahmoud@nriag.sci.eg*

Aging levees, particularly those with limited or undocumented construction histories, pose an increasing flood risk due to their deteriorating structural integrity. Subsurface leakage pathways, often concealed and difficult to detect, exacerbate this risk by compromising levee stability during high-water events. Real-time characterization of these pathways under flood conditions remains challenging due to insufficient field data and the inherent complexity of levee systems. To address these challenges, this study employed electrical resistivity tomography (ERT), a non-invasive geophysical method, in a large-scale experimental setup simulating flood conditions on a 40-meter artificial levee section near Békés, Hungary. Conducted in summer 2023, the experiment utilized time-lapse ERT measurements to monitor the evolution of potential leakage pathways within heterogeneous fluvial soils under both dry and saturated conditions. Core samples were analyzed to determine key physical parameters such as grain size distribution, hydraulic conductivity, porosity, density, and water content for validation of ERT results.

Using integrated 2D and 3D inversion techniques, the study successfully identified critical leakage zones, particularly where resistivity values dropped below 10 Ω·m, indicating saturated materials associated with water infiltration. Notably, three preferential water passage zones were detected along the levee crest and protected side, with water migrating laterally and toward the protected area. These findings highlight areas of significant concern for levee stability and provide insights into subsurface processes that compromise structural integrity.

This research demonstrates the potential of time-lapse ERT as a powerful tool for periodic levee health assessments. By simulating flood conditions and mapping subsurface vulnerabilities, this approach enhances understanding of levee behavior under stress, supporting safer and more efficient flood risk management strategies. The method facilitates data-driven decision-making, enabling improved protection of vulnerable areas through routine monitoring and targeted interventions.

Statistics on the frequency of rain and snow-rain floods on rivers of the Tisza basin within of Ukraine

Stanislav Moskalenko
Department of Hydrology and Hydroecology, Taras Shevchenko National University of Kyiv, Kyiv, Ukraine
stanislavmoskalenko@knu.ua

The purpose of the study is to conduct a detailed statistical analysis of the frequency of rain and snow-rain floods on the rivers of the Tisza River basin within Ukraine, which is the most humid and one of the most flood-prone. Floods occur here quite often throughout the year. The main factors of this are orographic (mountains and foothills of the Ukrainian Carpathians) and meteorological (characteristic long periods of precipitation of varying intensity).

The data for the observation period of 1946-2019 from the following hydrometric station were used: the Tysa River – Rakhov, the Rika River – Mezhhirya and the Latoritsa River – Mukachevo. At the first stage, the statistics of flood frequency were calculated using series of annual maximum discharges of rain floods for the warm period of the year and snow-rain floods for the cold period. At the second stage, a more complex statistical analysis was carried out, namely, the partial duration series. Such series are used to calculate the statistics of flood frequency for all values. In this case, the main criterion is the selection of peak values that exceed a certain threshold, which corresponds to the lowest value from the series of maximum discharges, in our case for the warm and cold periods of the year. The partial duration series have a larger number of members than series of maximum annual flood. They best describe minor floods with less than a 1–year return period. The flood frequency period is calculated using the inverse of the Weibull probability formula.

The conducted study allowed to estimate the probable values of floods in the Tisza River basin, which can form during a certain period of time and to estimate their recurrence. Practical interest - knowledge about potential floods can be used to assess the nature of such possible floods in the future.

Improving wind hazard assessment using high-resolution numerical weather prediction models and interpolation techniques in Hungary

Kinga Bokros[1*], Beatrix Izsák[1], Natália Szalontainé Gáspár[1], Dávid Lancz[1], Mónika Lakatos[1], Rita Pongrácz[2]

[1] *Department of Climate Research, HungaroMet Hungarian Meteorological Service, Budapest, Hungary*

[2]*Department of Meteorology, Eötvös Loránd University, Budapest, Hungary*

[*]*bokros.k@met.hu*

Extreme wind gusts are among the most impactful meteorological hazards in Hungary, frequently linked to frontal systems, cyclones, or convective storms. At the Hungarian Meteorological Service (HungaroMet), wind field maps used to assess wind-related damage are currently based solely on observed daily maximum wind gusts. To improve the spatial accuracy and objectivity of these maps, we investigate the integration of numerical model data as background information into the interpolation process.

