How often did the Sava River flood in the past? A sedimentological and chronological investigation of terrace overbank sediments, Šabac (Serbia)

Krsmanović, Petar; Constantin, Daniela; Timar-Gabor, Alida; Avram, Anka; Galić, Zoran; Feurdean, Angelica; Perić, Zoran; Marković, Slobodan B.

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INTERNATIONAL CONFERENCE Geospatial and Environmental Dynamics - LAMINATION

SERBIAN ACADEMY OF SCIENCES AND ARTS

University of Novi Sad | Faculty of Sciences
DEPARTMENT OF GEOGRAPHY, TOURISM AND HOTEL MANAGEMENT

INTERNATIONAL CONFERENCE Geospatial and Environmental Dynamics – LAMINATION

ABSTRACT BOOK

Novi Sad, 2025

This conference was supported by:

• Serbian Academy of Sciences and Arts,

• Department of Geography, tourism and hotel management,

• Science Fund of the Republic of Serbia (Program of Cooperation with the Serbian Scientific Diaspora – Joint Research Projects – DIASPORA 2023, from the Science Fund of the Republic of Serbia, under the project LAMINATION (The Loess Plateau Margins: Towards Innovative Sustainable Conservation), Project number: 17807),

• Provincial Secretariat for Higher Education and Scientific Research of Vojvodina,

• De Gruyter Brill Open Geosciences

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SERBIAN ACADEMY OF SCIENCES AND ARTS

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INTERNATIONAL CONFERENCE
Geospatial and Environmental Dynamics – LAMINATION

ABSTRACT BOOK

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CONTENT

CITY OF NOVI SAD – URBAN HEART OF VOJVODINA

Novi Sad is the capital of the Autonomous Province of Vojvodina and the second largest city in Serbia. It is the industrial, cultural, scientific, educational, and administrative centre of Vojvodina. Seen from above, City of Novi Sad reveals itself as a city located in a vast plain, spacious and open to all directions. Fortress of Petrovaradin, a historical site, is situated on the right bank of the River Danube, whereas a tall building of Central Post Office, massive construction of Spens Sports Centre, immense headquarter of Petroleum Industry of Serbia and elegant oval edifice of Banovina (a seat of Executive Council of Autonomous Province of Vojvodina) are situated on the left. What eyes could also perceive are green oases embodied in City parks, with labyrinth of streets and alleys meandering around them and cut across with wide and straight boulevards. Moreover, there is the Danube as an unsymmetrical, potent axe of the City, embraced with long quay and Štrand, the most beautiful city beach along the Danube. Nowadays, a widely recognizable symbol of the City is Exit Festival, while in the past, and even so today that place has been reserved for the Serbian cultural institutions: Matica srpska - the oldest cultural-scientific institution of Serbia, Serbian National Theatre, Sterijino pozorje Theatre Festival… Furthermore, our City, in contrast to many other European destinations, has the reputation, by full right, of a multinational, multicultural and multi-confessional metropolis in which all differences are seen as advantages.

DEPARTMENT OF GEOGRAPHY, TOURISM AND HOTEL MANAGEMENT

Department of Geography, Tourism and Hotel Management was established 1962 by academician Branislav Bukurov. During previous almost half century, the Department has grown and developed, which brings it today amongst the most respectable Institutes of Geography in South-East Europe. The main professional activities of the Department are educational/ teaching, scientific/research and publishing. Educational activity is provided through bachelor, master and PhD studying programmes. Long lasting scientific researches have been conducted through several projects funded by governmental bodies, such as “Geographic research of municipalities in Vojvodina ”, “Geomorphological map of Yugoslavia”, “Condition and developing directions of Vojvodina”, and “Loess-palaeosol sequences in Serbia”. The Department quarterly publishes two scientific journals: Geographica Pannonica and Turizam, and also the Department’s Collection of papers with the longest tradition. Besides geoscience, multidisciplinary activities of the Department also involve research in tourism, sustainable development, marketing, management, etc. Consequently, quality lectures, adequacy and eminence of the professors and assistants result with prosper and competitive students successfully employed worldwide.

INTERNATIONAL CONFERENCE GEOSPATIAL AND ENVIRONMENTAL DYNAMICS – LAMINATION

ABOUT THE CONFERENCE

The international conference Geospatial and Environmental Dynamics – LAMINATION serves as the official dissemination platform for the scientific project "The Loess Plateau Margins: Towards Innovative Sustainable Conservation," funded by the Science Fund of the Republic of Serbia. This event brings together leading global experts, researchers, policymakers, and practitioners to explore innovative and interdisciplinary approaches to the sustainable conservation of the Loess Plateau and its surrounding margins.

The conference aims to address the complex environmental, ecological, and socio-economic challenges facing the Loess Plateaux Margins—a regions recognized for its fragile loess landscapes, rich natural and cultural heritage, and significant ecological value. As a distinctive geological and geomorphological formation, the Loess Plateaux requires targeted conservation strategies that balance scientific insight, cultural sensitivity, and sustainable land use.

LAMINATION will highlight state-of-the-art research and practical solutions to combat land degradation, erosion problems, biodiversity loss, and the impacts of climate change. Particular emphasis will be placed on integrating geoheritage, geoconservation, and geotourism as essential pillars of long-term environmental stewardship in loess regions. Understanding the geological evolution of the loess province in the southeastern Pannonian Basin, preserving its geodiversity, and promoting sustainable geotourism approaches are vital components of any future-oriented conservation framework.

The conference will also explore paleoclimate records and past environmental dynamics, offering valuable perspectives on historical climate variability and its ecological implications. By bridging past and present scientific knowledge, participants will gain a comprehensive understanding of how historical processes can inform contemporary conservation strategies and improve regional resilience.

A key objective of the conference is to foster interdisciplinary dialogue and cross-sectoral collaboration, encouraging the exchange of knowledge, methodologies, and experiences that support the protection, restoration, and revitalization of the Loess Plateaux unique landscapes and geological heritage.

Participants will engage with thought leaders and contribute to the development of innovative, evidence-based strategies for safeguarding this critical region for future generations.

The conference sessions include the following themes:

(1) Paleoclimate records and environmental dynamics for understanding past ecosystem changes;
(2) Erosion processes and land degradation at loess plateau margins;
(3) Geoheritage and Geoconservation: Preserving the Geological Identity and Diversity of the Loess Plateau through Innovative Approaches;
(4) Landscape Art and Geotourism: Exploring Nature through Creative Perspectives;
(5) Advancing Geoenvironmental Solutions through Interdisciplinary Approaches and Applications.

Join us for an enriching scientific event that will contribute to shaping the future of conservation on the Loess Plateau Margins and inspire broader global efforts toward sustainable environmental stewardship, integrated geoscience, and the preservation of geological and cultural heritage.

WHO MIGHT BE INTERESTED?

- Academics, researchers, and students engaged in geospatial, environmental, and interdisciplinary studies.
- Professionals and stakeholders in conservation, geoheritage, land management, and cultural landscape preservation.
- Policymakers, NGOs, and members of professional societies interested in sustainable development and climate resilience.
- General public and enthusiasts eager to explore innovative approaches to environmental challenges and the preservation of geological heritage.

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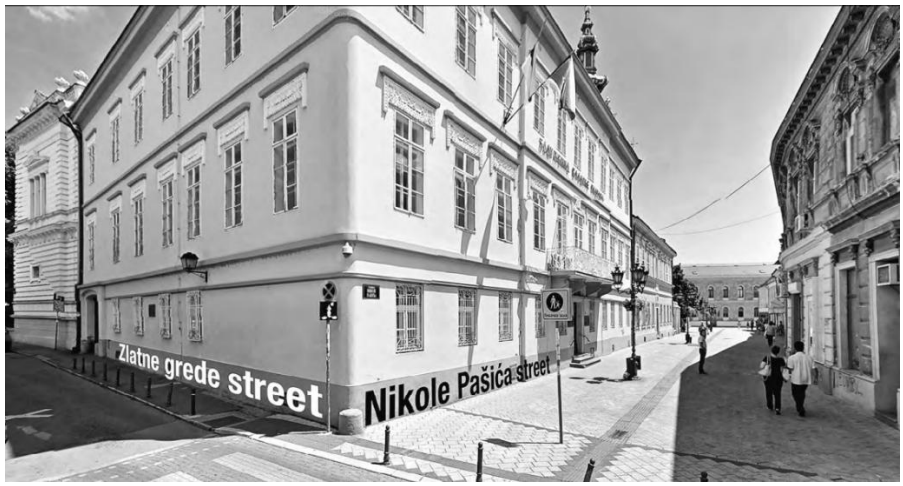


The conference will be held at Building of Branch of the Serbian Academy of Sciences and Arts in Novi Sad, Nikole Pašića 6.

The event is supported by: Serbian Academy of Sciences and Arts, Department of Geography, tourism and hotel management, Science Fund of the Republic of Serbia (Program of Cooperation with the Serbian Scientific Diaspora – Joint Research Projects – DIASPORA 2023, from the Science Fund of the Republic of Serbia, under the project LAMINATION (The Loess Plateau Margins: Towards Innovative Sustainable Conservation), Project number: 17807), Provincial Secretariat for Higher Education and Scientific Research of Vojvodina, De Gruyter Brill Open Geosciences (https://www.degruyter.com/journal/key/geo/html#latestIssue), MDPI - Publisher of Open Access Journals.

CONFERENCE PROGRAM

15th November	
8:00-9:00	REGISTRATION
9.00-9.30	OPENING CEREMONY
9.30-11.00	PLENARY SESSION (Part I)
11.00-11.30	Coffee break and Poster presentation (Part I)
11.30-12.30	PLENARY SESSION (Part II)
12.30-13.30	Lunch break (At the venue)
13.30-15.30	THEMATIC SESSION – Methodological Approaches related to reconstruction of Geospatial and Environmental Dynamics + Geoheritage and Geotourism (Part I)
15.30-16.30	Coffee break and Art exhibition of Miloš Vujanović guided tour
16.30-17.30	THEMATIC SESSION – Science and Art In-between
17.30-19.00	PLENARY SESSION (Part III)
19.00-20.00	Lecture recital – Music landscapes Milan Miladinović
20.00-21.00	CONFERENCE DINNER (At the venue)
16th November	
9.00-11.00	PLENARY SESSION (Part IV)
11.00-11.30	Coffee break and Poster presentation (Part II)
11.30-12.30	THEMATIC SESSION – Loess
12.30-13.30	PLENARY SESSION (Part V)
13.30-14.30	Lunch break (At the venue)
14.30-16.10	THEMATIC SESSION – Climate and Environment
16.10-16.30	Coffee break and Poster presentation (Part III)
16.30-17.10	THEMATIC SESSION – Social relations
17.10-18.00	Presentation of sponsors
18:00-18:30	Business meeting
18.30-19.00	CLOSING CEREMONY AND DISCUSSION
19.00-21.00	CONFERENCE DINNER (At the venue)

Conference program

15th November

8:00-9:00 REGISTRATION

Building of Branch of the Serbian Academy of Sciences and Arts in Novi Sad, Nikole Pašića 6.

9:00-9:30 OPENING CEREMONY

Building of Branch of the Serbian Academy of Sciences and Arts in Novi Sad, Nikole Pašića 6.

-Prof. Stevan Pilipović, President of Branch of Serbian Academy of Sciences and Arts in Novi Sad, Full member of Serbian Academy of Sciences and Arts

-Prof. Lazar Lazić, Director of Department for Geography, Tourism and Hotel Management, Faculty of Sciences, University of Novi Sad

-Prof. Srđan Rončević, Dean of Faculty of Sciences, University of Novi Sad

-Prof. Slobodan B. Marković, Full member of Serbian Academy of Sciences and Arts

9:30-11:00 PLENARY SESSION (Part I)

Chairmans: Velibor Spalević, György Sipos

1. **Jef Vandenberghe**
   What can loess signify for understanding landscape dynamics?
2. **Zoran Perić, Slobodan B. Marković, Petar Krsmanović, Helena Alexanderson, Tin Lukić, Milica G. Bosnić**
   Refining Loess Chronologies and Dust Flux Reconstructions in the Carpathian and Wallachian Basins

3. **Yunus Baykal, Gábor Újvári, Thomas Stevens, Sergio Andò, Adriano Banak, Sanja Šuica, Marta Barbarano, Eduardo Garzanti, Jan-Pieter Buylaert**
   Alpine Ice Sheet dynamics drive continental-hemispheric scale dust events: Age and source of last glacial loess in central Europe

11:00-11:30 Coffee break and Poster presentation

Presenting authors should be next to their posters.

11.30-12.30 PLENARY SESSION (Part II)

Chairmans: Tin Lukić, Slobodan B. Marković

4. **Vladimir Cvetković, Dalibor Milenković, Tin Lukić**
   Theoretical Evolution of Measuring Community Resilience to Natural and Technological Disasters: Past, Present, and Future – Empirical Insights from Qualitative Research in Serbia
5. **Dragana Blagojević, Dimitrije Stefanović, Sanja Brdar, Slobodan B. Marković**
   Automated classification of tree height in a windbreak ecosystem using multisource environmental data

12.30-13.30 LUNCH BREAK (At the venue)

13.30-15.30 THEMATIC SESSION – Methodological Approaches related to reconstruction of Geospatial and Environmental Dynamics + Geo-heritage and Geotourism

Chairmans: Milica Bosnić, Petar Krsmanović

1. **Aleksa Paunović**
   Analysis of the Jacobi Stencil in the Context of Selected Emerging Computing Paradigms

2. **Marko Panić, Branislav Jović**

   Overview of hyperspectral imaging in assessing soil quality

3. **Branislav Jović, Branko Kordić, Tin Lukić, Slobodan B. Marković**

   Comparative spectrochemical analysis of the organic matter character of sandy terraines from northern Serbia

4. **Marko Simić, Boris Vakanjac, Siniša Drobnjak, Jasmina M. Jovanović**

   Deep Learning Classification of Elevated Gamma-Radiation Zones Using Sentinel-2 Spectral Data

5. **Marina Ilić**

   Sustainable management of geodiversity in urban areas using spatial decision support systems

6. **Krzysztof Widawski, Zdzisław Jary**

   Anthropogeotourist attractions in Lower Silesia – the tourist potential of the region's underground attractions

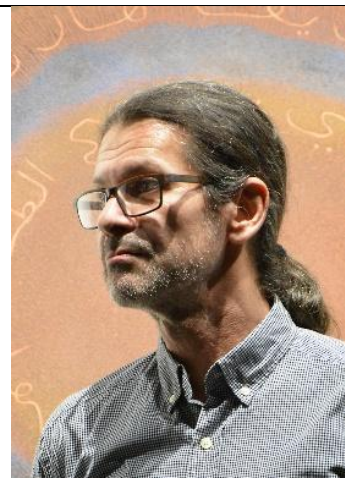
7. **Zoran Pavlović, Aleksandra Nikolić, Branka Nestorović**

   The Special Nature Reserve Titel Loess Plateau, Vojvodina, North Serbia

8. **Njegoš Tubić, Dobrila Lukić, Svetlana Terzić**

   Caves in the Middle Basin of the River Uvac – Geoheritage Sites in Serbia

15:30-16:30 Coffee break and Art exhibition of **Miloš Vujanović** guided tour

Miloš Vujanović (b. 1965) is a full professor of Anatomical Drawing at the Academy of Arts, University of Novi Sad, where he earned his BFA in Painting (1991), MFA in Drawing (2000), and PhD (2018) with the thesis *Analysis of Cognitive Vision as a Method of Artistic Reconstruction*. Since 2011, he has also taught Drawing for Animation, Visual Effects, and Storyboard at the Faculty of Technical Sciences. He has exhibited widely in Serbia and abroad, with over 100 solo and group shows, films, and projects, and has received multiple awards for his work.	

