

LANDSCAPING ARCHEOLOGY CONFERENCE. Vatra Dornei (onsite) LAC 2022 Onsite

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MONDAY, SEPTEMBER 12th 2022

VENUE:

VATRA DORNEI (Suceava county, Romania)

Centrul de Pregatire si Formare Continua Vatra Dornei, Universitatea Suceava

(Distance Education and Long-Life learning Office Vatra Dornei, University of Suceava)

Address:

Parcului 2 St., Vatra Dornei 725700, Suceava county, Romania.

Coordinate: 47.3418816, 25.3574445



TUESDAY, SEPTEMBER 13th 2022

9.00: OPENING CEREMONY

9.00 – 9.10

Marcel MINDRESCU. Charmain of conference, University of Suceava and GEOCONCEPT Association of Applied Geography (Romania)

9.10 - 9.20

Mihai DIMIAN. Vice-rector of University of Suceava (Romania)

9.20- 9.30

Sjoerd J. KLUIVING. President of International Association of Landscape Archaeology

Keynote speaker:

9.30-10.00

Sjoerd J. KLUIVING, Faculty of Humanities, Department Art and Culture, History, Antiquity, Vrije Universiteit Amsterdam, Netherlands

TERRANOVA from the last and current Interglacial periods into the Anthropocene: An Atlas database drawing lessons from ancient land use for future European landscape management

SESSION 07. Human-Earth interaction from the Quaternary to the Anthropocene: natural, social and cultural processes affecting landscapes (part 1)

Moderators: Sjoerd J. KLUIVING and Anneli EKBLÖM

10.00 – 10.20

Marleen van ZON, Faculty of Arts, Centre for Archaeological Research of Landscapes, KU Leuven & Faculty of Sciences, Dept. Earth and Environmental Sciences, Division of Geography and Tourism, KU Leuven (Belgium), marleen.vanzon@kuleuven.be

Renske Hoevers; Faculty of Sciences, Dept. Earth and Environmental Sciences, Division of Geography and Tourism, KU Leuven; renske.hoevers@kuleuven.be

Ward Swinnen; Faculty of Sciences, Dept. Earth and Environmental Sciences, Division of Geography and Tourism, KU Leuven; ward.swinnen@kuleuven.be

Bart Vanmontfort; Faculty of Arts, Centre for Archaeological Research of Landscapes, KU Leuven; bart.vanmontfort@kuleuven.be

Gert Verstraeten; Faculty of Sciences, Dept. Earth and Environmental Sciences, Division of Geography and Tourism, KU Leuven; gert.verstraeten@kuleuven.be

Human-environment interactions in the Gete catchment (Belgium). An interdisciplinary approach

10.20 - 10.40

Stefan L. SMITH, ANEE, University of Helsinki (Finland), stefan.smith@dunelm.org.uk

"Nomadic" Strategies for Sedentary Populations: Prehistoric Anthropogenic Landscape Alterations as Indications of Climatic Coping Strategies Applicable to the Present Day

10.40 - 11.00

Barbora DOHNALOVÁ, Mendel University in Brno, Czech Republic, barbora.dohnalova@mendelu.cz

Aleš Rudl, National Institute for the Protection and Conservation of Monuments and Sites, Czech Republic, rudl.ales@npu.cz

Tomáš Hájek, The Economic and Social Council of Most Region, Czech Republic, tomaseliezer.hajek@seznam.cz

Vegetation Accompaniment of Small Monuments and its Interpretation in Landscape Archaeology

11.00 - 11.20: COFFEE BREAK

11.20 - 11.40

Emily VELLA, Uppsala University (Sweden), emily.vella@arkeologi.uu.se

Introducing Energy Regimes: A novel method for classifying anthropogenic activities in landscapes

11.40 - 12.00

Bert GROENEWOUDT and Menne KOSIAN, Cultural Heritage Agency of the Netherlands, RCE (The Netherlands)

Better than pollen? An experiment to use structural information from archaeological excavations to reconstruct medieval deforestation and inspire future reforestation

12.00 - 12.20

Menne KOSIAN, Cultural Heritage Agency of the Netherlands, RCE (The Netherlands),
mkosian@xs4all.nl