This study focuses on the refinement of wind gust interpolation using the MISH (Meteorological Interpolation based on Surface Homogenized Data) method, which was developed for climatological and operational purposes. We incorporated surface observations along with background wind fields from high-resolution numerical weather predictions. The impact of two kinds of background information was investigated: AROME and AROME-RUC forecasts running at 2.5 and 1.3 km horizontal resolution, respectively. A series of case studies from 2024 and 2025 were selected, representing a wild range of meteorological conditions, including Mediterranean cyclones, cold fronts, and localized convective events.

The results show that both models correlate well with observations (with correlation values mostly between 0.8 and 0.9), while the AROME-RUC model, due to its finer spatial resolution and other developments, better captures spatial variability and peak gust values. However, localized convective wind events remain challenging to interpolate accurately, regardless of the model background.

Our findings highlight the potential of combining MISH interpolation with high-resolution model fields to enhance the representation of wind-related hazards. This approach contributes to the development of an automated wind hazard mapping framework that supports risk management, disaster risk reduction, and climate resilience strategies in a changing climate.

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Natural Hazards and Society in Croatia: Impacts and Public Health Interventions

Ivan Miskulin*, Ivana Kotromanovic Simic, Nika Lovrincevic Pavlovic, Jelena Kovacevic, Maja Miskulin
Faculty of Medicine Osijek, University of Osijek, Osijek, Croatia
**ivan.miskulin@mefos.hr*

Croatia has faced significant natural hazards over the past decade, including earthquakes, floods, droughts, and wildfires. These events have caused widespread societal disruption, economic losses, and public health challenges, exacerbated by climate change. The country's geographical location and geological characteristics make it vulnerable to these hazards.

The aim of this study is to analyze the societal and public health impacts of natural hazards in Croatia from 2015 to 2025, identify gaps in disaster preparedness, and propose evidence-based public health interventions to enhance resilience.

The 2020 Zagreb earthquake caused extensive damage to healthcare facilities, schools, and residential buildings. Similarly, the Sisak-Moslavina earthquake displaced thousands and required large-scale humanitarian responses. These events highlighted gaps in structural resilience and emergency preparedness. Frequent flooding events disrupted livelihoods and caused significant agricultural losses. For example, floods in May 2023 affected multiple counties, leading to casualties and economic damages. Droughts in 2011–2012 caused over €600 million in agricultural losses. Rising temperatures have increased water scarcity risks. Coastal wildfires during the summer of 2022 burned over 30,000 hectares, endangering communities and ecosystems.

Public health interventions have included mental health support for disaster survivors, improved emergency healthcare systems, early warning systems for floods and wildfires, and vaccination campaigns to prevent disease outbreaks post-disaster. However, challenges remain in integrating these measures into a cohesive national framework.

Natural hazards have had profound societal impacts in Croatia over the past decade. While progress has been made in disaster risk management through national programs and international cooperation, significant gaps remain in long-term planning and public health preparedness. Strengthening infrastructure resilience, enhancing community-based disaster education programs, and integrating mental health services into disaster response plans are critical steps toward reducing vulnerability. Adopting a proactive approach aligned with global frameworks will be essential for safeguarding Croatia's future against natural hazards.

Investigating Mortality Trends in a Warming Climate with a special focus on urban population in Asia

Sandugash Abisheva*, Rita Pongrácz
Department of Meteorology, Eötvös Loránd University, Budapest, Hungary
*as150496@gmail.com

Climate change poses escalating health risks, particularly in urban environments where the urban heat island (UHI) effect intensifies summer temperature extremes. This study investigates the relationship between rising temperatures and mortality trends across various Asian cities over the past 40 years. By integrating climate data analysis with socio-economic and demographic variables, we assess the extent to which temperature variations influence mortality rates, particularly among vulnerable populations.

The research employs statistical and geospatial modeling to evaluate changes in heatwave frequency, intensity, and duration and their disproportionate effects on different socio-economic groups. Key factors such as population density, and adaptive capacity are examined to determine their role in exacerbating or mitigating heat-related health risks. Our preliminary findings highlight that urban areas undergoing rapid expansion and inadequate climate adaptation measures exhibit significantly higher mortality rates during extreme heat events.