16:30-17:30 THEMATIC SESSION – Science and Art In-between

Chairmans: Slobodan B. Marković, Vuko Martinović

1. **Milan Miladinović**

   Artistic research as a road between "madness" and "method"

2. **Vuko Martinović, Miloš Vujanović**

   Depth Age Scale project

3. **Milica Kisić Božić**

   From clinical features to poetry: the plague through the perspective of four ancient authors

17:30-19:00 PLENARY SESSION (Part III)

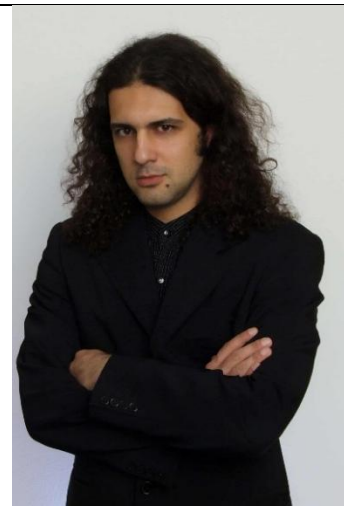
Chairmans: Jef Vandenberghe, Jan Barabach

1. **Slobodan B. Marković, Qingzhen Hao, Patrick Ludwig, Christian Zeeden, Zoran M. Perić, Dušan Mihailović, Predrag Radović, Mirjana Roksandić, Joshua Lindal, Petar Krsmanović, Yunus Baykal, Jef Vandenberghe, Milica G. Bosnić, Gerilyn Soreghan, Rastko S. Marković, Binggui Cai,**

Miaofa Li, Piotr Moska, Tin Lukić, Alida Timar-Gabor, Milivoj B. Gavrilov, György Sipos
Environmental dynamics recorded at Dupljaja loess section (Southeastern Carpathian Basin, Northern Serbia)

2. **Veljko Milutinović**
   Entrepreneurship and Creativity in Engineering and Sciences
3. **Nenad Filipović Science Fund of Republic of Serbia**
   Digital Twins as Platform for Climate Neutrality Action Plan

19:00-20:00 Lecture recital – Music landscapes **Milan Miladinović**

Milan Miladinović is a professor of Piano and Piano Performance History and Head of the Piano Department at the Academy of Arts in Novi Sad. He studied with Svetlana Bogino in Novi Sad and Fabio Bidini in Berlin, earning his DMA in Belgrade under Aleksandar Serdar. A laureate of many national and international competitions, he received Yamaha, DAAD, and Royal Family Karađorđević scholarships. He has performed across Europe, the USA, Brazil, and Israel, appearing as soloist and chamber musician, and has recorded for several international broadcasters. His students have won over 80 international prizes.	

20:00-21:30 CONFERENCE DINNER (At the venue)

16th November

9:30-11:00 PLENARY SESSION (Part IV)

Chairmans: Philip Hughes, Yunus Baykal

1. **Luka Sabljić, Tin Lukić, Davorin Bajić, Slobodan B. Marković, Dragica Delić, Dragutin Adžić, Velibor Spalević**

Application of GIS and Remote Sensing in Assessing Spatio-Temporal Dynamics of Land Degradation in Ugljevik Municipality, Bosnia and Herzegovina

2. **Velibor Spalević**
   Climate-Driven Soil Erosion and Hydrological Response in the Mountainous Basins of the Šekular River Network
3. **Jan Barabach, Ditta Kicińska, Paweł Matulewski, Liliana Siekacz, Danuta Michalska, Jacek Stienss, Michał Gąsiorowski, Adam Łada, Krzysztof Najdek**
   Vanishing Paleoenvironmental Archives of the Ice Caves in the Prokletije Mountains (Montenegro)

11:00-11:30 Coffee break and Poster presentation

Presenting authors should be next to their posters.

11:30-12:30 THEMATIC SESSION – LOESS

Chairmans: Slobodan B. Marković, Milica Bosnić

1. **György Sipos, Dávid Filyó, Slobodan Marković, Gergő Magyar, Zsófia Oláh, Rastko Marković, Milica G. Bosnić, Sándor Hajdu, Károly Barta**
   High-Resolution Reconstruction of Late Pleistocene Climate Varia
2. **György Varga**
   Loess under debate: uncertainties in dust flux reconstructions and stratigraphic interpretations
3. **Petar Krsmanović, Daniela Constantin, Alida Timar-Gabor, Anka Avram, Zoran Galić, Angelica Feurdean, Zoran Perić, Slobodan B. Marković**
   How often did the Sava River flood in the past? A sedimentological and chronological investigation of terrace overbank sediments, Šabac (Serbia)
4. **Rastko S. Marković, Petar Krsmanović, Aleksandar Radivojević, Piotr Moska, Grzegorz Poręba, Konrad**

Tudyka, Maksymilian Jędrzejowski, Milica G. Bosnić, Slobodan B. Marković, Tin Lukić
Paleoenvironmental Reconstruction of the Vrtište Site in the South Morava Valley (Serbia)

12:30 -13:30 PLENARY SESSION (Part V)

Chairmans: Zoran Perić, Zdzisław Jary

1. **Marcin Krawczyk, Agnieszka Szymak, Zdzisław Jary, Piotr Moska, Grzegorz Poręba, Zuzanna Sowińska, Grzegorz Adamiec, Michał Łopuch, Jerzy Raczyk, Jacek Skurzyński, Alicja Ustrzycka, Andrzej Wiśniewski, Andrzej Wojtalak**
   A short phase of intense loess deposition following a period of erosion at the Trzebnica site in SW Poland
2. **Philip Hughes, Rastko Marković, Milica G. Bosnić, Christoper Darvill, Slobodan Marković, Velibor Spalević, Bingdian Wang, Jamie Woodward**
   Glacial history of the mountains of Serbia, Montenegro and neighbouring regions

13:30-14:30 Lunch break (At the venue)

14:30-16:10 THEMATIC SESSTION – Climate and Environment

Chairmans: Tin Lukić, Milena Gocić

1. **Stevan Savić, Tania Sharmin, Jelena Dunjić, Milica Vasić, Vladimir Stojanović**
   Climate Change Impacts on Cultural Heritage: Perspectives for Future Research and Assessments in Serbia
2. **Dušica Jovanović, Sanja Stojković**
   The Drought Hazard Index (DHI) vs. the Extended Satellite-based Drought Condition Index (SDCI): A Case Study of the Zaječar District
3. **Milena Gocić, Aleksandar Radivojević, Rastko S. Marković, Tin Lukić**

Long-Term Drought Dynamics in the Region of Southern and Eastern Serbia

4. **Nenad Grba, Mirjana Petronijević, Sanja Panić, Miloš Dubovina, Jelena Tanasić, Slavica Ražić**
   Phenol Removal from wastewater by novel sustainable Geo-polymer materials
5. **Aleksandar Pilipović, Petróczy Máté Dániel, Szatmári József**
   Landscape changes and remediation in illegal landfill near Sombor, Serbia (2015-2025): Environmental hazards and recovery

16:10- 16:30 Coffee break and Poster presentation

Presenting authors should be next to their posters.

16:30-17:10 THEMATIC SESSION – Social relations

Chairmans: Dragica Delić, Luka Sabljić

1. **Srećko Živanović, Aleksandar Bulatović, Vojislav Filipović**
   Early Eneolithic Obrovac-Type Settlements in the Mačva Region: New Insights from Recent LiDAR Prospection
2. **Dragica Delić, Dragica Gatarić, Ivan Ratkaj, Luka Sabljić, Tin Lukić**
   Exploring Migration Scenarios in the Settlement Network of Ugljevik Municipality: Migration or Exploitation?

17:10-18:00 Presentation of sponsors

18:00-18:30 Business meeting

18:30-19:00 CLOSING CEREMONY AND DISCUSSION

19:00- 21:00 CONFERENCE DINNER (At the venue)

ABSTRACTS (PLENARY SESSIONS I, II, III, IV, V)

What can loess signify for understanding landscape dynamics?

Jef Vandenberghe[1]

[1]Vrije Universiteit Amsterdam

Corresponding author: jef.vandenberghe@vu.nl

Abstract: Loess contains a meaningful archive for the recognition of sedimentary processes. The term 'loess' is widely used for a broad range of environments, both primary eolian (1) and secondary reworked (2) eolian. Even the loess that is considered as purely eolian (1) does not show a uniform facies and may be subdivided in several subfacies. It may be supplied in different atmospheric conditions by saltation or in suspension at different altitudes above the surface. A main criterion for subdividing the reworked facie (2) is the way of transport of the originally deposited loess. A main transport process is by surface runoff (2a) at different intensities and transport distance (from afterflow to sheetflow and rill wash), next to river transport (2b, fluvio-eolian deposition) in channels or on floodplains, and deposition in lakes (2c, lacustro-eolian deposition). Finally, original loess may be transformed after deposition by soil weathering. Main sedimentary properties that enable distinguishing between those individual subfacies are grain size and sedimentary structures. In fact, those characteristics reflect the involved energy conditions during transport next to the properties of the source material. A number of cases will illustrate how landscape dynamics may be reconstructed by a combined use of grain-size distributions and field depositional characteristics.

Keywords: loess, eolian processes, reworked sediments, grain-size distribution, landscape dynamics

References:

Vandenberghe, J., Sun, Y., Wang, X., Abels, H.A. and Liu, X. 2018 Grain-size characterization of reworked fine-grained aeolian deposits. Earth Science Reviews 177, 43-52.

Liu, X., Sun, Y., Vandenberghe, J., Lia, Y. and An, Z. 2018 Palaeoenvironmental implication of grain-size compositions of terrace deposits on the western Chinese Loess Plateau. Aeolian Research 32, 202-209.

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Refining Loess Chronologies and Dust Flux Reconstructions in the Carpathian and Wallachian Basins

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Abstract: Loess-palaeosol sequences (LPS) are among the most continuous terrestrial archives of Quaternary climate change. Their widespread distribution, high accumulation potential, and sensitivity to environmental variability make them critical for reconstructing past dust fluxes, wind regimes, and regional ecosystem responses. However, the reliability of such reconstructions is fundamentally constrained by the quality and resolution of the underlying chronology. Even minor dating uncertainties can translate into significant errors in calculated sedimentation rates and dust mass accumulation rates (MARs), limiting the ability to compare records across regions or to global climate archives. Our research focuses on refining luminescence dating techniques and applying advanced Bayesian age-depth modelling to loess deposits in the Carpathian and Wallachian Basins. By constructing higher-resolution chronologies than previously available, we are able to portray more continuous and internally consistent records of sediment accumulation covering the later stages of the last glacial cycle and the Holocene. This approach also reveals discrepancies with earlier, lower-resolution studies and helps to identify processes such as partial bleaching, post-depositional mixing, or local geomorphological disturbance that can compromise loess chronologies. A central outcome of this work is the improved reconstruction of dust flux variability through time. Our results show that MARs do not always follow simplified expectations of high dust input during glacials and low input during interglacials. Instead, distinct peaks and fluctuations suggest the importance of regional controls such as

palaeowind intensity, sediment availability from large river systems, and the trapping efficiency of local landscapes. These findings highlight the necessity of considering both global climate drivers and local environmental settings when interpreting loess records. The broader aim of our research is to integrate refined chronologies and dust flux reconstructions from across the Carpathian and Wallachian Basins, establishing a framework for comparing loess archives at both regional and continental scales. By doing so, we provide new insights into the timing, magnitude, and variability of past atmospheric dust activity, while contributing to the development of loess stratigraphy as a robust tool for Quaternary paleoenvironmental reconstruction.

Keywords: loess-palaeosol sequences, luminescence dating, Bayesian age-depth modelling, dust flux variability, Quaternary climate reconstruction

Alpine Ice Sheet dynamics drive continental-hemispheric scale dust events: Age and source of last glacial loess in central Europe

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Abstract: Last glacial Greenland ice cores record that cold climate events (stadials) were associated with greatly enhanced atmospheric dust activity. Detailed radiocarbon dating from loess in Hungary, central Europe demonstrates concurrent increases in dust activity across dust emitting regions. Yet, the causes of these coupled changes in last glacial dust and climate and the role of dust in rapid climate change remain unclear. Here we address this gap through multi-proxy source analysis (detrital zircon U-Pb ages, heavy mineral assemblages, garnet chemistry and quartz grain morphology) of the previously radiocarbon dated loess in Hungary. We show that loess-dust particles were dominantly produced by subglacial grinding processes in the eastern Alps. Particles were released along with stadial Alpine Ice Sheet-driven meltwater pulses, turning major river systems draining the Alps into efficient but intermittent sources for dust deflation and loess deposition in Europe. During the LGM, strengthened anticyclonic circulation potentially facilitated wider dispersal of Alpine Ice Sheet-produced dust to source distal regions as far as Greenland. We propose that resultant continental-hemispheric scale changes in atmospheric dust loading amplified concomitant North Atlantic climate cooling and ice sheet decay during Greenland stadials.

Keywords: loess, dust provenance, Alpine Ice Sheet, stadials, rapid climate change

Theoretical Evolution of Measuring Community Resilience to Natural and Technological Disasters: Past, Present, and Future – Empirical Insights from Qualitative Research in Serbia

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Abstract: In disaster studies, the measurement of resilience has developed through several conceptual phases, reflecting broader transformations in disaster risk research. It is clear that the initial approaches, rooted in ecology and engineering, defined resilience primarily as the ability of a system to absorb shocks and return to equilibrium. Although such perspectives provided clarity and measurability, they often reduced complex social realities to simplified technical indicators. Certainly, this did not offer comprehensive and precise insights into levels of resilience to different disasters. Over time, critiques emphasized that resilience cannot be captured solely through stability or recovery speed, since communities are not mechanical systems but socio-political entities shaped by governance, culture, and inequality. In contrast, second-generation models introduced multidimensionality, incorporating economic, institutional, infrastructural, and environmental factors. Nevertheless, these frameworks frequently faced problems of comparability, data availability, and context sensitivity. Composite indicators, such as the Baseline Resilience Indicators for Communities (BRIC), sought to operationalize resilience systematically, but they encountered limitations related to weighting procedures, variable selection, and the neglect of qualitative dimensions such as trust, solidarity, and adaptive learning.

Similarly, the Disaster Resilience of Place (DROP) model provided valuable theoretical grounding, yet its transferability across diverse socio-political settings remained a challenge. According to various theoretical analyses, resilience measurement continues to face methodological and practical limitations, such as conceptual ambiguity (the absence of a universally accepted definition), indicator overload (large sets of variables that reduce analytical precision), underdeveloped statistical assessments (overlooking the dynamic, process-oriented nature of resilience), and contextual gaps (insufficient adaptation to local governance and cultural conditions). To address these challenges on a theoretical level, research was conducted in Serbia applying a qualitative empirical approach. Nineteen experienced local-level disaster management practitioners were interviewed. Semi-structured interviews and thematic analysis revealed how resilience is perceived and operationalized in practice, highlighting the gap between formal strategies and local realities. Findings indicate limited awareness, fragmented institutional cooperation, and an over-reliance on central authorities. Such results emphasize the need for flexible, participatory, and context-sensitive models of measurement. By critically tracing the evolution of resilience measurement—its achievements and shortcomings—this research underscores that resilience cannot be fully understood through indicators alone. A synthesis of quantitative rigor and qualitative insight is required, linking global frameworks with local experiences. Such a comprehensive approach not only improves measurement but also strengthens governance and societal capacities, which are essential for addressing future risks.

Keywords: disaster resilience; resilience measurement; disaster risk reduction; natural hazards; technological disasters; DROP framework; BRIC indicators; qualitative research; local governance; community resilience; Serbia.