This study underscores the urgent need for climate-resilient urban planning, targeted public health policies, and enhanced early-warning systems to minimize heatwave-induced fatalities. By providing a comprehensive analysis of climate-driven health risks, our research offers critical insights for policymakers, urban planners, and meteorologists seeking to develop sustainable adaptation strategies.

The influence of small canopy gaps and previous logging on understorey plant communities in topographic depressions

Kata Frei[1*], Zsófia Krivács[1], Gábor Li[1], Csaba Tölgyesi[1,2], Zoltán Bátori[1]
[1]*Department of Ecology, University of Szeged, Szeged, Hungary*
[2]*MTA-SZTE 'Momentum' Applied Ecology Research Group, University of Szeged, Szeged, Hungary*
[*]*freikata98@gmail.com*

Topographic depressions in karst landscapes (dolines) may act as microrefugia for biodiversity during anthropogenic climate change. They provide stable microclimatic conditions that are decoupled from the regional climate. However, their refugial capacity (i.e. their capacity to buffer against changes in the macroclimate) may be influenced by natural (e.g., formation of small canopy gaps) and/or anthropogenic (e.g., previous logging) disturbances. Here we studied the effects of forest age and the presence of small canopy gaps (50–200 m^2) on various environmental factors, as well as on the species composition of understorey plant communities in 12 dolines and on the surrounding plateau in the Mecsek Mountains, Hungary. We classified dolines into three types based on their canopy structure and previous forest management activities: 1) dolines covered by older forests (>80 years) with small canopy gap at the bottom, 2) dolines covered by older forests (>80 years) with closed canopy, and 3) dolines covered by younger forests (~50 years) with closed canopy. We found that all habitat types differed in most of the environmental variables studied and harboured distinct plant communities. For instance, the plateau was warmer, drier and had less resource-rich soils than the other habitats, while dolines with canopy gap were relatively cool and had the highest soil moisture levels. We identified 25 indicator plant species for the habitat types (e.g., Melica uniflora for the plateau, Chrysosplenium alternifolium for dolines with canopy gap, while no indicator species were found for dolines covered by younger forests). We can conclude that both natural and anthropogenic disturbances may have a strong impact on the vegetation in dolines, as forest age and the presence of canopy gaps influence the light regime, air temperature, soil characteristics, and plant species composition, thereby affecting their capacity to provide microrefugia for biodiversity.

Effects of natural and anthropogenic disturbances on microrefugia: the soil microbiota of dolines

Zsófia Krivács[1*], Kata Frei[1], Gábor Li[1], Csaba Tölgyesi[1], Attila Bodor[2], Roland Wirth[2,3], Gergely Maróti[3], Zoltán Bátori[1]
[1]*Department of Ecology, University of Szeged, Szeged, Hungary*
[2]*Department of Biotechnology and Microbiology, University of Szeged, Szeged, Hungary*
[3]*Institute of Plant Biology, HUN-REN Biological Research Centre, Szeged, Hungary*
[*]*krivacs.zsofi@gmail.com*

Dolines (local depressions in karst landscapes) serve as microrefugia for certain species during climate changes. However, there is limited information on the factors influencing the refugial capacity of dolines (i.e., their ability to decouple local microclimate from regional climate changes). In our study, we analyzed the impact of treefall gaps and previous logging as examples of natural and anthropogenic disturbances on the refugial capacity of dolines (Mecsek Mts, Hungary) by studying the patterns of soil microbiota, a previously understudied but biogeochemically important group of organisms in European karst depressions. We aimed to answer how previous logging and the presence of natural treefall gaps influence abiotic factors in dolines, and through these factors, the composition of soil microbiota, and how these parameters differ between dolines and the surrounding plateau. We studied the following doline types: dolines covered by mature forest (>80 years) with a canopy gap, dolines covered by mature forest (>80 years) with a closed canopy, and dolines covered by younger forest (50 years) with a closed canopy. We studied the following parameters at each site: air temperature, air humidity, soil moisture, soil nutrient content, pH, amount of deadwood, and canopy cover. We applied metagenomic analysis to taxonomically characterize the soil microbiota at each location. According to our results, the studied natural and anthropogenic disturbances have a significant effect on the local microclimate, the soil, and consequently, the patterns of soil microbiota. The composition of soil microbiota in dolines showed significant differences from that of the plateau, while no differences were found among the doline types. The distinct communities were distributed along sharp environmental gradients. Our study contributes to a better understanding of the refugial capacity of dolines, supporting the development of appropriate conservation measures and management strategies.

Advancing soil erosion mapping with Machine Learning: A comparative performance assessment

Fatemeh Nooshin Nokhandan*, Erzsébet Horváth
Department of Physical Geography, Eötvös Loránd University, Budapest, Hungary
**fatimanooshin@gmail.com*

This study integrates field investigations, remote sensing data, and advanced machine learning techniques including Random Forest, XGBoost, CatBoost, and LightGBM to model soil erosion in the loess-covered regions of Uri and Mende, Hungary. The primary objective is to evaluate the performance of these algorithms and identify the most influential geo-environmental factors using the Shapley Additive Explanation (SHAP) method, an emerging approach for model interpretability. A total of 13 key factors, including slope, aspect, elevation, lithology, NDVI, land use/land cover, plan curvature, profile curvature, topographic position index (TPI), topographic wetness index (TWI), stream power index (SPI), and distances from roads and streams, were selected for analysis. A dataset comprising 1000 points (500 erosion and 500 non-erosion) was used to develop a soil erosion inventory map. The dataset was randomly split into 70% for model training and 30% for validation. Prior to model implementation, multicollinearity and correlation analyses were conducted to detect and address collinearity issues, ensuring the statistical robustness of selected variables. The predictive performance of the machine learning models was assessed using 10-fold cross-validation, with key evaluation metrics including Root Mean Squared Error (RMSE), Mean Absolute Error (MAE), the Kappa coefficient, overall accuracy, and the Area Under the Receiver Operating Characteristic Curve (AUROC). Additionally, SHAP summary plots were generated to interpret the contribution of each geo-environmental factor across all models. By systematically comparing multiple machine learning approaches, this research enhances our understanding of soil erosion dynamics and offers a data-driven framework for improving erosion risk assessment. Identifying the most accurate model not only improves soil erosion prediction but also provides a benchmark for future studies, guiding researchers toward more reliable methodologies. Moreover, SHAP-based interpretation ensures transparency in machine learning applications, making these models more accessible and applicable in real-world environmental management. The findings may have significant implications for land management and soil conservation strategies, aiding policymakers and environmental planners in developing more effective mitigation measures.

Geospatial and Geomorphometric Analysis on Landslides based on UAV Remote Sensing and GIS – Case from the Crnik Landslide in North Macedonia

Bojana Aleksova[1*], Ivica Milevski[2], Tin Lukić[1]
[1]*Department of Geography, Tourism and Hotel Management, University of Novi Sad, Novi Sad, Serbia*
[2]*Institute of Geography, Faculty of Natural Sciences and Mathematics, Ss. Cyril and Methodius University, Skopje, North Macedonia*
[*]*aleksova_bojana@yahoo.com*

This study presents a detailed geomorphometric and geospatial analysis of the Crnik landslide, the largest within the Crnička Reka catchment, North Macedonia, using high-resolution UAV-based surveys (0.1 m). The research evaluates the landslide's morphometric parameters, including volume, elevation changes, slope, aspect, and terrain ruggedness index (TRI). High-precision drones captured aerial imagery, which was processed using Agisoft Metashape to generate high-resolution DEMs for 2018 and 2024. A comparative analysis of these DEMs revealed minimal elevation differences, with mean values of 817.3 m in 2018 and 817.4 m in 2024, alongside localized variations ranging from -3 m (erosion) to +7.3 m (deposition). Erosion affected 31.8% of the landslide area, while 21% exhibited deposition, with an estimated total displaced material volume of 8,512.7 m^3 over 0.48 km^2. Slope analysis indicated predominantly moderate slopes (10–20°) covering 36.6% of the area, while aspect analysis revealed a dominance of north- (48.2%) and east-facing (42.0%) slopes, influencing slope stability. The TRI values ranged from 0 to 7.5 m^3/m^2, with 51.3% of the landslide area characterized by low ruggedness. UAV-derived models were validated using a 1-m LiDAR-based DTM from 2020, field surveys, and the Landslide Susceptibility Index (LSI). The LSI analysis confirmed that the Crnik landslide is within a very high susceptibility zone, highlighting its ongoing geomorphic activity and significant hazard potential. This study underscores the effectiveness of UAV-based DEMs in landslide monitoring by providing high-resolution spatial and temporal data critical for assessing slope stability and terrain dynamics.