Automated classification of tree height in a windbreak ecosystem using multisource environmental data

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Abstract: A windbreak is a vegetative barrier composed of strategically planted trees and shrubs designed to mitigate wind speed, reduce soil erosion, and provide protection to crops. This study investigates the tree height fluctuations within a 10 km-long windbreak in the Srem District of the Vojvodina region, Serbia. The windbreak is composed of hybrid black poplar (*Populus* × *euroamericana*), planted under uniform climatic conditions. Ground truth height values were derived from LiDAR-based point clouds and classified into two and three categories, corresponding to low and high, and low, medium, and high height classes, respectively. For each of these classes, four groups of environmental features were provided: topographic, hydrological, satellite, and soil data. To align the differing spatial resolutions of the data sources, the median tree height (0.5 m resolution) within each Sentinel-2 pixel footprint (10 m resolution) was computed and used as the reference value. These aggregated values were used as labels for model training and evaluation. Several algorithms, including Random Forest (RF), XGBoost, K-Nearest Neighbors (KNN), and Multi-Layer Perceptron (MLP), were applied to predict the tree height class. The RF model outperformed the other algorithms, achieving 71% accuracy and 0.7 F1 score for the two-class dataset, indicating its ability to capture relationships between environmental/spectral features and tree height classes. This performance indicates that observed features alone capture a substantial, but not complete, portion of tree height variability. The lower performance on the three-class dataset, 52% accuracy and 0.3 F1 score, suggests that overlapping data distributions, which are common in ecological datasets, made it more challenging for the model to distinguish between neighbouring height categories. The most influential feature was the green spectral band (B03),

since it can capture leaf pigmentation, density, and canopy pigmentation. Following closely are the red-edge band (B05), flow direction, digital terrain model, and red spectral band (B04), in that order. These results suggest that both spectral and environmental variables are important for capturing the variability in windbreak tree heights. The other models achieved approximately similar metrics as RF for both datasets, which suggests that the predictive signal in the dataset is moderate.

Keywords: windbreak; tree height; machine learning; classification; topography; remote sensing

Environmental dynamics recorded at Dupljaja loess section (Southeastern Carpathian Basin, Northern Serbia)

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Abstract: Dupljaja loess-palaeosol sequence in southeasternmost sector of the Banat Loess Plateau (Serbia), situated in the southeastern Carpathian (Middle Danube) Basin, is important for understanding the evolution of the Last Glacial climate and southeastern Carpathian as a potential corridor for human migration throughout Europe. The Dupljaja loess-palaeosol sequence in the southeasternmost sector of the Banat Loess Plateau, Serbia, is of significant paleoenvironmental importance. Situated within the southeastern Carpathian (Middle Danube) Basin, it provides valuable insights into the climatic evolution during the last glacial period and highlights the southeastern Carpathians as a potential migration corridor for early humans across Europe. The stratigraphic pattern of the Dupljaja section from the Holocene to the Last Glacial period mirrors analogous profiles in the northern Serbia, with the robust support based on luminescence dating and the correlation of magnetic record with the Marine Oxygen Isotope stratigraphy. Importantly, the grain size data from the section provides crucial insight into egional dust accumulation dynamics on the southeastern Banat Loess Plateau. Three distinct depositional modes are identified: two finer modes were dominant in the Holocene and late Last Glacial intervals, whereas a coarser mode prevailed in the Marine Isotope Stage (MIS) 3 interval. To better understand these variations in grain size records, we have undertaken a comparative analysis of regional palaeoclimate model data between the Last Glacial Maximum (LGM) and typical Greenland Stadial and Interstadial conditions. Model results indicate slightly drier regional climate conditions during the LGM than during stadial, while granulometry data suggests that the deposition of coarser loess during MIS 3 is related to drier conditions in the local source area (the Danube River alluvial plain), resulting in coarser material available for aeolian action. We propose that the drier hydroclimate of the Danube Palaeolithic corridor associated with steppic and more seasonal environmental conditions between 53–37 ka may have facilitated migrations of anatomically modern humans from southwest Asia into Europe.

Keywords: Serbia; loess; Late Pleistocene; palaeoclimate; palaeoenvironment.

Entrepreneurship and Creativity in Engineering and Sciences

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Abstract: This presentation sheds light on the high-tech-supported methodology that teaches entrepreneurship and creativity to students of engineering and sciences. It covers 12 topics of emerging interest and could be scheduled as either a one-semester 12-week course/program, or as an obligatory-presence workshop/seminar followed by optional research-for-credit on the M.Sc. level or the Ph.D. thesis level. The version presented here corresponds to the Purdue University Fall 2025 experiences, including 116 computing-oriented electrical engineering students with obliged in-class presence, and another 244 computing-oriented general sciences students (geo plysics, physics, chemistry, biology, math, mechanics, civil, cyber, etc...), of which 31 had the in-class presence obligation, while the remaining 213 had the on-line presence option. The course has been created almost 4 decades ago, while its current contents are inspired by the success of past Serbian students at the Vice President positions in leading six computing and VLSI companies of the USA (Qualcomm, Intel, AMD, IBM, NCR, HP Labs) and also by those on the Tenured Professorship positions in computing and VLSI programs of leading six universities of the USA (Harvard, MIT, Stanford, Brekeley, UCLA, and USC). This presentation also shares the most interesting teaching experiences from the above mentioned companies/universities, as well as others from the USA, Europe, Asia, and Australia.

Keywords: Entrepreneurship education; STEM innovation; high-tech pedagogy; interdisciplinary learning; global academic collaboration

Digital Twins as Platform for Climate Neutrality Action Plan

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Abstract: Digital twins also help cities approach climate action planning from an equity lens by providing a holistic view of the city to ensure that climate action initiatives don't marginalize already vulnerable populations. They make health impact assessments easily comparable and explore the effectiveness of dynamic abatement strategies by monitoring changes in pollution levels. We can create detailed 3D models at any scale – from individual locations to entire cities and regions – which serve as the models for digital twins. We will use layered data from satellite imaging, aerial photography, IoT sensors, GIS technology and open data sources for a comprehensive view of the urban environment. We can use the Mission Platform, which performs a completeness check where a Climate City Contract (CCC) is considered complete and mature enough for submission to the Commission if the Mission Platform can confirm the completeness of the co-creation process in which all relevant stakeholders have participated and agreed to the vision and related activities set out in the main commitment part of the CCC, as well as the completeness of the Climate Neutrality Action Plan and the Climate Neutrality Investment Plan. Digital twins will help leaders make data-informed decisions about sustainable transportation and energy efficiency policies. To increase the energy efficiency of the built environment – digital twins can be used to visualize current energy consumption and related emissions, simulate solar exposure and thermal leakage, and thus identify the buildings that are candidates for retrofitting or installing solar panels. Here is overview of different technologies for the intersection between ML, computational tools and geoscience, focusing on how ML algorithms have been utilized to address challenges in digital twins.

Keywords: Digital twins; climate action; equity; machine learning; geoscience

Application of GIS and Remote Sensing in Assessing Spatio-Temporal Dynamics of Land Degradation in Ugljevik Municipality, Bosnia and Herzegovina

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Abstract: The subject of this research is the application of GIS and remote sensing technologies to investigate land degradation in the Ugljevik municipality, Bosnia and Herzegovina. The aim is to identify and quantify spatial changes over a 40-year period (1984–2024) through the analysis of multi-temporal satellite data. A special focus is placed on landscape changes driven by the surface exploitation of mineral resources, as nearly one-third of the municipality (46.02 km², or 27.00%) is designated for mineral exploration or extraction. The approved area for surface mining alone covers 20.03 km² (11.75% of the municipality). Land use change was monitored by applying a supervised classification process to Landsat-5 and Sentinel-2 imagery. The results reveal a significant loss of meadows and pastures, with a decrease of 27.49% at the municipal level and 26.74% within the approved exploitation area. Furthermore, significant deforestation was identified using the Hansen Global Forest Change dataset. Mining-induced deforestation in Bosnia and Herzegovina totaled 8.37 km² during the study period (2001–2024). The Ugljevik municipality accounts for 0.90 km² of this total, representing a substantial 10.75% of all mining-related deforestation in the country. Over

half of this cleared forest area is located within the municipality's designated exploitation zone. This extensive, mining-induced deforestation is a key anthropogenic driver of subsequent land degradation, primarily through accelerated soil erosion. To quantify this impact, the analysis showed a high erosion coefficient (Z) within the exploitation area, spatially correlating with the identified deforestation patterns. Correspondingly, results from the empirical model for mechanical water erosion (W_y) indicate high potential soil loss in the same zone. The study also assessed the potential for recultivating this degraded land, including a review of past reclamation activities and a cartographic representation of restored areas. This research enhances the understanding of spatial dynamics caused by mining and provides crucial data for practical applications, including sustainable land use policy, spatial planning, and the protection of forest ecosystems and the environment.

Keywords: GIS; remote sensing; land degradation risk; deforestation; mechanical water erosion; Ugljevik municipality; Bosnia and Herzegovina

Climate-Driven Soil Erosion and Hydrological Response in the Mountainous Basins of the Šekular River Network

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Abstract: This study examines hydrology and erosion in the Šekularska (65 km²) and Navotinska (8.5 km²) basins, focusing on climate and erosion changes from 2000 to 2024. Understanding the effects of climate change, including 3 °C warming and variable precipitation, on erosion is vital for adaptation. The aim of the research was to quantify long-term climate and erosion variability in order to assess the link between temperature and precipitation changes and erosion intensity. The IntErO model of Spalevic was applied to assess basin parameters, with climate data (2000–2024) analyzed for temperature and precipitation. Erosion intensity was calculated in terms of sediment yield, gross erosion, and erosion per unit area. Temperature increased from 10.3 °C (2000–2009), to 10.8 °C (2010–2019), and further to 11.3 °C (2020–2024), with a minimum of 9.2 °C in 2005 and a maximum of 12.2 °C in 2024. This represents a rise of about 3 °C, over the observed period, which is more than the global warming trend of +1.5 °C. Precipitation varied between 700–1,100 mm/year, with frequent extremes, including droughts in 2002–2019 and 2024. The Šekularska basin exhibited high erosion intensity, with an average annual sediment yield of 45,817 m³/year (34,702–58,097; standard deviation 6,626), gross erosion averaging 19,230 m³/year (14,565–24,384), and gross erosion per unit area 296 m³/km²/year (224–376). Erosion fluctuated strongly, with the lowest in 2011, the highest in 2023, and another peak during 2013–2015. The Navotinska basin had lower erosion but a similar pattern. Its average annual sediment yield amounted to 2,555 m³/year (1,935–3,240; standard deviation 369), gross erosion 766 m³/year (580–972; standard deviation 110), and gross erosion per unit area 92 m³/km²/year (69–116; standard deviation 13). Warmer years bring unstable rainfall, with droughts and heavy showers alternating, increasing risks for farming, water resources, and ecosystems. Rising temperatures and variable precipitation further intensified erosion extremes, with the lowest values in 2011 and peaks in 2023, underscoring the need for continuous monitoring and adaptive watershed management.

Keywords: Soil erosion; Sediment yield; Hydrological response; Temperature; Precipitation variability; Šekular; River Basin

Vanishing Paleoenvironmental Archives of the Ice Caves in the Prokletije Mountains (Montenegro)

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Abstract: Monitoring of cave ice in the Prokletije Mountains was launched in 2020. So far, fifteen ice caves have been discovered in the Kolata Massif and the neighboring Belić Massif. Three sites were selected for temperature monitoring (Golden Cave System, Crystal Cave System, and Ice Giant Cave) and two for seasonal ice surveys (Crystal Cave System and Ice Giant Cave). In addition, since 2022, changes in humidity in Ice Giant Cave have also been investigated. Due to the early stage of the research and limited availability of equipment, the results of meteorological measurements were compared with data from the nearest weather stations in Podgorica, Shkodra, and Peja. Preliminary results show that the temperature inside the cave during winter follows the same trends as those recorded outside. Moreover, high precipitation values observed in Podgorica and Shkodra correspond to increased temperatures in Ice Giant Cave. The cave surveying technique was also applied to create seasonal Digital Ice Models (DIMs). A differential digital model based on DIMs from 2022-2024 confirms cavers' observations that, year by year, the ice cover is decreasing dramatically; the farther from the entrance, the more intense the process becomes. Initial paleoenvironmental data derived from the cave ice were also analyzed. A wood fragment extracted from the ice was subjected to microscopic anatomical identification and determined to belong to the *Juniperus* genus. Dendrochronological analysis revealed 93 growth rings. Due to the absence of *Juniperus* reference chronologies for this region, the sample was tentatively cross-dated against a nearby *Pinus heldreichii* chronology, indicating that the tree grew between AD 1461 and 1553. This suggests that the ice deposits in this part of the profile likely formed during the Little Ice Age.

Keywords: Prokletije Mountains; ice caves; climate monitoring: Digital Ice Models; Little Ice Age

A short phase of intense loess deposition following a period of erosion at the Trzebnica site in SW Poland

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Abstract: The Trzebnica Hills represent the northernmost loess patch in southwestern Poland. The first scientific studies of loess deposits in Trzebnica were linked to archaeological investigations at the Lower Paleolithic site Trzebnica 2. The results indicated that the loess in Trzebnica is underlain by Neogene clays, with a local gravel pavement interpreted as a remnant of Pleistocene glacial tills. The loess deposition was initially dated to the Last Glacial period and correlated mainly with MIS 2, with relict paleosols formed during MIS 3. This interpretation, however, was clearly inconsistent with the stratigraphy proposed by archaeologists. New OSL dating results obtained from 15 samples collected from the loess–paleosol sequence at Trzebnica do not support the earlier stratigraphic interpretation suggested during archaeological research. The results show that the studied loess–paleosol sequence formed during the final phase of the last glaciation, between approximately 18.5 and 15 ka BP. This was a period characterized by high rates of aeolian dust deposition, with loess thickness exceeding 7 meters. The direct contact of loess with the underlying gravel pavement indicates a phase of intense erosion and deflation that removed older deposits. This observation fits well within the general loess sedimentation model for the Trzebnica Hills, as similar results have been documented in the loess–paleosol sequence at Zaprężyn. Additionally, the Trzebnica sequence preserves evidence of permafrost conditions in the form of ice-wedge pseudomorphs.

Keywords: Trzebnica Hills; loess–paleosol sequence; OSL dating; Last Glacial period; permafrost conditions

Glacial history of the mountains of Serbia, Montenegro and neighbouring regions

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Abstract: Glaciers were widespread in the mountains of Serbia and Montenegro in the Pleistocene. Today only a handful of small cirque glaciers exist: they survive under conditions strongly controlled by local topoclimate in a few cirques of Durmitor and the Prokletije. Since glaciers have a close relationship with climate, the glacial record provides important information on past and present climates in this region. The largest glaciation occurred during the Middle Pleistocene, during Marine isotope Stage (MIS) 12 (480-430 ka). In Montenegro, large ice caps covered much of the country, from Durmitor to the Prokletije. Smaller ice caps formed on the mountains of the Adriatic coast, over Mount Orjen, for example. Later glaciations are recorded by moraines dating to MIS 6 (190-130 ka) and MIS 5d-2 (110-11.7 ka). The formation of large, and low-lying, ice caps over the Dinaric Alps indicates sustained moisture supply during Pleistocene cold stages. These ice masses would have blocked the inland penetration of moisture from the Mediterranean, resulting in much drier conditions in the Central CarpathianBalkan interior, creating favourable conditions for the accumulation of thick loess deposits. It has been assumed that glaciers in Serbia were restricted to the highest cirques, since the mountains lie to the east and in the lee of the Dinaric Alps. However, in the Stara Planina in SE Serbia, there is evidence of ice field glaciation that is much more extensive than previously recognised. Work is under way to establish the timing of glaciation in this region using terrestrial cosmogenic nuclide exposure dating. The extent of this glaciation implies significant moisture supply which is counter to prevailing ideas on atmospheric circulation and palaeoclimate in this region during Pleistocene cold stages. The palaeoclimate setting of this region is

important for understanding the environments encountered by Palaeolithic humans in the Balkans. It also has important bearing on interpretation of the ecological record, since this region was a key refugia for temperate flora and fauna during Pleistocene cold stages.

Keywords: Pleistocene glaciation; Dinaric Alps; Ice extent; Stara Planina; Palaeoclimate

ABSTRACTS (THEMATIC SESSION – Methodological Approaches related to reconstruction of Geospatial and Environmental Dynamics + Geoheritage + Geotourism)

Analysis of the Jacobi Stencil in the Context of Selected Emerging Computing Paradigms

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Abstract - Stencil computations are a well-studied class of problems important in a number of different scientific areas, including geoscience. Used primarily as multi-dimensional partial differential equation (PDE) solvers, these algorithms have long been applied to weather prediction, climate simulation, fluid dynamics, and image and video processing. In this work, the three-dimensional Jacobi stencil, a numerical heat equation solver, is examined. Three-dimensional stencils pose a unique challenge for efficient computation, owing to their non-contiguous memory-access patterns. Since multiple iterations of the algorithm are performed, memory transfers between the accelerator and the CPU may pose an additional problem in some cases. First, the existing CPU single-core and multi-core solutions are summarized, paying particular attention to different ways to exploit the memory hierarchy of traditional processors. Second, two existing CUDA solutions are discussed. The first is a naive fine-grained implementation of the algorithm. The second solution expands on the first with blocking in two dimensions, using the GPU shared memory, and thread coarsening techniques. Finally, two new implementations of the Jacobi stencil are proposed for distinct dataflow architectures. The first transforms the problem into a matrix-based computation targeting the Google Tensor Processing Unit, an accelerator optimized for tensor arithmetic chiefly used for speeding up machine learning algorithms. The second, a stream-based approach to the problem, is a sketch for the Maxeler Technologies FPGA-based devices. Potential improvements to some of the implementations are discussed at the end.