Geospatial Modeling of Landslide and Wildfire Susceptibility Using GIS and Remote Sensing Data in Djerdap UNESCO Global Geopark, Serbia

Uroš Durlević*, Nina Čegar, Aleksandar Kovjanić, Natalija Batoćanin
Faculty of Geography, University of Belgrade, Belgrade, Serbia
**uros.durlevic@gef.bg.ac.rs*

Landslides and wildfires are frequent natural disasters that cause major ecological, material, and human losses worldwide. Identifying vulnerable areas within protected areas is crucial for adopting adequate measures to protect the environment. The Djerdap Global Geopark is the first and only protected area of this type in Serbia. Due to its rich geodiversity and other natural and cultural values, in 2020, Djerdap received the international designation of a Global Geopark from UNESCO for an area of up to 1,330 km^2. In order to establish adequate geopark management measures, one of the main tasks is to identify locations vulnerable to wildfires and landslides. The study used geographic information systems and remote sensing to analyze eight natural and anthropogenic conditions for assessing the spatial distribution of landslides and nine criteria for spatial modeling of wildfires. Both natural and anthropogenic factors were analyzed: geological, geomorphological, climatological, hydrological, biogeographical, and distance from the settlements and roads. The results showed that 99.96 km2 of the area is highly susceptible to landslides, while 12 km^2 is very highly susceptible. Regarding wildfires, 268.18 km^2 of the area is designated as highly susceptible, while 30.23 km^2 of the Djerdap Global Geopark is very highly susceptible. Synthesis maps of landslide and wildfire hazards can be useful for decision-makers, protected area managers, spatial planners, and emergency management services in implementing landslide and wildfire protection measures. The study represents an integration of advanced remote sensing techniques and interdisciplinary research, offering a deeper insight into the natural hazard under investigation.

Landscape changes and remediation in illegal landfill near Sombor, Serbia (2015-2025): Environmental hazards and recovery

Aleksandar Pilipovic*, Máté Dániel Petróczy, József Szatmári
Department of Atmospheric and Geospatial Data Sciences, University of Szeged, Szeged, Hungary
*acopilipovic@gmail.com

Illegal waste disposal has become a growing issue in many developing countries, including Serbia. Such waste often contains hazardous materials that can lead to environmental disasters, such as glass bottles contributing to fires, plastics releasing microplastics into the surrounding environment, and construction debris causing air pollution. Monitoring these sites with remote sensing technology provides critical insights for disaster prevention. However, despite preventive efforts, disasters still occur, such as the landfill fire in Sombor, Serbia, during the summer of 2024.

Previously used as the main waste disposal site for the city of Sombor until 1990, this area was closed due to urban expansion toward the southeast. Despite its closure, the site has continued to receive illegal waste, including household trash and construction debris. In 2024, extreme temperatures and intense solar radiation ignited nearby vegetation, leading to a fire that burned a significant portion of the landfill and caused minor damage to nearby homes. Remote sensing methods, including drone and satellite imagery, offer valuable tools for tracking illegal waste and assessing disaster risks.

In this study, a DJI Mini 2 rotary drone was used to capture imagery of the landfill a few days after the fire. This data was compared to Serbian orthomosaics from 2015 and 2016 to analyze landscape changes. A follow-up survey was conducted in spring 2025 to assess vegetation recovery. The final results present comparative analyses of land use, including vegetation, waste, built-up areas, and burnt areas (2024) across the study periods.