Keywords: Stencil computations; PDE solvers; GPU acceleration; Tensor Processing Unit; FPGA

Overview of hyperspectral imaging in assessing soil quality

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Abstract: Hyperspectral imaging (HSI) quantifies the reflectance characteristics of an object by measuring the amount of electromagnetic energy it reflects. As a non-destructive optical technique, HSI enables detailed characterization of soil composition and condition by capturing reflected energy within the near-infrared (NIR, 900–1700 nm) and shortwave infrared (SWIR, 1000–2500 nm) regions of the electromagnetic spectrum. In these wavelength ranges, specific optical absorption features of molecular bonds such as O–H, C–H, N–H, and Al–OH provide high sensitivity to soil constituents, including moisture, organic matter, and clay minerals. The NIR domain primarily captures information related to water content and organic carbon, while the SWIR domain reveals mineralogical and chemical properties such as clay type, carbonates, and salinity. Supported by advanced data analytics involving calibration, noise correction, and signal processing based on artificial intelligence principles, this methodology offers significant improvements in quantifying soil properties. Despite certain limitations related to surface variability and illumination, HSI provides rapid, repeatable, and spatial–spectral insights into soil heterogeneity. The integration of NIR–SWIR HSI with AI-driven analytical approaches establishes a robust technological foundation for next-generation soil quality assessment and environmental diagnostics.

Keywords: Hyperspectral imaging; near-infrared; shortwave infrared; soil composition; artificial intelligence

Comparative spectrochemical analysis of the organic matter character of sandy terraines from northern Serbia

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Abstract: In order to monitor the sandstones of the northern Serbia region as potential measures for the restoration of these areas, this work has analyzed and compared the character of organic matter of three Arenosols from the Vojvodina region. The organic matter of the arenosols of three regions of Vojvodina was compared spectrochemically with the organic matter of the soil substrate as well as the organic matter of the Danube sediment. Using the methods of FTIR spectroscopy, aquaphotomics, and comparative analysis of UV/VIS parameters of extracts of the labile aqueous fraction, the specificities and differences of these three environmental variations for the evolution of organic matter were determined. Certain similarities in the character of organic matter with sediment organic matter have been established and it has also been established that certain spectroscopic methods have the potential for classifying sandy soils. Three important wavelength ranges (3490-3725cm$^{-1,}$ 2140-3054cm^{-1} ,1720-2140cm^{-1}) for sandy soils were determined by PCA loadings. The values of UV/VIS paremeters of the labile SOM aqueous extracts (E2/E3 and Sr) are too similar, so this method should be further investigated. Based on the aquagram analysis, it can be concluded that the extracted labile organic matter of the sediment is the least soluble in water of all the tested samples. This result is somewhat expected knowing this type of soil, because the sediments are sampled at different depths and below the water surface where the biochemical processes and the evolution of organic matter are different than in the soil.

Keywords: Arenosols, organic matter, FTIR spectroscopy, aquaphotomics, sandy soils

Deep Learning Classification of Elevated Gamma-Radiation Zones Using Sentinel-2 Spectral Data

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Abstract: In our previous work, we introduced the Normalized Difference Gamma-Ray Index (NDGRI = (B4–B12)/(B4+B12)) as a spectral approach to highlight surface conditions associated with elevated gamma radiation. Validated against car-borne and airborne spectrometry surveys, NDGRI demonstrated potential for delineating radiation anomalies in semi-arid terrains. Detecting such anomalies directly from satellite data is of practical importance, as it offers a cost-effective way to narrow down prospective zones before deploying expensive car-borne or airborne surveys. Building on this foundation, the present study investigates whether deep learning can extend this approach beyond index-based methods by classifying elevated radiation directly from Sentinel-2 spectral data. We implemented multilayer perceptron (MLP) networks designed for per-pixel spectral classification, using fully connected dense layers with dropout regularization. Hyperparameters, including number of layers, neurons per layer, dropout rates, optimizers, and learning rates, were tuned via Keras Tuner and AutoKeras in Python to balance model complexity and generalization. Training and validation samples were extracted from car-borne and air-borne gamma-ray spectrometry heatmaps, providing pixel-level labels for supervised learning. Three input configurations were tested: (i) NDGRI provided as a single-band raster, (ii) the full set of 11 Sentinel-2 bands, and (iii) selected band subsets that showed diagnostic potential in our previous NDGRI analysis (B3, B8, B11; B4, B8A, B11, B12; B5, B6, B8, B11; B3, B4, B8, B8A, B11). Results showed that the NDGRI raster performed strongly as a compact predictor of elevated radiation, but that multi-band inputs provided better overall performance, with certain subsets consistently outperforming NDGRI alone. These findings indicate that while NDGRI efficiently captures key spectral contrasts, the inclusion of targeted spectral combinations enables the network to exploit complementary features and improve robustness. Our findings suggest that deep learning can serve as a powerful extension of NDGRI-based

workflows, combining the interpretability of targeted indices with the flexibility of data-driven classification. This approach could offer a scalable and computationally efficient means of mapping elevated gamma-radiation anomalies from multispectral satellite imagery, with implications for cost-effective uranium exploration in semi-arid terrains.

Keywords: Deep learning classification; Sentinel-2 Remote Sensing; NDGRI; Uranium exploration

Sustainable management of geodiversity in urban areas using spatial decision support systems

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Abstract: Conflict over natural resources figured prominently in th urban areas of Belgrade. On the one hand there is a constant need for space for the construction of new buildings for housing, agriculture and industrial production, and on the other hand the resources need protection because of the threat of degradation or even complete destruction. Therefore, the geodiversity, as well as natural resource, must be managed in a sustainable manner in which it is very important protection locations that potentially represent geoheritage. In what way and how will these resources be used depends on the vulnerability and values of the elements of geodiversity (geological, geomorphological, hydrological and soil). Spatial decision-making process is often complex, multidisciplinary and includes a large number of stakeholders. Relevant information regarding the problem to be solved must be collected and organized in a way to support the analysis of the problems and meet the needs of decision makers and various stakeholders. Complex situations when it has a large amount of information, requires a computer system to support decision-making. The introduction of spatial decision support systems in the process of managing geodiversity contributes to achieving these goals. The default setting of this system, involves a combination of Geographic Information System (GIS) techniques with spatial multi-criteria analysis in order to support solving problems of sustainable management of geodiversity in the city of Belgrade especially when selecting locations that have potential as geoheritage sites. The final result is a selection of geosites that have the greatest potential to be part of the protected area of Belgrade.

Keywords: geodiversity; geoheritage; Spatial Decision Support Systems; sustainable management; urban areas

Anthropogeotourist attractions in Lower Silesia – the tourist potential of the region's underground attractions

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Abstract: The article is devoted to the analysis of the geotourism potential of underground facilities of a cultural nature, based on selected examples from the Lower Silesia region. The region is one of the best equipped with such assets in the country. Former mines, underground passages and tunnels are increasingly being used for tourism purposes. In addition to entertainment, an important aspect of preparing a tourist product is its educational context. Geological knowledge can be, and often is, as important as historical knowledge related to the functioning of the site in the past. For many years, Lower Silesia has emphasised the importance of both aspects in the development and promotion of its tourist offer, whether it be specific places or themed trails. After presenting the geotourism offer, which was created on the basis of culturally transformed resources, their functioning was analysed, taking into account the different groups of recipients of the offer. To this end, a review of relevant documents was carried out, as well as the methods of presenting resources in virtual space, which is usually the first and often the only form of contact through which a potential customer can obtain knowledge about the nature of the asset and its functioning on the tourist market. The diversity of the offer and its adaptation to the needs of various target groups makes Lower Silesia one of the most attractive geotourism regions not only in Poland but also in this part of Europe. This type of asset, referred to as anthropogeotouristic for the purposes of this publication, is an exceptionally attractive offering that usually harmoniously combines entertainment and knowledge, constituting one of the main pillars of education through entertainment and contributing to raising the level of public awareness of the region's geodiversity, which is the first important step towards the sustainable development of the area.

Keywords: Geotourism; underground heritage; Lower Silesia; cultural resources; sustainable development

The Special Nature Reserve Titel Loess Plateau, Vojvodina, North Serbia

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Abstract: The Special Nature Reserve (SNR) "Titelski Breg - Titel Loess Plateau" is located within the municipality of Titel, in the heart of Vojvodina (North Serbia), along the banks of the Tisa River and not far from its confluence with the Danube. The Institution for Nature Protection "Titelski Breg - Titel Loess Plateau" manages this protected area and also serves as a cornerstone for the tourism development and offerings of the Titel municipality. This Loess Plateau is a geological and archaeological phenomenon known as the "Witness Hill". Segments of the Titel Loess Plateau preserve a paleoecological and paleoclimatic record spanning 620,000 years, depicting the shifts between ice ages and interglacial periods. On the periphery of the Plateau, traces and continuity of life from prehistory to the late Middle Ages are conserved. The distinctive relief and geomorphic forms possess narratives painted with mystical colors. The Plateau's periphery safeguards a relic steppe that accommodates numerous rare, endangered, and protected species, providing a home for diverse fauna. Recognized as an important botanical area, it is part of the national IPA (Important Plant Areas) region of Central and Eastern Europe, and it is also situated within the internationally significant Important Bird and Biodiversity Area (IBA). Titel Embankment holds potential that is, or can be, inspiring for enthusiasts of active recreation such as hiking, walking, cycling, and birdwatching. The biodiversity and cultural diversity of Titel Embankment hold the potential for new content and layered insights for visitors, both official and those seeking a touch of mystery. As legal guardians of the SNR Titel Loess Plateau, we too are eager for new knowledge hidden within the loess-palaeosol sequences, knowledge gained through scientists from Serbia and around the world who seek to uncover its secrets. New insights about turbulent geological and climatic processes, the changing landscape, and the Plateau dynamics that provided refuge and protection for ancient humans allow us to see Titel Loess Plateau again and again, discovering new potentials for its promotion and presentation to the world. During spring and autumn, the most interesting viewpoint for visitors is "Kalvarija" a site with great potential, even as an archaeological location. In the winter months, bird enthusiasts and photographers have access to a bird-watching facility at the feeding site established at the "Titel Old Brickyard –

Stara Ciglana" location. The periphery of the Titel Loess Plateau, along the Tisza River, holds immense potential for establishing geological and educational trails. Within the informative-visitor center of the Institution, an interactive model is available, and ongoing activities include several projects such as dioramic displays of the Loess Plateau sections and exhibitions on geological, archaeological, and historical heritage. At the site of Veliki Surduk in Mošorin village, preparations are underway for the creation of "Staircase Through Epochs", which will follow the visible geological layers.

Keywords: Titel Loess Plateau; Special Nature Reserve; Conservation; Promotion; Vojvodina; North Serbia

Caves in the Middle Basin of the River Uvac – Geoheritage Sites in Serbia

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Abstract: This paper analyzes the significance of the caves located in the middle basin of the River Uvac which are listed on the official *Inventory of Geoheritage Sites in Serbia*. Four caves, namely the Ušački Cave System, Bukovik Cave, Tubića Cave and Baždarska Cave, have been selected for analysis because of their scientific, educational, and scenic value. The paper presents their morphological and hydrological characteristics and the abundance of speleothems found in those caves. It also gives an analysis of the current status of conservation and the extent to which those caves have been developed and used for tourism. The aim of the study is to evaluate the natural, functional, and tourism-related values of the analyzed caves in order to determine their significance at the local, national, and international levels. By identifying their scientific, educational, scenic and conservation potential, the paper contributes to a better understanding of Serbia's speleological heritage and suggests possibilities for its sustainable use. In addition to providing a geomorphological assessment, the study examines the role of these caves in the development of geo-tourism, environmental education and local development. The study is based on a combination of the review of relevant literature, fieldwork and personal observations. The caves were evaluated using the GAM methodology, which is an internationally recognized method for assessing geoheritage sites. This method numerically evaluates both the main values (scientific/educational, scenic/aesthetic and the conservation value) and additional values (the functional and tourism-related ones) of each site using a set of sub-indicators. The results show that the Ušački Cave System constitutes the most complex and representative speleological site in the study area, with outstanding educational, scientific, and aesthetic values, and a strong potential for eco and adventure tourism. Although scientifically and scenically important, Bukovik, Tubića and Baždarska Caves remain underutilized in terms of tourism due to a lack of promotion and infrastructure. The paper leads to a conclusion that systematic planning, increasing promotional activities and infrastructure development are essential for reaching the full potential of these caves for sustainable

development and strengthening their role as significant elements of geoheritage in Serbia.

Keywords: Caves; Geoheritage; Middle basin of the River Uvac; GAM; Geoconservation

Role of morphodynamics in the rise and fall of human and other biological civilizations

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Abstract: Morphodynamics integrates natural (climate, tectonic) and anthropogenic forcings to provide ever-changing *de facto* habitation environments for life, human or otherwise. Here I will present and analyze particular morphodynamic cases from my past and current projects: early hominids in lacustrine-desertic southern Africa; Indus and Sumerian civilizations in fluvial-deltaic settings; and ecosystem-human interactions in the Danube-Black Sea system since Neolithic.

Keywords: morphodynamics; climate and tectonics; human-environment interactions; fluvial-deltaic systems; paleoecology

ABSTRACTS (THEMATIC SESSION – Science and Art In-between)

Artistic research as a road between "madness" and "method"

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Abstract: In this presentation I will share my experiences in research from two points of view: artistic and scientific. I will also make my presentation from three different angles: as a performer, piano professor, and professor of History of piano performance. *A temporal art, live music can only manifest itself in ever-varied performances, yet it "remains unchanged behind this relativity"* (Rosen). The relationship between the absolute and the relative aspects of music constitutes the basic concern of performance practice. This relative element provides unconventional possibilities for creative freedom or „madness", and it is a major difference from science (which seeks for definitive answers). Ideal performance exists only as an abstract idea. Even composers play or conduct their own works differently from the printed text, and great performers change artistic approaches in different stages of their career. Artistic research can help in artistic development of an artist, by providing tools to approach to works of music from many different perspectives. Research methods should not pervert artistic practice, and limite imagination - they should enriched it. From my artistic practice and pedagogical experience I can confirm that artistic 'madness' and research 'method' can be compatible. Freedom is in choosing and developing the appropriate methods, but method in any research should be applied rigorously. Then, this new knowledge can be used as a „platform"for artistic intuition.

Keywords: Artistic research; piano performance; creativity; methodology; interpretation

Depth Age Scale project

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Abstract: Depth Age Scale is an art project based on previous intensive scientific research located on Titel Hill (Veliki Surduk locality), an isolated loess plateau in Vojvodina region that preserves loess and soil (mostly fossil soil horizons) layers approximately 600,000 years old. Through three works — a wooden totem with an educational panel, the *Loess Doll House*, and spiral drawings of fossil snails in a wheat crops — the authors (*New Cave Art* collective) visualize abstract concepts such as time, memory, and geological history. The *Loess Doll House* will serve as a space where impressive specimens of loess dolls found on-site will be exhibited in a museum-like setting, further emphasizing the uniqueness of the location. The works belong to the Land Art movement and combine art, science, and landscape, with the aim of promoting natural and geological heritage and fostering geotourism. The project draws inspiration from successful regional examples, such as *New Cave Art*'s interventions on Mount Durmitor, which have shown strong potential for visibility on social media and increased visitor numbers. Such interventions also have a positive impact on local communities by raising awareness of natural values, and opening new opportunities for education, promotion, and sustainable development.