Small canopy gaps increase the refugial capacity of karstic microrefugia in the face of anthropogenic climate change

Gábor Li[1*], Bonita Ratkai[1], Benedek György Tóth[1], László Erdős[2], Csaba Tölgyesi[1], Kata Frei[1], Zoltán Bátori[1]

[1]*Department of Ecology, University of Szeged, Szeged, Hungary*

[2]*Department of Ecology, University of Debrecen, Debrecen, Hungary*

[*]*gaborli0622@gmail.com*

Topographic complexity plays a significant role in shaping local microclimates. Specific landforms, such as dolines, can maintain stable climatic conditions that offer safe havens for species during regional climatic changes. Canopy cover can also buffer regional trends and climatic extremes. However, canopy cover is not always continuous, as gaps of varying sizes may form due to both natural and anthropogenic disturbances. While research on the individual effects of topographic position and canopy gaps on local microclimates and vegetation patterns has expanded, knowledge of their combined effects remains limited. In this study, we compared four habitat types based on their environmental factors, trait composition, and the species and functional diversity of understory plant communities: (1) doline bottoms with a closed canopy, (2) doline bottoms with small canopy gaps, (3) plateaus with a closed canopy, and (4) plateaus with small canopy gaps. We found that topographic complexity and small canopy gaps significantly affect vegetation patterns and functionality in karst areas, supporting both taxonomic and functional diversity. Small canopy gaps played distinct roles across different habitats. In doline bottoms, for instance, they preserved species and functional traits that were rare or absent in other habitats, thereby increasing their refugial capacity. On the plateaus, however, small canopy gaps contributed to the natural forest dynamics and facilitated forest renewal. Based on our findings, the creation of small artificial canopy gaps in doline bottoms with closed canopy cover may be beneficial and could potentially contribute to the conservation of species and traits vulnerable to anthropogenic climate change.

Natural multihazards analysis in Hungary

Gábor Mezősi
Department of Physical and Environmental Geography, University of Szeged, Szeged, Hungary
mezosi@geo.u-szeged.hu

Due to the interrelationships of natural hazards, they often do not occur in isolation. They may be interconnected, if only in the sense that they appear at the same time and in the same space. In other words, they are not causally related, and their simultaneous occurrence is called compounded hazards. If the hazards are causally related, then the concept of multihazard is used, where the primary natural hazard and the secondary natural hazard can be identified. This series may continue, additional hazards may appear and human impacts are not yet included in the series (e.g. extra rainfall - flash floods - soil degradation - landslides). The triggering effect is not necessarily a natural hazard. The effects of interconnected hazards may be amplified, and methods are known to measure and mitigate this, but these require the precise definition of the connection of the systems. The methods for this are usually divided into three large groups: hazard matrices, hazard cascades (where one hazard triggers and amplifies the next) and cumulative (compound effect) networks of hazards. In the case of Hungary, the hazard matrix presents eight interconnected hazards. It indicates the triggered secondary hazards in color, and their mostly quantitative, statistically based changes in the frequency of occurrence.

Macroeconomic challenges of climate change and the contribution of the circular economy to community resilience to natural disasters

Milica Stanković*, Gordana Mrdak
Academy of Applied Technical and Preschool Studies, Department Vranje, Niš, Serbia
**milica.stankovic@akademijanis.edu.rs*

Climate changes are inevitable today, and they will significantly affect the economies of all countries at the global level. Natural disasters and climate change increasingly condition migration and threaten to permanently threaten the well-being of both current and future generations. The global aspiration towards sustainability, which means meeting the needs of current generations without endangering future generations to meet their needs, is increasingly difficult to achieve with global climate changes and potential negative effects. The consequences of climate change are visible both at the macroeconomic and microeconomic levels, which is reflected in the impact of catastrophic events on the slowdown of economic activity and the impossibility of achieving long-term economic sustainability. The increasingly obvious climate changes are influenced by the industrial revolution, but also by everyday human activities, whereby the consequences of the human factor are increasingly unfavorable for life on planet Earth.

The paper presents the results of research conducted by the authors on a sample of 65 respondents from Serbia on the perception of natural disasters and climate change. The results of the survey show that the respondents are familiar with the concept of climate change and its consequences, and that more than half of the respondents assess the economic consequences of natural disasters in your country as very serious. When it comes to the circular economy, more than ¾ of the respondents are familiar with the concept of the circular economy and more than half of the respondents believe that the implementation of the circular economy can contribute to increasing the community's resistance to natural disasters. The study highlights the importance of circular economy education and the contribution of the implementation of circular economy principles to the economy's resilience to climate change.