Keywords: Depth Age Scale; loess plateau; Titel Hill; land art; geotourism

From clinical features to poetry: the plague through the perspective of four ancient authors

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Abstract: In his *History of the Peloponnesian War*, the Greek historian Thucydides provided us with valuable information on the plague epidemic in Athens in 430 B.C.E. An eyewitness to the epidemic and even a convalescent himself, Thucydides writes about the disease in a scientifically grounded and fairly precise manner. Several centuries later, his text would serve as a template upon which Lucretius, the author of the philosophical poem *De Rerum Natura*, relies in the conclusion of the VI and final book of his work. Being an Epicurean, Lucretius strives to write about the etiology, symptomatology and epidemic of the disease primarily objectively and scientifically credibly through numerous details and descriptions. His follower and also a student of Philodemus's Epicurean school, Virgil, is primarily a poet, diving into the eternal mystery of Thanatos in a completely different manner than Lucretius, whose text undoubtedly served as a model for the finale of the III book of the didactic poem *Georgics*. Finally, Virgil's significant transformation of Lucretius's text is also utilized by Ovid in *Metamorphoses*, as the last in our series. Thus, we will have the opportunity to observe how this verdureless and highly objectively presented historical episode from the *History of the Peloponnesian War* was transformed through later ancient authors, primarily poets.

Keywords: Plague in Athens 430 B.C.E.; Thucydides; Lucretius; Virgil; Ovid.

ABSTRACTS (THEMATIC SESSION – Loess)

High-Resolution Reconstruction of Late Pleistocene Climate Variability from the Surduk Loess–Paleosol Sequence, Northern Serbia

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Abstract:This study investigates Late Pleistocene climatic variations through detailed grain-size and chronological analyses of the Surduk loess–paleosol sequence located along the Danube River in Northern Serbia. The primary objective of the research is to reconstruct the rate of loess accumulation and identify major and short-term climate events by linking sedimentological data with absolute ages. The upper 16 m of the Surduk loess profile was sampled. Grain size samples were collected at every 5 cm and were analyzed using laser diffraction, while optically stimulated luminescence (OSL) samples were collected at an exceptionally high resolution, every 20 cm, to provide a robust chronological control. Key grain-size parameters (D10, D50, D90, U-ratio, and fractions <5 μm and >63 μm) were used to interpret sedimentation dynamics and aeolian intensity. The results reveal distinct textural fluctuations corresponding to glacial–interglacial cycles and several short-term climatic oscillations. High U-ratio and coarse fractions indicate cold, arid, and windy phases (e.g., MIS 2), while finer deposits correspond to warmer, more humid intervals (e.g., MIS 3). Several well-known climate events, such as the Younger and Older Dryas, Lascaux and Laugerie interstadials, and four Dansgaard–Oeschger oscillations, were successfully identified. Comparison with Greenland $\delta^{18}O$ records confirms the correlation of local loess deposition with global paleoclimate patterns in the reliable range of quartz OSL. The study demonstrates that high-resolution OSL dating and grain-size analysis is a powerful combination of methods for reconstructing paleoclimatic variability in the Carpathian Basin. The Surduk section provides one of the most detailed records of Late Pleistocene environmental changes in southeastern Europe, highlighting the regional sensitivity of loess accumulation to global climate forcing.

Keywords: Late Pleistocene; loess–paleosol sequence; grain-size analysis; optically stimulated luminescence, U-ratio; aeolian sedimentation

Loess under debate: uncertainties in dust flux reconstructions and stratigraphic interpretations

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Abstract: The role of external dust addition to sedimentary sequences must be carefully considered in paleoenvironmental reconstructions. Yet, constraining potential areas of dust accumulation is highly challenging, and identifying mineral dust particles or quantifying dust fluxes remains even more problematic. In this study, we present new and sometimes unexpected insights from recent long-range Saharan dust transport events, highlighting the influence of ongoing climate change and the significance of coarse dust particles. For paleoclimate reconstructions, three key lessons emerge: (1) dust deposition can affect much larger areas than previously assumed; (2) not only fine fractions but also coarse particles exceeding 100 μm can be transported across thousands of kilometres; and (3) the volume of deposited material may be considerably greater than suggested by earlier numerical models. Over recent decades, the frequency and intensity of Saharan dust storm events across Europe have increased, as revealed by satellite imagery, numerical modelling, meteorological analyses, back-trajectory studies, and surface observations. Between 1979 and 2024, at least 275 Saharan dust incursions reached the Carpathian Basin. These events clearly reflected the influence of amplified meridional jet stream patterns, which contributed both to extreme weather and to enhanced dust storm activity over the Atlas region. To further investigate such processes, we extended our research to meridional dust transport and to northern Europe. In Iceland, we identified 15 Saharan dust events between 2008 and 2020, including two episodes confirmed by surface sampling. Laboratory analyses of these samples revealed abundant quartz grains larger than 100 μm, confirming that coarse particles can indeed be carried over transcontinental distances. Comparable findings were obtained in Finland, where more than 60 Saharan dust events were identified between 1980 and 2022.

Keywords: Saharan dust, long-range transport, coarse particles, climate change, Europe

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How often did the Sava River flood in the past? A sedimentological and chronological investigation of terrace overbank sediments, Šabac (Serbia)

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Abstract: In this study, we investigated overbank sediments of the first terrace of Sava river in Šabac, exposed at a residential building construction site. Sediment characteristics such as grain size, magnetic susceptibility, chemical composition, and loss on ignition (LOI) at 550 °C and 950 °C were determined at 5 cm resolution, accompanied by visual inspection to assess color, pedogenic structure, and other pedogenic features. A total of eight samples were dated using optically stimulated luminescence (OSL) at two grain-size fractions (4–11 μm and 63–90 μm). The obtained ages were used to calculate mass accumulation rates (MAR). The profile is 2.25 m thick and composed predominantly of clayey loam. The modern soil developed at the site is an anthropogenically modified cambisol, containing a 75 cm thick terric horizon that differs in sedimentological characteristics from the rest of the profile. It is characterized by a higher sand content and increased LOI at 950 °C. The lowermost horizon of this cambisol extends into the late pleistocene, indicating downward progression of the cambic B horizon. The obtained OSL ages reach up to ~32 ka. High MAR values persist until ~19 ka, after which

they decrease and remain low toward the present, suggesting incision of the Sava River and subsequent abandonment of this (now former) floodplain. Two peaks in MAR at ~25 ka and ~32 ka correspond to periods of intensified melting of the Alpine ice sheet, indicating that enhanced meltwater discharge led to increased flooding and more rapid accumulation of overbank sediments. The investigated sequence does not record the melting event that occurred around ~28 ka.

Keywords: loess; fluvial sediments; Wallachian basin; geochemistry; loess provenance

Paleoenvironmental Reconstruction of the Vrtište Site in the South Morava Valley (Serbia)

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Abstract: This study presents the results of paleoenvironmental research conducted at the Vrtište site in the South Morava River valley, close to the city of Niš. Based on sediment analyses and XRF data, the profile reveals distinct phases of climatic and sedimentological change during the Late Pleistocene. The upper layers reflect arid conditions, while the deeper horizons indicate periods of increased humidity and weathering intensity. Comparison with the nearby Belotinac section shows that Vrtište was exposed to more dynamic and variable climatic conditions, whereas Belotinac experienced more stable sedimentation. These findings suggest pronounced local differences in landscape evolution and climate variability within the South Morava basin. Optically stimulated luminescence (OSL) dating, currently in progress, will further clarify the chronological framework of these changes and contribute to a more comprehensive understanding of Late Pleistocene environments in the central Balkans.

Keywords: Paleoenvironmental reconstruction; XRF; OSL; Vrtište; South Morava Valley; Niš

ABSTRACTS (THEMATIC SESSION – Climate and Environment)

Climate Change Impacts on Cultural Heritage: Perspectives for Future Research and Assessments in Serbia

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Abstract: The integration of heritage and culture into climate adaptation can make a substantial contribution to resilience. As Dr. Hoesung Lee, Chair of the IPCC, stated at the launch of the International Co-Sponsored Meeting on Culture, Heritage and Climate Change in December 2021, "*Culture and heritage are vitally important aspects of our lives and resources influencing how our communities and societies adapt to climate change*". It is therefore essential to safeguard cultural heritage by adapting to climate variability and extremes, while strengthening resilience through the reorientation of climate policy, planning, and action at all levels to better incorporate cultural dimensions (CHN, 2022). The threats that climate change poses to cultural heritage have become increasingly evident, as demonstrated by initiatives such as the Noah's Ark project (2004–2007) in Europe (Aarrevaara and Carroll, 2025). Urban environments are especially vulnerable, as they are exposed to multiple climate stressors, including rising air and surface temperatures and intensified air pollution, which in turn undermine both public health and overall urban resilience. Recent findings indicate that green façades on stone-built heritage can mitigate common degradation processes by reducing incoming solar radiation and limiting moisture accumulation on wall surfaces, thereby lowering the risk of biodeterioration (Groeve et al 2024). They also moderate relative humidity fluctuations and provide shading, which helps to reduce surface temperatures and decreases the likelihood of salt crystallisation. In colder climates, evergreen vegetation enhances resistance to freeze–thaw cycles by maintaining higher minimum surface temperatures through thermal blanketing and further reducing surface moisture (De Grove et al., 2025; Kale et al., 2025). Consequently, vertical greening systems (VGS), including façade-bound and ground-based greenery, are increasingly being integrated into built heritage as strategies to support

both preservation and urban sustainability. Complementing these technical approaches, Sharmin et al. (2025) highlight how the conservation of tangible heritage, exemplified by the historical stepwells of India, can also inform broader climate change mitigation and governance policies.

Against this background, the present study sets out the following research objectives:

1. To develop methodological approaches that can better capture and quantify the diversity of heritage types and conditions.
2. To bridge the gap between long-term climate projections and short-term heritage protection and adaptation strategies.
3. To account for the local specificity of cultural and geo-heritage assets and their climatic contexts, while exploring pathways toward broader comparability and transferability of findings.

Together, these objectives aim to strengthen the integration of cultural heritage within climate adaptation strategies, ensuring that both tangible and intangible heritage are safeguarded as part of wider efforts to build climate resilience.

Keywords: climate change; heritage; culture; climate adaptation; governance policies

The Drought Hazard Index (DHI) vs. the Extended Satellite-based Drought Condition Index (SDCI): A Case Study of the Zaječar District

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Abstract: This paper examines the application of Geographic Information Systems (GIS) in the identification of drought-prone areas in the Zaječar district. Drought is one of the most severe natural hazards, leading to the depletion of essential resources such as water and food. Its increasing frequency causes significant damage to socio-economic systems, the environment, and human well-being, posing a major challenge for affected communities. As climate variability intensifies, the need for accurate, spatially explicit drought assessment becomes more urgent, especially in vulnerable regions. The aim of the study is to identify the most drought susceptible areas of the Zaječar district by processing satellite imagery. The study applies the Drought Hazard Index (DHI), Analytic Hierarchy Process (AHP) and Extended Satellite-based Drought Condition Index (SDCI), combining remote sensing data with decision-support methodologies. The Drought Hazard Index (DHI) is derived from four parameters: Land Surface Temperature (LST), Normalized Difference Vegetation Index (NDVI), Normalized Difference Moisture Index (NDMI) and Topographic Wetness Index (TWI). Each of these components is assigned a weighting coefficient using the Analytical Hierarchy Process (AHP), which enables the prioritization of variables based on expert judgment and pairwise comparison. The Extended Satellite-based Drought Condition Index (SDCI) is calculated by incorporating LST, NDVI, NDMI, TWI, Albedo and Soil Moisture. These variables are normalized and combined to reflect drought severity, with higher values indicating more extreme drought conditions. The integration of additional parameters such as Albedo and Soil Moisture enhances the sensitivity of the index to surface and subsurface dryness. These methods aim to assess the spatial distribution of drought susceptibility, emphasizing potential risks and identifying critical zones for intervention. The results contribute to proactive planning, sustainable resource management, and informed decision-making in crisis situations. This research also highlights the importance of integrating geospatial technologies with environmental indicators to improve early warning systems and long-term drought mitigation strategies. Ultimately, this GIS-based approach supports resilience-building and adaptive strategies in the face of increasing environmental stressors.

Keywords: GIS; drought; DHI; SDCI

Long-Term Drought Dynamics in the Region of Southern and Eastern Serbia

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Abstract: This study investigates the spatial and temporal characteristics of drought in Southern and Eastern Serbia using the Standardized Precipitation Index (SPI) and the Standardized Precipitation-Evapotranspiration Index (SPEI). Drought duration, severity, and frequency were assessed at four time scales: 1 month (SPI1, SPEI1), 3 months (SPI3, SPEI3), 6 months (SPI6, SPEI6), and 12 months (SPI12, SPEI12). The analysis covers nine meteorological stations across the study area for the period 1961–2024. Results indicate that 28.8% of years were classified as extremely wet, while extremely dry and near-normal years accounted for 27.7% and 23.1% of years, respectively. The 2000–2001 drought was recorded as extremely dry at all stations and across all time scales by both indices. The longest drought occurred in Vranje, lasting from June 1990 to April 1995 (59 months), with a severity of -7.26 and an average intensity of -1.13 according to SPEI12. Significant droughts were also observed at nearly all stations during the periods 1961–1963, 1971–1972, 1987–1993, 2000–2003, 2011–2012, and 2019. Overall, the SPEI shows longer and more severe drought periods than the SPI, particularly in the latter part of the study period. SPEI is therefore considered a more suitable index than SPI for evaluating drought characteristics over long-term periods. This study demonstrates that droughts in Southern and Eastern Serbia are frequent, severe, and long-lasting, with the SPEI index providing a more accurate assessment than SPI. Using SPEI for drought monitoring and early warning can improve understanding and management of drought risks, supporting more effective water resource planning and climate adaptation strategies in the region.

Keywords: drought; hazard; SPI; SPEI; drought risk indices; Eastern Serbia

Phenol Removal from wastewater by novel sustainable Geo-polymer materials

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Abstract: Phenolic compounds are classified categorized as priority pollutants due to their significant toxicity, environmental persistence, and resistance to biodegradation in aquatic systems. Various natural and synthetic aluminosilicate materials including: kaolinite, metakaolin, zeolites, clinoptilolite, and montmorillonite, have been extensively studied as alternative adsorbents to conventional commercial materials such as activated carbon. Experimental investigations have ussed rigorously designed synthesis protocols for geopolymer production, providing a foundation for further conceptual and applied research in phenol removal processes from wastewater. Insights into several selected methodologies could lead to novel synthesized pathways for geopolymers. In a paper by Ghogomu et al, 2014, experiments were conducted at pH 8.5 by mixing 25 mL of phenol solution (100 mg L^{-1}) with 0.10 g of adsorbent, maintaining constant agitation at room temperature. Phenol removal from aqueous solutions showed that the percentage adsorption of phenol increased with adsorbent dose up to 0.1 g — 45% for metakaolinite and 90% for kaolinite —and then stabilized, with no significant further increase. It is important to note that the quantity adsorbed remains constant (for concentrations greater than 200 mg/L) as the adsorption sites become saturated and the exchange sites are filled (Ghogomu et al, 2014). Other studies showed that phenol removal efficiencies ranged from 41 to 74% for exadecyltrimethylammonium bromide (HDTMA) - zeolite and from 45% to 80% for benzyltetradecylammonium chloride (BDTDA)-zeolite at adsorbent dosages of 20–100 g/L. The adsorbed amount increases with adsorbent concentration, following non-linear dynamics with no significant change in phenol removal after about 4 hours during batch experiments at room temperature (Kuleyin, 2007). Further research will focus on improving the cost-benefit performance of these or other techniques supported by novel

protocols based on process optimization, using Artificial Neural Networks (ANN)) modeling.

Keywords: Phenolic compounds; adsorption; aluminosilicate materials; geopolymers; wastewater treatment

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

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Abstract: 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 southwest areas. This illegal landfill has continued to receive 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 results provide two main outcomes: (1) a comparative land use analysis across multiple periods, highlighting vegetation dynamics, debris distribution, built-up areas, and burnt zones; and (2) a volumetric comparison of the 2024 and 2025 surveys, quantifying the amount of waste deposited between survey periods.