Natural disaster beyond media barricades? Online news coverage on the 2022 drought in Hungary

Péter Kacsó[1*], Viktória Priszcilla Hafenscher[2], Ferenc Jankó[1,2]
[1]*Department of Human and Economic Geography, Eötvös Loránd University, Budapest, Hungary*
[2]*Alexandre Lamfalussy Faculty of Economics, University of Sopron, Sopron, Hungary*
[*]*peti.kacso@gmail.com*

A severe drought impacted Europe in 2022, leading to water shortages and significant agricultural crop losses in several countries, including Hungary. Previous research indicated that media outlets' political or ideological orientation can shape the portrayal of climate change and related environmental issues. To examine this phenomenon in Hungary, we performed a quantitative content analysis on 200 articles discussing the Hungarian drought, evenly representing three pro-government and three independent online news portals, to identify and classify frames, tones, information sources, themes, and images to uncover the key differences between the two samples. Our findings reveal that Hungarian media, similarly to many other countries, is polarized on environmental issues, with right-wing populism influencing this polarization.

Prospects of social action - Possible legal framework in avoiding climate change crisis

Csaba Jaksa
Department of Public Health Medicine, University of Pécs Medical School, Pécs, Hungary
csaba.jaksa@aok.pte.hu

The presentation aims to designate the threats of climate change to society, and outline frameworks within which the predictable disturbances can be addressed on social and political level. Human-activities interfere in the ecosystem which have direct (immediate) effects on the environment, i.e., they either damage the environment or at least disrupt the ecosystem insomuch as we humans depend on it. Indirectly, the modern, large scale human interruption of the ecosystem indirectly causes social effects as well. The paper focuses on the shifts and changes in interhuman relations. How can we tackle the looming danger of climate change to our society? I approach the crisis-prevention in two steps which both refer to two levels we have to address: climate change mitigation and social-crisis prevention. For the first step, I explore what the political conditions, ramifications, and possibilities are. Democratic formations are indispensable, but only with underlying principles as conditions, e.g., survival precedes economic growth. Secondably, does any legal framework exist to manage the question and if so, what can it offer? The current climate change differs from the cyclic changes, furthermore, the system which facilitated the events developed along a new society. Global warming must be interpreted and addressed within international setting. Human rights are often explained through three generations, where the third group consists the international or solidarity rights. The human right for a healthy environment connects countries on multiple level because it is not only their moral duty to help others, it is also their interest to prevent climate induced crises.

DIRECTED Project: Enhancing Disaster Resilience in Europe

Levente Huszti
Zala Special Rescue Team Association, Zalaegerszeg, Hungary
levente.huszti@gmail.com

The DIRECTED project aims to reduce the vulnerability of European societies to extreme weather events and foster disaster resilience. To achieve this, the project focuses on improving interoperability in data, models, communication, and governance among stakeholders in disaster risk management and climate adaptation. By bridging sectoral and disciplinary gaps, DIRECTED seeks to create a more integrated and efficient approach to multi-hazard risk governance.

The project establishes four Real-World Labs in Europe: Rhein-Erft District (Germany), the Capital Region of Denmark, Emilia-Romagna (Italy), and the Danube Region. In these living labs, local stakeholders and project partners collaboratively assess and refine existing disaster risk management workflows and governance structures. The outcome is the RISK-TANDEM framework, a transdisciplinary governance approach that enhances risk assessment, management, and communication for climate-related hazards.

A key innovation of the project is the development of an integrated Data Fabric, which connects existing datasets and models into a unified system. This structure strengthens synergies between disaster data and climate services, providing decision-makers and practitioners with actionable insights for proactive risk reduction.

Moreover, DIRECTED enhances communication between technical experts, policymakers, and various sectors, fostering multi-level governance and cross-scale synergies. The project promotes multi-hazard thinking, capacity-building, and the establishment of long-term partnerships that endure beyond its completion.

By addressing fragmentation in risk governance and improving knowledge-sharing mechanisms, DIRECTED contributes to a more resilient, adaptive, and well-connected European disaster management system.