Keywords: UAVs; SfM photogrammetry; Land Use; Point cloud; Modelling

ABSTRACTS (THEMATIC SESSION – Social relations)

Early Eneolithic Obrovac-Type Settlements in the Mačva Region: New Insights from Recent LiDAR Prospection

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Abstract: The Early Eneolithic period (mid-5th millennium BC) in western Serbia is characterized by a unique type of settlement not known elsewhere in southeastern Europe. These are small circular settlements, usually up to 50 meters in diameter, known as *Obrovac-type settlements*. They were well-fortified with a surrounding ditch and, in some cases, also with an earthen rampart. This represents a distinct and specific settlement form that, according to current research, appears to be characteristic only of western Serbia, particularly the Mačva region. In addition to the settlement's primary function, a major question concerns the role of the surrounding ditch. These ditches were often connected to nearby water sources—such as channels, rivers, or groundwater springs—which maintained a constant water level. Some researchers have proposed that the ditches represent natural meanders of ancient watercourses, although this explanation seems unlikely. In the 1980s, the idea emerged that such features may have been related to land-reclamation activities during the period when these settlements were formed. Considering the natural hydro-potential of the Mačva region, researchers observed that between the Drina and Jerez rivers there are no continuous natural watercourses with permanent sources, but instead the remains of two distinct hydro-systems. The first includes Bitva–Bitvić–Mandača–Jereščić, and the second Žurava–Žabar–Batar, each with several smaller tributaries. Based on geological evidence, it has been suggested that Eneolithic communities made use of marshy and waterlogged areas that had not been filled by the shifting Drina riverbed. These areas were periodically inundated by floodwaters from the Drina River and supplemented by abundant groundwater—conditions influenced by the high-water levels of both the Drina and Sava rivers. From these wetlands, a network of channels was excavated to drain and regulate the water flow. These channels run irregularly across the entire Mačva plain, frequently intersecting, diverging, and reconnecting, thus distributing water throughout the region. Along the banks of these channels, during the Early Eneolithic period, numerous agricultural settlements developed—particularly those of the *Obrovac-type*. This paper presents the latest LiDAR prospection results for this type of settlement and discusses their relationship with the existing canal network.

Keywords: Early Eneolithic; Mačva; Obrovac-type; LiDAR; hydro-system

Exploring Migration Scenarios in the Settlement Network of Ugljevik Municipality: Migration or Exploitation?

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Abstract: Mining activities are important drivers of economic development and demographic change, reshaping the social and environmental landscape of affected areas. This study investigates migration intentions in the coal mining-affected municipality of Ugljevik, Bosnia and Herzegovina, focusing on socio-demographic, spatial, and perceptual factors. Empirical evidence was obtained through a household survey of 545 respondents, covering socio-demographic characteristics, household conditions, spatial proximity to the mine, and perceptions of environmental quality. Descriptive statistics outlined the population structure and general migration patterns. Bivariate analyses (chi-square tests and ANOVA) revealed significant associations between relocation decisions and factors such as age, employment status, and distance from the surface coal mine. The Perceived Mining Impact on Environmental Quality Index (PMIEQ) was applied to capture subjective assessments of environmental conditions, while a multinomial logistic regression model evaluated their combined effects. The results indicate that younger respondents ($\chi^2 = 31.503$, $p = 0.002$) are more likely to consider migration. A higher tendency is also observed among the unemployed and those with university education, though without strong statistical significance. Settlements located closer to the mine (<1500 m) show significantly greater proportions of residents willing to relocate ($\chi^2 = 14.762$, $p = 0.022$). Negative environmental perceptions, measured through PMIEQ, are strongly linked to relocation decisions ($F = 13.005$, $p < 0.001$), underscoring environmental degradation as a major push factor. Multinomial regression confirmed that migration intentions are most strongly associated with younger age and

negative environmental perceptions, while employment in the mining-energy sector also plays a role. These findings highlight the multidimensional character of migration in mining regions, where socio-economic vulnerability, spatial position, and environmental dissatisfaction intersect. The study demonstrates that migration in coal mining areas is not solely shaped by economic factors but is equally influenced by environmental perceptions and spatial context. The results advance understanding of the social impacts of mining and emphasize the need to integrate demographic and environmental dimensions into local development planning. Importantly, identified out-migration patterns may accelerate depopulation and weaken the functional capacity of settlement network. Ensuring long-term settlement sustainability therefore requires strategies that jointly address environmental rehabilitation and socio-economic resilience.

Keywords: migration intentions; coal mining; settlement network; socio-demographic factors; environmental perception; SPSS; GIS; Ugljevik Municipality

ABSTRACTS (Poster presentations I, II, III)

Stabilizing the Unstable: The Role of Black Locust in Erosion Control on Loess Plateaus

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Abstract: The loess landscapes of northern Serbia, particularly the margins of loess plateaus such as the Titel and Srem plateaus, represent highly sensitive geomorphological systems prone to rapid and often unpredictable changes. Due to their porous structure, low compaction, and high sensitivity to moisture, loess deposits are extremely susceptible to various erosion processes. The marginal areas of these plateaus frequently experience landslides, slope instability, and the formation of pseudokarst landforms—including loess caves, dolines, and gullies—emphasizing the need for careful monitoring, management, and protection of these dynamic environments.This study investigates the role of *Robinia pseudoacacia* L. (black locust) in mitigating erosion processes along loess margins, using two case study sites: the Veliki Surduk on the Titel Plateau and an area near the village of Surduk on the Srem Loess Plateau. The methodological framework included a detailed literature review, field observations, morphometric measurements, and the application of precipitation erosion indices—namely the Precipitation Concentration Index (*PCI*) and the Modified Fournier Index (*MFI*)—based on data from the Mošorin weather station (1992–2011). Results indicate that extreme and irregular precipitation patterns significantly accelerate piping erosion and the formation of loess caves. However, in areas with established *R. pseudoacacia* populations, a marked reduction in erosion and slope degradation was observed. The species' extensive root system enhances soil cohesion, reinforcing the loess structure and slowing the collapse of underground voids. Additionally, black locust improves the physical and

chemical properties of surface soils, increasing their resistance to runoff and surface erosion. Although considered invasive in many ecosystems, *R. pseudoacacia* demonstrates substantial bioengineering potential in degraded and erosion-prone loess environments. Its nitrogen-fixing ability enables it to colonize poor and unstable soils, where native species often struggle to establish. These findings support its selective and ecologically informed application in erosion control strategies, particularly in areas requiring urgent stabilization interventions. This research highlights the importance of interdisciplinary approaches that integrate geomorphology, ecological engineering, and climate-resilient landscape planning. Future applications may include the development of regionally adapted restoration protocols that leverage the bioengineering benefits of *R. pseudoacacia*, while minimizing ecological risks. Additionally, the initial results offer valuable input for predictive modeling of erosion dynamics under projected climate variability, with potential relevance for similarly sensitive loess terrains in other parts of Europe, Asia, and North America.

Keywords: *Robinia pseudoacacia L.*, loess, erosion, pseudokarst, soil stabilization, climate indices.

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Geospatial Patterns of Cardiovascular Diseases: A Case Study from the Institute for Cardiovascular Diseases of Vojvodina (Northern Serbia)

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Abstract: Cardiovascular diseases (CVDs) represent one of the most dominant categories of non-communicable diseases, with a high prevalence both in the Republic of Serbia and globally. Understanding their spatial distribution provides valuable insights for public health planning and disease prevention. This study applies geospatial analysis to examine the patterns of CVDs among patients treated at the Institute for Cardiovascular Diseases of Vojvodina (ICDV) in the Republic of Serbia, over the period 1995–2023. The spatial dimension of the research was addressed using the Emerging Hot Spot Analysis tool in ArcGIS Pro, which implements the Getis-Ord Gi* statistic to detect statistically significant clusters of high and low values. The results revealed 12 clusters categorised as Consecutive Hot Spots and 3 clusters categorised as Sporadic Hot Spots, including 48 and 18 settlements in those clusters, respectively. The remaining clusters showed no patterns. To further refine the spatial representation of CVD clusters, the Kriging interpolation method was applied. For this analysis, settlements' polygons were converted to points, after which a Kriging-interpolated raster was generated and

subsequently transformed into contour lines to facilitate interpretation and presentation. The number of patients per settlement over the entire study period ranged from 1 to 357,076. A total of 37 settlements recorded only one patient. The highest number of patients was observed in Novi Sad, indicating that settlements within South Bačka County exhibited the greatest disease burden in the ICDV. The findings underscore the significance of geospatial methods in pinpointing high-risk areas in cardiovascular diseases, providing an evidence-based foundation for targeted healthcare interventions and resource allocation. Moreover, this study demonstrates the potential of integrating spatial geostatistics with health data to support the development of preventive strategies and to guide future epidemiological research on non-communicable diseases in Serbia and beyond.

Keywords: cardiovascular diseases; Institute for Cardiovascular Diseases of Vojvodina; Emerging Hot Spot Analysis; Kriging method; health geography

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Application of Artificial Intelligence for Terrain Slope Mapping

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Abstract: A terrain slope map represents one of the fundamental geospatial layers used for assessing soil stability, erosion risk, infrastructure planning, and environmental monitoring. With the advancement of Geographic Information Systems (GIS) and automated algorithms, the process of generating such maps has become increasingly accurate and efficient. This study examines the feasibility of utilising artificial intelligence (AI) to generate a slope map for Serbia's entire territory, with a focus on developing Python code for map creation. The research presents the workflow from acquiring a digital terrain model (DTM), through data processing in ArcGIS Pro, to the final visualisation of the slope map. The objective is to examine the effectiveness of AI in optimising GIS workflows and to evaluate the accuracy and reliability of AI-generated scripts compared with conventional spatial data processing methods. The findings demonstrate that the application of AI in slope map production offers multiple advantages, particularly in automating procedures, accelerating the generation of Python scripts, and reducing the likelihood of errors. Although some cases required additional code verification, the results confirmed that AI can serve as a valuable tool in GIS analyses. Automating Python script generation with AI has substantially accelerated spatial data processing while minimising potential errors. The spatial analysis produced a representation of slopes across the DTM area, incorporating cartographic elements of the map as geographic coordinates, legend, north arrow, and scale bar, essential for accurate interpretation. Additionally, the use of the matplotlib library enabled interactive data visualisation, including zooming and panning functions, which significantly enhanced terrain analysis. Future research may extend this methodology to other spatial analyses, such as erosion modelling, slope stability assessment, or hydrological simulations. Moreover, integrating AI with GIS tools and further optimising algorithms could improve both the precision and efficiency

of spatial analyses. This study confirms that the adoption of modern AI technologies in GIS can substantially enhance the quality and efficiency of spatial data processing, opening new opportunities for the application of AI in geospatial research.

Keywords: Artificial Intelligence (AI); Python; Geographic Information Systems (GIS); terrain slope map; Republic of Serbia

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Unveiling the Dynamics Behind the Mramor Landslide, Serbia

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Abstract: This study investigates the complex causal factors driving the long-lasting Mramor creep landslide, situated within Neogene formations along the left bank of the South Morava River in southern Serbia. Spanning roughly 1 km² and active for over seven decades, this landslide significantly affects the local community of Mramor, part of the Niš metropolitan area, along with critical infrastructure. Our analysis highlights the intricate interplay between climatic conditions, geological substrate properties, and anthropogenic influences, all contributing to ongoing landscape transformation and increasing terrain instability. We utilized daily precipitation and air temperature data from 1950 to 2019, obtained from the European Climate Assessment and Dataset (ECA&D) for Niš. These meteorological parameters were used to calculate rainfall erosivity indices—including the Precipitation Concentration Index (PCI), Modified Fournier Index (MFI), Rainfall Erosivity

(RE), and Erosivity Density (ED)—to assess soil erosion risks. Additionally, drought and moisture indicators such as the Standardized Precipitation Index (SPI) and Lang aridity index (AI_{Lang}) were employed to evaluate climate influences on groundwater and landslide behavior. Trend analysis using the Mann–Kendall test identified significant shifts in meteorological and erosivity indices over the study period. We cross-referenced extreme rainfall events with reports of pluvial flooding and landslide incidents from online news sources and scientific literature (2000–2019), providing validation for rainfall erosivity thresholds linked to landslide activity. To explore climate teleconnections, we analyzed correlations between landslide-related rainfall indices and the North Atlantic Oscillation (NAO) using Pearson and Spearman methods at various confidence levels. Advanced numerical modeling, GIS mapping, a modified Analytic Hierarchy Process (M–AHP), and remote sensing were applied to track topographic changes and landslide progression over time. Furthermore, the study reveals that significant changes in land use and vegetation–particularly the shift from crop farming to animal husbandry—alongside rural depopulation, have led to the gradual restoration of natural vegetation cover. This recovery has contributed to a steady reduction in erosion intensity. Nonetheless, the landslide continues to be influenced by the complex interplay of geological characteristics, climate drivers, and evolving land use patterns. The Mramor landslide emerges as a critical case for understanding the dynamic interactions of natural and human-induced factors shaping landslide-prone regions in southern Serbia. Our findings contribute valuable knowledge toward hazard prediction, risk management, and sustainable land use planning. Continued monitoring and integrated approaches are vital for devising effective mitigation and disaster preparedness strategies at local and regional scales.

Keywords: Mramor; natural hazard; landslide analysis; landslide monitoring; causal factors; rainfall erosivity; erosion; land cover; southern Serbia.

Acknowledgment: T.L. and S.B.M. acknowledge the support by the Science Fund of the Republic of Serbia, #17807, The Loess Plateau Margins: Towards Innovative Sustainable Conservation – LAMINATION.

Deep landslide dynamics on the Danube slope – Novi Sad case study

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Abstract: The largest and deepest landslides in Serbia are located on the right valley side of the River Danube. These areas are characterized by unstable slopes, with both deep and shallow landslides. The deep landslides consist of several sliding blocks, ranging in depth from 20 to 40 meters. Landslides on the right bank of the Danube in Serbia are notably large and deep, exhibiting very specific characteristics. One distinctive feature is that the sliding along deep slip planes occurs at an exceptionally slow rate, approximately 1 cm per

year. However, the mechanisms behind these landslide displacements have not been sufficiently studied. All these landslides have developed in the Pliocene clays and sands, within the weathered crust of these sediments. Highly porous Late Pleistocene loess-paleosol sequences overlay these strata. The landslide under investigation is situated on an unstable slope in Sremska Kamenica, near the city of Novi Sad, Serbia. Its structure is highly sensitive to even minor displacements. This landslide is classified as a Danube-type landslide, but its causal factors have not been observed to date. The aim of this research is to investigate the characteristics and causal factors influencing the Sremska Kamenica landslide. Our study focuses on key factors, including climatological conditions (rainfall erosivity factors), the properties of the geological substrate, land cover, and human activities, which have contributed to significant landscape changes and the acceleration of terrain instability. Initial findings provide insight into the broader implications of Danube-type landslides and highlight the importance of ongoing research and monitoring in the field of hydro-meteorological hazards and risk management. The results from this research will inform future strategies for disaster preparedness and sustainable land management, with implications for mitigation efforts at both local and national levels.

Keywords: natural hazard; deep landslides; landslide analysis; causal factors; rainfall erosivity; Novi Sad; Serbia

Acknowledgment: T.L. and S.B.M. acknowledge the support by the Science Fund of the Republic of Serbia, #17807, The Loess Plateau Margins: Towards Innovative Sustainable Conservation – LAMINATION.

Geothermal Energy in Vojvodina: Potential, Challenges, and Statistical Approaches

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Abstract: The Republic of Serbia's industrial sector remains heavily reliant on fossil fuels, despite the abundant geothermal energy potential in regions like Vojvodina, part of the Pannonian basin. This study explores the significant geothermal resources of Serbia, emphasizing the need for sustainable energy solutions aligned with national strategies and EU regulations. While geothermal energy in Serbia has primarily been utilized for balneology, its application for electricity generation and heating remains underdeveloped due to insufficient public awareness and investment. Using robust statistical methods, including Principal Component Analysis (PCA), we analyze the interdependencies of borehole data characteristics such as temperature, depth, and flow rate, revealing crucial insights into geothermal resource utilization. Our findings highlight the necessity of establishing comprehensive databases and reliable models to enhance geothermal energy application. This research aims to lay the groundwork for effective management and development of geothermal resources, thereby contributing to sustainable development in Serbia.

Keywords: Geothermal energy; sustainable development; Serbia; Pannonian basin; renewable resources

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Morphological Dynamics and Soil Drivers of Gully Erosion in the Nopha District, Ethiopia

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Abstract: In several regions of Ethiopia, gully erosion is a primary cause of soil degradation and a significant contributor to watershed soil loss. This problem is progressively worsening, yet there is a scarcity of research on gully development and expansion. To address this gap, this study assesses the spatio-temporal dynamics and controlling factors of gully erosion in the Nopha district by analyzing the morphology of 27 gullies across three kebeles, their expansion over 37 years (1985–2022), and the correlation with soil properties. Morphological data reveal significant variability, with gully lip width ranging from 0.96 to 65.97m and a total soil loss volume of 43,919m³. Strong positive skewness and kurtosis for volume (2.15, 4.40) and surface area (2.09, 4.07) show that the size distribution is strongly skewed, indicating that a small number of large gullies contribute disproportionately to the overall erosion. The gully length tripled from 1.23km to 4.2km, indicating rapid and accelerated expansion, according to temporal study. Compared to the previous 17 years (1985-2002: 62.98% rise), the rate of volumetric soil loss more than doubled in the most recent period (2002-2022: 162.63% increase). Strong positive connections between gully dimensions (such as total soil loss volume) and soil organic carbon (r=0.851) and total nitrogen (r=0.913) were found using correlation analysis, which also highlighted important soil drivers. On the other hand, there was a significant inverse relationship between bulk density and total soil loss volume (r=-0.981). According to these correlations, compacted soils are more resilient to gully erosion, whereas fertile, well-structured soils get the worst of it. Along with these biophysical elements, social issues including population pressure, land use/cover change, and road construction all have an impact on gully formation. According to the results, gully erosion is a process of land degradation that is getting worse and is fueled by a complicated interaction between soil characteristics and human activity. As a result, it is advised that gully growth be managed through the use of easily accessible physical and biological conservation methods, carried out through

a coordinated approach involving the government, the local population, and pertinent organizations.

Keywords: Gully erosion; Soil properties; determinants; Ilubabor zone

Neural Network Modeling for Forecasting Tourism Demand in Stopića Cave: A Serbian Cave Tourism Study

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Abstract: In this paper, the number of tourist visits to Stopića Cave (Serbia) is predicted using three different forecasting approaches: the classical Auto-Regressive Integrated Moving Average (ARIMA) model, the Machine Learning (ML) method Support Vector Regression (SVR), and the hybrid NeuralProphet model, which carefully integrates both statistical and neural network components. The dataset encompasses 168 months of visitation data (2010–2023), supplemented with Google Trends data as an exogenous variable to capture public search interest specifically related to the cave. Model performance was evaluated using the Root Mean Square Error (RMSE) metric on a test period covering the full year 2023. Results clearly demonstrate that the NeuralProphet model, which includes seasonal components, a growing trend, and nonlinearity modeled through a shallow neural network, achieved the highest predictive accuracy, significantly outperforming both ARIMA and SVR in terms of forecasting reliability and model interpretability. Beyond methodological contributions, the findings provide valuable insights for sustainable cave tourism management. Forecasting results reveal pronounced seasonality, with visitation peaks during summer months, and highlight a substantial increase in 2020 linked to domestic travel restrictions during the COVID-19 pandemic. The strong correlation between Google search interest and actual visits underscores the potential of internet-based indicators for improving tourism demand forecasting accuracy. These outcomes are crucial for destination managers and policymakers, as accurate modeling can inform strategies for carrying capacity management, visitor flow optimization, and sustainable resource allocation. By combining traditional and machine learning techniques, this research clearly demonstrates the advantages of hybrid forecasting models in tourism analytics and emphasizes their strong relevance for sustainable geotourism development. The proposed framework offers a comprehensive, highly detailed, data-driven foundation for monitoring and effectively managing visitor dynamics while preserving

the ecological integrity of fragile subterranean ecosystems such as Stopića Cave, ultimately contributing to the broader goal of balancing conservation and sustainable tourism growth.

Keywords: Tourism forecasting; Stopića Cave; NeuralProphet; ARIMA; sustainable geotourism

Assessment of Speleological Geosites in Montenegro through the SCAM Model: An Initial Study of Geotourism Potential

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Abstract: The aim of this paper is to create an inventory of caves in Montenegro, as well as to assess the current state of protection and conservation of subterranean ecosystems, with the goal of further tourist valorization and strategically balancing the potential economic benefits with the preservation of nature from tourism impacts in Montenegro, using the Show Cave Assessment Model (SCAM). The research included the following caves in Montenegro: Lipska Cave near Cetinje, Magara Cave near Podgorica, Đalovica Cave near Bijelo Polje, Ćirkova Cave near Rožaje, Novakova Cave near Bijelo Polje, and the Globočica and Babatuša caves near Bar. All caves, except Ćirkova, are protected as Natural Monuments. The results of the SCAM analysis indicate significant geotourism and educational potential of these sites, while at the same time revealing serious shortcomings in the protection of subterranean ecosystems, tourist valorization, infrastructure, and visitor management. Currently, Montenegro has over 1,000 caves, of which only Lipska Cave is developed and accessible for tourist visits. The application of the SCAM methodology enabled a systematic evaluation of their scientific-research, educational, and touristic values, emphasizing the need for initial investments in the tourism development of Montenegrin caves. A particular objective of the research is the application of the concept of geoethics, which implies the ethical responsibility of scientists and researchers to identify and highlight potential risks and problems in the protection of speleological geoheritage before they occur, and to promote the sustainable use of cave

resources. This means adopting a proactive approach to the preservation of natural values through a balance between scientific knowledge, social interests, and environmental protection. By implementing these measures, caves in Montenegro can become significant geotourism destinations, enhance scientific research, and contribute to the sustainable development of local communities. However, achieving this requires stronger institutional support – from national authorities to local tourism organizations – as well as greater investments in the promotion and valorization of these unique natural resources. It is recommended to establish basic cave development, including lighting and organized access routes, the development of guided tours, educational centers, and visitor-oriented infrastructure, while at the same time ensuring adequate protection and preservation of speleological geoheritage.

Keywords: caves; Montenegro; geotourism; Show Cave Assessment Model (SCAM); geoethics

Enhancing Risk Assessment in Protected Areas: Landslide and Wildfire Hazard Modeling in Đerdap Geopark, Serbia

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Abstract: The Đerdap area, designated in 2020 as the first and only UNESCO Global Geopark in Serbia, covers approximately 1,330 km² and is distinguished by exceptional geodiversity, biodiversity, and a wealth of natural and cultural heritage. Despite these values, the geopark remains vulnerable to natural hazards, particularly landslides and wildfires, which cause significant ecological, material, and human losses at various scales. Accordingly, a central priority in geopark management is the identification of the most threatened locations, or hazard hotspots. In this study, geographic information systems (GIS) and remote sensing techniques were employed to assess susceptibility to these hazards. For landslide analysis, eight natural and anthropogenic factors were considered, while wildfire susceptibility modeling was based on 15 criteria. The evaluation incorporated geological, geomorphological, climatic, hydrological, and biogeographical conditions, together with proximity to settlements and transportation infrastructure. The results indicate that 99.96 km² of the geopark is highly prone to landslides, with an additional 12 km² falling into the very high susceptibility category. For wildfires, 268.18 km² were identified as highly susceptible, while 30.23 km² are considered very highly susceptible. The synthesis maps of landslide and wildfire hazards provide an essential evidence base for decision-makers, protected area managers, spatial planners, and emergency services to design and implement effective preventive and protective strategies. By integrating advanced remote sensing methods within an interdisciplinary framework, this study not only advances scientific understanding of natural hazards in the Đerdap Global Geopark but also offers practical tools for risk reduction, sustainable land management, and the safeguarding of cultural and natural heritage. Furthermore, the approach outlined here could serve as a model for hazard assessment and management in other geoparks and protected areas worldwide, supporting broader goals of resilience and sustainability.

Keywords: remote sensing; GIS; protected areas; environmental management and resilience; natural hazards; Serbia

Applicability of Automated Static Image Analysis for Granulometric Characterization of Fluvial Sediments

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Abstract: The grain size and shape characteristics of sediments provide insight into their formation, transport, deposition, and alteration processes. With the spread of new, high-resolution analytical methods, it has become possible to rapidly examine the granulometric properties of large numbers of individual mineral particles. We applied automatic static image analysis (Malvern Morphologi G3SE-ID) to examine recent channel and floodplain sediments (n=23) from the two main rivers of the Carpathian Basin and their tributaries. During the analysis, we also used recent sediments of aeolian origin (n=6) and ice-transported sediments (n=4) as references for the riverine sample set. During the analysis and data processing (hierarchical cluster analysis, Kruskal-Wallis, MANOVA, PCA), four grain shape variables were examined: high-sensitivity circularity (form), convexity (surface texture, roughness), solidity (roundness), and elongation (form). We projected the complex granulometric analysis onto grain shape distributions and the selected medium sand fraction (250-500 μm). We aimed to identify key variables that could help distinguish between certain geomorphological environments and sediment types. Circularity was the most effective variable for separating sediments, while the elongation parameter had the weakest separating power. However, high elongation values indicated the relatively fresh state of grains from glacial and some fluvial samples. Based on objective and quantitative analysis, the solidity parameter was an effective variable for separating sediments with similar convexity values, such as aeolian and fluvial sediments. The solidity values of fluvial sediments were lower than those of aeolian sands. Typically, sediment samples from the Danube and Tisza rivers were grouped separately. However, floodplain and upper course samples fell into one category, as they had the lowest morphological values within the fluvial sample set and had the highest elongation values. Increasing the number of samples and documenting the granulometry of different geomorphological environments makes it possible to define preliminary grain size limits (e.g., compactness: glacial-fluvial: 0.95; fluvial-aeolian: 0.97).

Keywords: grain size; grain shape; fluvial sediments; aeolian sediments; image analysis

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Storms of Change: Climate Extremes and the Vulnerability of Cultural Heritage in Southeast Europe

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Abstract: Climate change increasingly threatens cultural heritage, with historic buildings and monuments exposed to flooding, erosion, and extreme weather. The supercell storms that struck northern Serbia (Vojvodina) in summer 2023 highlighted the vulnerability of this multicultural heritage shaped by centuries of migration and the Habsburg legacy. This study integrates climatic, synoptic, and heritage analyses to assess the impacts of extreme events on cultural assets. Data sources include ECA&D climate records, statistics from the Republic Hydrometeorological Service of Serbia, Meteologix synoptic maps, satellite imagery, field reports, and archival documentation. Extreme conditions were quantified using ETCCDI indices and the Precipitation Concentration Index (PCI), and linked to large-scale synoptic circulation across Europe. The storms caused major damage to religious heritage: in the Bačka Diocese of the Serbian Orthodox Church, temples in Futog, Begeč, Novi Sad, Mladenovo, Bačka Palanka, and Opovo; in the Srem Diocese, churches in Stejanovci, Dobrince, Vojka, Golubinci, Berkasovo, and Vašica. Numerous Roman Catholic churches were also affected in Obrovac, Bačka Palanka, Čelarevo, Gajdobra, and Novi Sad, with further losses in the Zrenjanin and Srem dioceses. Additional damage occurred at the Jewish cemetery chapel and monument in Novi Sad, the Greek Catholic Church in Bačinci, and the Reformed Church in Sivac. The analysis enabled the development of vulnerability indicators to support adaptation planning. Results emphasize the urgent need for integrated risk management strategies to safeguard cultural heritage under intensifying climatic stress. The proposed approach is transferable to other regions of Southeast Europe to identify vulnerabilities, inform adaptation, and enhance resilience of cultural assets in the face of climate change.

Keywords: climate change; cultural heritage; extreme weather; precipitation indices; adaptation; Vojvodina; Southeast Europe

Vegetation Density Analysis in the Floodplain of the Tisza River in Southern Hungary Using Photogrammetric Methods

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Abstract: The rapid advancement of drone technology has revolutionized environmental research. High-resolution geospatial data, obtained using drones, offers unprecedented opportunities to monitor changes in natural landscapes efficiently. This research focuses on analyzing vegetation density in the floodplain of the Tisza River in Southern Hungary, leveraging drone-based photogrammetric methods and LiDAR data. The study aims to identify changes in vegetation density over time and its influence on hydrological processes. Understanding the interplay between vegetation density and river dynamics is critical for sustainable floodplain management. Vegetation impacts water flow, erosion, and sediment deposition, influencing flood risks and ecological balance. The objective of this study is to assess vegetation dynamics across the Tisza floodplain and to evaluate their geomorphological and hydrological impacts on Tisza river water levels influencing flood risks. The research combines multi-scale surveys with advanced monitoring techniques. Satellite-based data from Sentinel-2 will be used to generate Normalized Difference Vegetation Index (NDVI) models, providing large-scale temporal insights into vegetation cover across the entire floodplain. Complementing this, a two-year survey program will employ Unmanned Aerial Vehicles (UAVs) equipped with LiDAR sensors to obtain high-resolution data on vegetation height, density, and type at several pre-selected sites. Ground-based surveys will also be conducted to collect detailed information from areas inaccessible or obscured in aerial surveys, ensuring comprehensive spatial coverage. The study pays particular attention to distinguishing between cultivated and naturally grown vegetation, as these categories may have different impacts on sediment deposition and water flow. By integrating remote sensing, UAV-based LiDAR, and ground-based methods, the research will enable precise monitoring of vegetation change with high temporal and spatial resolution. The findings are expected to provide valuable insights into the role of vegetation in shaping river floodplain interactions, influencing water levels, and regulating sediment dynamics.

Ultimately, the study aims to inform strategies for sustainable floodplain management, with a focus on reducing flood risks, preserving ecological balance, and supporting long-term resilience of the Tisza River system.

Keywords: Geomorphology; Hidrology; UAVs; NDVI; Water management; Flood risks

Logistic Regression Approach to Estimating Lake Surface Water Temperature from Landsat 9: A Case Study of Vrana Lake, Croatia

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Abstract: Monitoring lake surface water temperature (LSWT) is a key component in understanding hydrological processes, ecosystem functioning, and the influence of climate variability on freshwater resources. This study focuses on Vrana Lake in Croatia with the aim of assessing the potential of integrating satellite remote sensing and logistic regression for LSWT estimation. Landsat 9 imagery was utilized to derive four spectral indices relevant to aquatic environments: Surface Temperature (ST), Normalized Difference Vegetation Index (NDVI), Normalized Difference Water Index (NDWI), and Chlorophyll-a Index (CHL). In situ water temperature measurements were collected simultaneously to provide reference data for model calibration and validation. To establish the relationship between satellite-derived indices and field observations, a logistic regression approach was applied. In the logistic regression model for Vrana Lake, ST emerged as the dominant predictor, providing the greatest explanatory power. NDVI and NDWI contributed only marginally and were not statistically significant, while CHL was excluded from the analysis due to its negligible contribution. Results showed that the logistic regression model for Vrana Lake achieved a high coefficient of determination (R^2 = 0.80), explaining about 80% of the variability in model. The adjusted R^2 of 0.76 further indicates that the model remained robust after accounting for the number of predictors. The study demonstrated that logistic regression using Landsat 9 index is useful for estimating LSWT in Vrana Lake. Future research should include a larger number of in situ samples to enable the development of improved machine learning models.