Investigation of the relationship between solar activity, natural hazards and human mobility: Evidence from the Balkans

Milica Langović[1*], Vladimir A. Srećković[1], Zoran Mijić[1], Marko Langović[2]
[1]*Institute of Physics Belgrade, University of Belgrade, Belgrade, Serbia*
[2]*Faculty of Geography, University of Belgrade, Belgrade, Serbia*
[*]*milica.langovic@ipb.ac.rs*

Solar activity, as the main feature of the Sun, determines the changes in the solar-terrestrial environment and affects technologies, nature, humans and their activities on earth. The aim of this paper is to investigate the complex relationship between solar activity, natural hazards and human mobility in the Balkan Peninsula in the period 2008-2023. The primarily hypothesis of this study is that all processes in the solar-terrestrial environment are interconnected and that the change of one element in this system influences the changes of another element. In this regard, special emphasis is placed on the study of the characteristics of environmental migration as a phenomenon triggered by natural hazards, and possibly related to solar activity. The methodological framework includes data on Solar cycle 24 and Solar cycle 25 (current cycle) and environmental migration, as well as the application of statistical methods based on correlation procedures. The research results indicate intertwined connections among the mentioned categories, and revealed a statistically significant correlation between the number of sunspots (as indicator of solar activity) and internal displacements caused by weather-related hazards in the Balkans during the observed period. The paper offers insights into a new transdisciplinary field in which human mobility patterns have not yet been incorporated into the understanding of the Sun-Earth system, and provides guidelines for future research on this issue.

AI-Driven Geoinformatics Solutions for Precision Agriculture in a Climate-Stressed Region

Boudewijn van Leeuwen*, Tamás Bánhidi, Gergely Kitka, Beáta Molnár-Farkas, Orsolya Tóth
BAY Division of Biotechnology, Bay Zoltán Nonprofit Ltd. for Applied Research, Szeged, Hungary
*leeuwen@bayzoltan.hu

Climate change has intensified weather extremes, posing major challenges to agriculture in climate-stressed regions. To meet increasing demands for food production while complying with stricter environmental regulations, farmers must adopt more sustainable and efficient practices. Precision agriculture, supported by AI-driven geoinformatics, offers promising solutions. It enables optimized use of resource, such as water, fertilizers, and pesticides by leveraging high-resolution spatial data and machine learning to inform decision-making.

We have developed a methodology to estimate plant counts over large areas using a combination of drone and satellite imagery. Multispectral drone data with centimeter spatial resolution is used to train a convolutional neural network for segmentation of individual plants on several sample areas of a few hectares in size. The resulting plant counts then are correlated with OSAVI or LCI vegetation indices derived from same-day Sentinel-2 satellite imagery, enabling extrapolation of plant density across areas of several 100s of hectares.

The methodology was tested in two study sites on the Great Hungarian Plain, a region highly vulnerable to climate change. The first area is a biomass crop field of Virginia mallow and the second is an irrigated corn field. The resulting plant counts help farmers to avoid over- or underapplication of agricultural inputs, saving costs and reducing environmental impact. Early plant density is also an important variable in estimating potential yield, which allows farmers to plan sales, storage, and logistics more effectively.

Hydrologic and hydraulic analysis of the 2005 flood on the Bârzava River and its impact on hydrotechnical infrastructure

Minda-Codruța Bădăluță[1], Petru Urdea[2], Alexandru Onaca[2], Fabian Timofte[2*]
[1]*Department of Hydrotechnics, Polytechnic University of Timişoara, Timişoara, Romania*
[2]*Department of Geography, West University of Timişoara, Timişoara, Romania*
[*]*fabian.timofte@e-uvt.ro*

This paper explores the effects of flooding caused by the damage and/or failure of hydraulic structures. The volumes and flow rates resulting from such incidents are considerably higher than those associated with natural floods, which can have catastrophic environmental impacts. Understanding the factors and parameters that lead to flooding is essential for effectively controlling and mitigating this phenomenon. The first section of the paper analyzes the rainfall-runoff relationship in the Bârzava hydrographic basin using the HEC-HMS software. Calibration is performed using observed and measured flow rates from 2005, provided by ABA Banat. Model validation is deemed satisfactory based on correlation values, RMSE, and Nash criteria. Following this, flood-prone areas are identified based on flow rates with different exceedance probabilities. Additionally, the integration of HEC-RAS and GIS analysis is employed to create a flood map for the selected basin, considering floods with various return periods. The flood risk assessment aims to examine the consequences of flooding and identify potential weaknesses in existing flood control measures, with the goal of enhancing future strategies for mitigating flash floods and reducing their harmful effects.