Keywords: water temperature; Landsat 9; logistic regression; remote sensing; Vrana Lake

Multifunctional Biocrust Approach for Restoring Degraded Loess Surfaces by Integrating Cyanobacterial Inoculum with Cellulose and Gauze

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Abstract: Loess is a highly erodible sediment and a major source of atmospheric dust with broad environmental impacts. Cyanobacterial inoculation is a sustainable strategy for dryland restoration, but harsh conditions often hinder biocrust establishment. To address this, the Pan-Life-Carpet (PLC) strategy has been proposed as a multifunctional system combining cyanobacteria for biocrust initiation, a polysaccharide matrix for water and nutrient retention, and a physical support for soil stabilization and inoculum application. Thus, this study analyzes the potential of PLC as a novel restoration approach by integrating cyanobacteria with cellulose as the polysaccharide support and the gauze as the physical support. Biocrust were developed by inoculating a) cyanobacteria *Tolypothrix* sp. L4 only; b) *Tolypothrix* sp. L4 with cellulose isolated from plum stones at 1% and 5% (w/v); and (c) *Tolypothrix* sp. L4 with cellulose at 1% and 5% (w/v) inoculated onto gauze placed over the loess sediment. Control samples received only water. Biocrusts were cultivated for 30 days under natural light, at room temperature, watered on weekdays (50 mL) and left to dry on weekends. Development was assessed by chlorophyll *a* content. Treatments with cyanobacteria, cellulose and gauze induced biocrust growth with significantly higher chlorophyll *a* content compared to the control ($p < 0.05$). Combinations of cyanobacteria with cellulose, with or without gauze, consistently outperformed cyanobacterial inoculation alone in chlorophyll *a* content ($p < 0.05$), indicating that the PLC strategy provides more favorable conditions for biocrust development. Treatments with gauze showed even stronger effects,

confirming its important role in PLC. This was confirmed by significantly higher chlorophyll *a* in gauze treatments at 1% and 5% cellulose concentrations (118.24 µg/g biocrust and 107.17 µg/g biocrust, respectively) compared to those with cellulose but without gauze (67.83 µg/g biocrust and 61.94 µg/g biocrust, respectively). In contrast, no statistically significant differences in chlorophyll *a* production were observed between biocrusts treated with different cellulose concentrations, either with or without gauze. PLC treatments with cellulose and gauze significantly enhanced biocrust development, with gauze inclusion proving more important than cellulose concentration, highlighting strong potential for restoring degraded loess surfaces.

Keywords: loess restoration; biocrust; cyanobacteria; polysaccharide matrix; Pan-Life-Carpet (PLC) strategy

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Enhancing Artificially Induced Cyanobacterial Biocrust Development on Degraded Substrates

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Abstract: Degraded surfaces, a global problem today, can be restored through artificially induced biocrust development. Various techniques have been proposed to enhance biocrust formation following cyanobacterial inoculation. This study aims to test the ability of the loess-derived strain *Tolypothrix* sp. L4, to develop biocrusts on different degraded substrates and to evaluate the potential of combining cyanobacteria with a physical support and a physico-polysaccharide support to promote biocrust development. Biocrust were developed on loess sediment, yellow quartz sand and soil-loam mixture by inoculating a) cyanobacteria *Tolypothrix* sp. L4 only; b) *Tolypothrix* sp. L4 inoculated onto gauze used as a physical support placed over the substrates; and (c) *Tolypothrix* sp. L4 with BG11 medium solidified by 1% agar, inoculated onto gauze placed over the substrates (hereafter referred to as a physico-polysaccharide support). Control samples were supplied with water only. Biocrusts were cultivated for one year under natural light at room temperature, watered on weekdays and left to dry on weekends, and their development was evaluated by chlorophyll *a* content. On loess sediment, cyanobacterial treatments, either inoculation alone or combined with physical or physico-polysaccharide supports, produced biocrusts with significantly higher chlorophyll *a* content than the control ($p < 0.0001$). On yellow quartz sand and the soil–loam mixture, cyanobacterial-only inoculation did not enhance biocrust formation ($p > 0.05$), whereas combinations with physical and physico-polysaccharide supports significantly increased chlorophyll *a* ($p < 0.0001$), promoting biocrust development with chlorophyll *a* levels even surpassing those on loess, the strain's natural substrate. On loess, combining cyanobacteria with physical support did not enhance biocrust growth but also did not inhibit it, producing biocrusts with chlorophyll *a* level comparable to cyanobacterial inoculation alone, while facilitating inoculum transfer and initial sediment stabilization until biocrusts are fully established. Overall, across all substrates, physical support alone outperformed physico-

polysaccharide support ($p < 0.05$). These results show that the strain's ability to develop biocrusts depends on the type of degraded substrate and highlight the potential of the applied techniques, particularly combining cyanobacteria with gauze which serves as a physical carrier providing a moist microenvironment alongside the polysaccharide support, to improve inoculum application and promote biocrust development, offering promising strategies for the restoration of various degraded surfaces.

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GIS Analysis and Valuation of Natural and Tourism Potentials of the Prošćenske Mountains for Sustainable Tourism Development

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Abstract: The Prošćenske Mountains, located between Durmitor and Bjelasica in northern Montenegro, represent a valuable but underexplored landscape with significant potential for sustainable tourism development. This study aims to evaluate their natural and cultural resources through an integrated methodological framework combining Stanković's valorization model, Hilary du Cros's heritage assessment matrix, and GIS-based spatial analysis. Multiple data sources were employed, including digital elevation models, hydrology and infrastructure shapefiles, statistical tourism and climate datasets, and field inventories of cultural and historical sites. The GIS analysis produced slope, aspect, hypsometry, and accessibility (cost-distance) layers, overlaid with Natura 2000 areas and zones of Durmitor National Park. Supplementary NDVI change detection and wildfire risk assessments were integrated to highlight ecological vulnerability. Results of Stanković's model revealed a high overall valorization score, where natural factors—such as landscape integrity, biodiversity, and hydrological resources—dominate, while accessibility and tourism infrastructure remain limiting factors. Application of Hilary du Cros's methodology identified priority attractions, including peaks, viewpoints, and traditional *katun* settlements, with high attractiveness but low managerial capacity. GIS analyses further delineated zones of ecological sensitivity, especially where vegetation degradation and wildfire exposure intersect. The findings emphasize that the Prošćenske Mountains hold significant but underutilized potential for sustainable tourism. The integrated assessment underscores the importance of eco-tourism development, improved trail and viewpoint infrastructure, inclusion of local communities, and strengthening of protective measures. By merging traditional valorization approaches with GIS-supported analysis, this study provides both a scientific and practical foundation for sustainable tourism planning. The research contributes to broader discussions on geoheritage, geoconservation, and the sustainable management of mountainous landscapes in Southeast Europe.

Keywords: GIS; resource valorization; Prošćenske Mountains; Stanković's model; Hilary du Cros; sustainable tourism; Montenegro

Assessment of the viewshed of antenna towers in Montenegro for installing surveillance cameras for monitoring wildfire outbreaks

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Abstract: Viewshed assessment is a fundamental step in designing and implementing surveillance systems for early wildfire detection. Effective positioning of surveillance cameras ensures timely identification of wildfire outbreaks and enables rapid response to minimize environmental, economic, and social damage. Geographic Information Systems (GIS), when combined with Digital Elevation Models (DEM), provide advanced capabilities for simulating line-of-sight visibility and optimizing camera placement strategies. In this study, antenna towers operated by the Broadcasting Center of Montenegro were selected as reference infrastructure for potential camera installation, given their wide spatial distribution and existing technical facilities. A GIS-based viewshed analysis was conducted to evaluate the visibility coverage provided by these towers under four different scenarios, representing smoke column heights of 0 m, 20 m, 50 m, and 100 m. These scenarios simulate various stages of fire development, from ground-level outbreaks to larger, more intense fires producing significant smoke plumes. The results highlight the potential of leveraging existing antenna infrastructure to establish a cost-effective and spatially comprehensive wildfire monitoring system across Montenegro. This approach reduces the need for building new structures, ensures better integration into the landscape, and provides a practical foundation for enhancing national wildfire surveillance capacity. The study also demonstrates the flexibility of GIS-based methods in supporting decision-making processes related to wildfire risk management and landscape monitoring. The main limitation of this study is the use of static smoke height scenarios, and future research should include field validation and dynamic environmental conditions to improve reliability and applicability.

Keywords: Viewshed analysis; Wildfire surveillance; Antenna towers; GIS; Montenegro

An Interdisciplinary Case Study of Geoheritage and Fibrex Functional Foods in the Context of Sustainable Tourism and Nutrition in Montenegro

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Abstract: This case study examines the relationship between Montenegro's geoheritage and functional food enriched with Fibrex dietary fiber as a pathway to sustainable development. Geotourism is emphasized as a tool for promoting natural heritage, while functional food is considered a response to modern nutritional challenges. For geoheritage evaluation, the GMA and M-GMA models were applied, whereas standardized AOAC and AACC methods combined with the Furd technique were used for dietary fiber analysis. The analysis employed standardized procedures from the AOAC Official Methods of Analysis and the AACC International Approved Methods, which serve as recognized reference protocols in food chemistry and technology. A functional bread product with 0%, 5%, and 10% Fibrex fiber was developed and assessed through sensory evaluation and instrumental texture analysis. Findings confirm that Fibrex enrichment improves the nutritional value of bread and indicate the need for further empirical testing in real tourism contexts. Integrating Fibrex-based functional food with Montenegrin gastronomy and geoheritage, supported by consumer education and industry collaboration, highlights opportunities for enhancing public health, advancing sustainable tourism, and positioning Montenegro as a destination that successfully combines functional nutrition and geoheritage into a sustainable offering.

Keywords: Montenegro's geoheritage; functional food; Fibrex dietary fiber

Two Geosites, One Goal: Geoheritage as a Catalyst for Sustainable Geotourism at Titelski Breg (Serbia) and De Hondsrug (Netherlands)

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Abstract: This study presents the results of a comparative analysis of two European geoheritage sites. The first is the Titelski breg Nature Reserve in Serbia—a unique loess island that serves as the most significant European terrestrial archive of climate and environmental changes over the past 640,000 years. The second site is the De Hondsrug Geopark in the Netherlands, known for its distinctive glacial landscape formed during the Saalian Ice Age. De Hondsrug is also notable for its unique interweaving of natural and cultural heritage, including ancient glacial ridges, Neolithic dolmens (hunebedden), and rich archaeological sites. The main aim of this research is a comparative analysis of the effectiveness of geotourism strategies at these sites and the determination of the connection between their unique geological features and the impact of strategies in promoting sustainable development in their regions.

Keywords: Geotourism; Titelski Breg; De Hondsrug; Geopark

Tracing sediment provenance using luminescence and ESR parameters in fluvial and aeolian environments

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Abstract: While electron spin resonance (ESR) and optically stimulated luminescence (OSL) are well-established methods for dating sediments, their combined application as provenance indicators has recently gained renewed interest. Exploring how ESR and OSL parameters vary between different sedimentary environments provides new insights into sediment sources and transport histories. This study evaluates the ability of ESR (E'_1, Ti-h, peroxy, Al-h centers) and OSL-derived parameters (CW-OSL, total and component-resolved LM-OSL signals) together with the 110 °C TL peak to distinguish fluvial and aeolian quartz samples from the Pannonian Basin. We also examine correlations between ESR and OSL metrics to refine sediment provenance discrimination. Our results reveal clear differentiation between aeolian and fluvial samples based on E'_1 and the LM-OSL medium component, while Ti-h effectively separates Danube and Tisza River sediments. The strongest ESR and OSL correlation is observed between E'_1 and the LM-OSL medium component. Downstream trends are most pronounced in Al-h and Ti-h parameters, with the 110 °C TL peak showing a consistent downstream increase ($R^2 = 0.9$). In the upper Tisza, LM-OSL fast component and CW-OSL sensitivity values resemble those of the Danube, but both increase downstream

due to high-sensitivity quartz input from tributaries. In contrast, the Danube shows a fluctuating downstream change in luminescence sensitivity, primarily controlled by riverbank erosion processes.

Keywords: sediment provenance; luminescence sensitivity; ESR parameters; fluvial and aeolian quartz grains; downstream variation; sediment transport processes

Late Weichselian ice wedge pseudomorphs as climate indicators (SW Poland)

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Abstract: The area of southwestern Poland was repeatedly under the influence of the Fennoscandinavian ice-sheet during the Pleistocene glaciations. This particular environment, characterized by cold climate, intense erosion and scarce vegetation, was favorable to the sedimentation of loess covers. Those sediments, often used in climate reconstructions, contain various structures resulting from processes such as gelifluction, thermokarst or frost processes. The largest structures associated with the periglacial environment are ice wedge pseudomorphs, often used as indicators of past permafrost extent. Their nature is dual, as they are marks of not only a cold climate, but also of the shift to warmer temperatures and permafrost termination. The final appearance of an ice wedge pseudomorph depends primarily on the type of sediment in which it is formed. Due to the potential high ground ice content, fine-grained materials like clay and silt can melt almost as long as the ice wedge itself. During melting, pressure increases significantly in the pores of the soil, often leading to dynamic filling of the post-ice wedge void. As ice wedge pseudomorphs are highly dependent on the particular site they are in, they make for a unique record of the changing climate.Two ice wedge pseudomorphs were recently documented in Trzebnica Hills and Niemcza-Strzelin Hills (southwestern Poland). Their structure bears marks of various processes, such as thermokarst, which are evidence of environment changes during the permafrost termination. The ice wedge pseudomorph in Trzebnica (Trzebnica Hills) is especially deformed by intense thermokarst, most likely as a result of water stagnation at the site. The second structure in Henryków (Niemcza-Strzelin Hills) is clearly marked by bent, gley laminae, but its apperance greatly differs from the pseudomorph in Trzebnica. OSL and radiocarbon dating of the ice wedge pseudomorphs and the surrounding sediment point to permafrost degradation around 15-16 ka, at the end of the Late Weichselian (MIS 2).

Keywords: Ice wedge pseudomorphs; permafrost; Trzebnica Hills; Niemcza-Strzelin Hills; Late Weichselian

Toward Sustainable Coatings: Hyperbranched Polymers for Reducing VOC Emissions

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Abstract: Volatile organic compounds (VOCs) are added to coating formulations to reduce the viscosity of the resin, facilitating easy processing and uniform application. However, after the coating is applied, the VOCs evaporate, contributing to environmental pollution. A promising solution to minimize VOCs in organic coatings is the development of coatings using hyperbranched polymers (HBP). In this study, HBPs were modified with ricinoleic acid using titanium(IV) isopropoxide as the catalyst. Theoretically, 25% of the hydroxyl (OH) end-groups of the HBP were modified with ricinoleic acid. The curing process of the resin mixtures occurs through reactions between the hydroxyl and carboxyl groups of the HBP and the methoxymethyl groups found in melamine resins. Physico-mechanical characteristics were determined, including adhesion, gloss values, hardness, flexibility, impact test. Additionally, the thermal properties, thermal stability, and chemical resistance of the cured films to methylethylketone were also evaluated. Based on the obtained results, it can be assumed that mixtures of synthesized hyperbranched resin with melamine resin would be suitable as an advanced surface coating material with good chemical resistance and physical-mechanical properties.

Keywords: Volatile organic compounds; hyperbranched polymers; ricinoleic acid modification; melamine resin; surface coatings

The chronological framework of high-altitude loess in the Zeravshan valley, Western Tian San

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Abstract: The high mountain regions of Central Asia play an important role in understanding the climate and environmental change during the Pleistocene and Holocene in Eurasia. The high-altitude loess deposits in Tajikistan represent crucial paleoclimatic archives, providing significant insights into environmental and climatic variation during the Plesitocene. However, existing loess palaeoclimate research has predominantly focused on the East Asian monsoon region. Tajikistan's high-altitude loess sequence not only provides a continuous record of Central Asia's aridification history but also serves as an invaluable key to deciphering past variations in the intensity and pathways of the westerly circulation. The present research focuses on a 200 km section of the Zeravshan valley in Northern Tajikistan and aims to investigate the timing of loess formation in high mountain environments. Our main goal is to set up a chronological framework by employing high-precision optically stimulated luminescence (OSL) dating. The sampled loess deposits are situated on fluvial terraces at variable altitudes and of different relative height above the present floodplain. Relative heights vary between 5-500 m, and the thickness of loess between 1-20 m. Based on preliminary dating results on the underlying fluvial material, the age of loess in the valley is expected to span from the Late Pleistocene to the Holocene.

Keywords: high-altitude loess; fluvial terraces; Western Tian San; Central Asia