Rowin van Lanen, Wageningen University and Research; department of Soil Geography and
Landscape (SGL)/Cultural Heritage Agency of the Netherlands; landscape department,
r.van.lanen@outlook.com

Roy van Beek, Wageningen University and Research; department of Soil Geography and
Landscape (SGL), roy.vanbeek@wur.nl

***Conflicts in landscapes. The potential of HGIS for sustainable heritage management and
research in dynamic landscapes and multi-stakeholder environments***

12.20 - 12.40

Aspassia KOUZOUPI, School of Architecture NTUA (Greece), a.space.ia@gmail.com

Anna -Maria Anagnostopoulou, PhD, Ephorate of Antiquities of Piraeus & Islands

John Siropoulos, Ephorate of Antiquities of Piraeus & Islands

Eirini Skiadaresi, Ephorate of Antiquities of Piraeus & Islands

Petros Kyriakou, School of Rural, Surveying & Geoinformatics Engineering, NTUA

Panos Kiouis, Department of Architecture, UTH

Konstantinos Moraitis, School of Architecture NTUA

Was the Anthropocene anticipated by the Long Walls zone?

13.00 - 15.00: LUNCH

Keynote speakers:

15.00 – 15.30

Erle ELLIS, University of Maryland, Baltimore (USA)

***Deepening the Anthropocene: Connecting Archaeology, Global Environmental Change, and
Biodiversity Conservation***

15.30 - 16.00

William KEETON, University of Vermont (USA)

***Sustaining Europe's temperate and boreal forests through closer emulation of natural
dynamics***

SESSION 07. Human-Earth interaction from the Quaternary to the Anthropocene: natural, social and cultural processes affecting landscapes (part 2)

Moderator: **Sjoerd J. KLUIVING** and **Anneli EKBLOM**

16.00 - 16.20

Tijmen Yvo Christiaan OPSOMER, Vrije University, Amsterdam, The Netherlands, tijmen.opsomer@gmail.com

Sjoerd Kluiving, Vrije Universiteit Amsterdam, s.j.kluiving@vu.nl

Alexandre Martinez, Vrije Universiteit Amsterdam, almartinezcontact@gmail.com

Quantification of societal energy consumption during the industrial revolution in northwest Iberia

16.20 - 16.40

Esther RUMORA, Universiteit van Amsterdam, The Netherlands, esther.rumora@gmail.com

Sjoerd Kluiving, Vrije Universiteit, s.j.kluiving@vu.nl,

Anco Lankreijer, Amsterdam University College, A.C.Lankreijer@auc.nl

Energy Landscapes in the Rhine Meuse delta

16.40 - 17.00

Anco LANKREIJER, Department of Archaeology and Ancient History, Amsterdam University College, The Netherlands, A.C.Lankreijer@auc.nl

Sjoer Kluiving, s.j.kluiving@vu.nl, Amsterdam University College, University of Amsterdam/Vrije Universiteit, The Netherlands

Lia van Wesenbeeck, c.f.a.van.wesenbeeck@vu.nl, Amsterdam University College, University of Amsterdam/Vrije Universiteit, The Netherlands

Alexandra Brown, a.e.brown@uva.nl, Amsterdam University College

Big questions in the Anthropocene

17.00 - 17.20

Anneli EKBLOM, Department of Archaeology and Ancient History, Uppsala University (Sweden), anneli.ekblom@arkeologi.uu.se

The Time Lab

17.20 - 17.40

Sjoerd J. KLUIVING, Faculty of Humanities, Department Art and Culture, History, Antiquity, Vrije Universiteit Amsterdam, Netherlands

The Anthropocene in the proposed UNESCO Geopark Scheldt delta: geological history and future in Aquapuncture

17.40

Poster:

Andrea PINTAR, Vrije University, Amsterdam, The Netherlands, a.pintar@vu.nl

Alexandre Martinez, Vrije University, Amsterdam, The Netherlands (a.f.martinez@vu.nl);

Sjoerd Kluiving, Vrije University, Amsterdam, The Netherlands (s.j.kluiving@vu.nl)

Romanticized Landscapes and Idealized People: Imperialist, Colonialist, and Nationalist Narratives in European/Eurasian Stone Age Archaeology

18.00 - 20.00: DINER

WEDNESDAY, SEPTEMBER 14th 2022

Keynote speaker:

9.00 - 9.30

Angelica FEURDEAN, Goethe-Universität Frankfurt am Main (Germany)

Contrasting timing and intensity in land cover changes between low and high elevation in CE Europe during the Holocene

SESSION 09. Perspectives through palaeoscience for future environmental sustainability in Europe

Moderators: Gabriela FLORESCU and Aritina HALIUC

9.40 - 10.00

Gabriela FLORESCU et al., University of Suceava, Department of Geography (Romania)

Tree cover composition and canopy density shape long-term fire regimes and lake-catchment interactions in the Bavarian temperate mixed mountain forests, Central Europe

10.00 - 10.20

Aritina HALIUC, University of Suceava, Dep. of Geography (Romania), aritinahaliuc@gmail.com

Andrea Demjén, National Museum of Transylvanian History, Cluj-Napoca, Romania and Emil. G. Racoviță Institute, Babeș-Bolyai University, Cluj-Napoca, Romania; demjenandi@yahoo.com

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Bogdan P. Onac: Karst Research Group, School of Geosciences, University of South Florida, Tampa, USA and Emil. G. Racoviță Institute, Babeș-Bolyai University, Cluj-Napoca, Romania; bonac@usf.edu

Ioana N. Meleg, Emil. G. Racoviță Institute, Babeș-Bolyai University, Cluj-Napoca, Romania; ioana.meleg@ubbcluj.ro

Bringing pieces together: What multiproxy records from cave sediments can tell us about human dynamics in relation to past environmental changes in the Western Romanian Carpathians?

10.20 - 10.40

Piotr KŁAPYTA, Jagiellonian University, Faculty of Geography and Geology, Institute of Geography and Spatial Management, Kraków, Poland, woytastry@gmail.com

Jerzy Zasadni, Faculty of Geology, Geophysics and Environmental Protection, AGH University of Science and Technology, Kraków, Poland

Marcel Mindrescu, University of Suceava, Department of Geography (Romania)

Title Late Pleistocene glaciation in the Eastern Carpathians - holistic view

10.40 - 11.00

Carmen BĂDĂLUTĂ, University of Suceava, Department of Geography and Stable Isotope Laboratory (Romania), carmenbadaluta@yahoo.com

Gheorghe Bădăluță, University of Suceava, Department of Geography (Romania)

The archaeology of climate change: The Eastern Carpathians case

11.00 - 11.20

Anisoara FILIP, University of Suceava, Dep. of. Geography (Romania)

Marcel Mîndrescu, University of Suceava, Dep. of. Geography (Romania)

Gheorghe Bădăluță, University of Suceava, Dep. of. Geography (Romania)

Ancuța Petraș, University of Suceava, Dep. of. Geography (Romania)

Paul Narcis Vieru, ANANP, Botosani branch, Romania

Gabriela Florescu, University of Suceava, Dep. of. Geography (Romania)

Context for human habitation dynamics over the Holocene in the north-eastern Romanian lowlands provided by Dersca-Lozna palaeoenvironmental archive and morphometric analysis

11.20 - 11.40

Ancuta PETRAS, University of Suceava, Dep. of. Geography (Romania)

Marcel Mindrescu, University of Suceava, Dep. of. Geography (Romania)

Gabriela Florescu, University of Suceava, Department of Geography (Romania)

A review of charcoal as a fire proxy over the late Holocene in Romania

11.40 - 12.00

Gheorghe BĂDĂLUTĂ, University of Suceava, Dep. of. Geography (Romania)

Gabriela Florescu, University of Suceava, Dep. of. Geography (Romania)

Marcel Mîndrescu, University of Suceava, Dep. of. Geography (Romania)

Angelica Feurdean, Goethe-Universität Frankfurt am Main (Germany)

Simon Hutchinson, University of Salford (United Kingdom)

Dirk Nowacki, Goethe-Universität Frankfurt am Main (Germany)

Erosion, landscape change and anthropogenic intervention in the Transylvanian lowlands during the Holocene

12.00 - 12.20

Domenic Raul BECICA and Marcel Mindrescu, University of Suceava, Department of Geography (Romania)

The vulnerability of settlements to climate change (Bistrita-Nasaud county, Romania)

12.20

Poster:

Aritina HALIUC et al., University of Suceava, Dep. of Geography (Romania),
aritinahaliuc@gmail.com

Human activities and landscape shaping since the Neolithic Revolution using multi-proxy analysis from lake sediment records

13.00 - 14.30: LUNCH

Keynote speaker:

14.30-15.00

Derk LOORBACH, Erasmus University Rotterdam (The Netherlands)

Developments in the Anthropocene from a transition science perspective

15.00: CLOSING CEREMONY

15.30 - 20.00: Discussion in the field (Zugreni Gorge/Bistrița River and Rarău Mts-TransRarău)

THURSDAY, SEPTEMBER 15th 2022

10.00: VATRA DORNEI. Sightseeing Tour

FRIDAY, SEPTEMBER 16th 2022

DEPARTURE

LAC 2022 Onsite ORGANIZING COMMITTEE:

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Web site:

<https://geoconcept.ro/lac2022-onsite/>

BOOK of ABSTRACTS:

SESSION 07: Human-Earth interaction from the Quaternary to the Anthropocene: natural, social and cultural processes affecting landscapes

Erle ELLIS, University of Maryland, Baltimore (USA)

Deepening the Anthropocene: Connecting Archaeology, Global Environmental Change, and Biodiversity Conservation

Keywords: Land use change, landscapes, anthromes, agriculture, ecology

Earth's ecology for thousands of years, starting long before the emergence of agriculture and urbanization. Landscape archaeological research has long been critical to advancing scientific understanding of early changes in land use and their ecological consequences, including changes in biodiversity, over the past 12,000 years. More recently, international interdisciplinary scientific collaborations and procedures initially developed by the Earth system science community are facilitating improved global historical land use reconstructions that integrate archaeological, palaeoecological, and historical data in ways that are transforming global environmental change and biodiversity conservation. Results from ArchaeoGLOBE, LandCover6K (and other PAGES projects), together with historical reconstructions by Earth scientists and geographers, have already deepened global understanding of human transformation of Earth's ecology, challenging dominant narratives of wilderness conservation and the emergence of the Anthropocene Epoch in the 1950s. With this deeper understanding of long-term social ecological change, including past and current evidence that human societies can shape and sustain biodiverse ecosystems for centuries to millennia, some key questions arise. Can human capacities to transform ecology be redirected toward shaping a better future for people together with the rest of nature at planetary scales? Could some of the same social-ecological processes that have transformed this planet for the worse also transform it for the better? These questions will be explored from a global landscape change perspective.

Sjoerd J. KLUIVING, Vrije Universiteit Amsterdam (The Netherlands)

The Anthropocene in the proposed UNESCO Geopark Scheldt delta: geological history and future in Aquapuncture

Keywords: Schelde delta, geological history, cultural processes

In North-western Europe the rivers Rhine, Meuse and Scheldt have created a giant river delta over the past three million years. The area is usually observed by people as a flat and featureless type of terrain, although sometimes unexpected elevation differences and sharp contrasts in landscapes and omnipresent waterways occur. Geological phenomena, in the Scheldt region, in north-western Belgium and in the southern Netherlands testify from a highly dynamic landscape showing a range from very old to very young geological processes. The great diversity in geological processes and resulting landscapes is unprecedented on a global scale and has had its impact on the region's cultural and economic history, shaping Today's reality. In this paper we aim to a) reconstruct the Holocene Dutch-Flemish Scheldt delta history, in conjunction with the Holocene geological history of the area, b) review the typical lowland theme of the human battle against water in this region, along a cultural history that evolves into the Anthropocene in this area, c) the future in the Anthropocene along aquatic phenomena introducing the concept of Aquapuncture.

Marleen van ZON et al.

Human-environment interactions in the Gete catchment (Belgium). An interdisciplinary approach

Keywords: interdisciplinary, long-term, transformations, floodplain geo-ecology, human activities

Floodplains are highly dynamic environments that have attracted humans throughout history. As such, they have not only been shaped by the interplay of geomorphological, ecological and hydrological processes. They have also been directly and indirectly impacted by human activity. It is in these parts of the landscape that we find ideal research areas to study and reconstruct how humans affected the environment as well as vice versa. For this paper we will focus on one such area: the Gete catchment, situated in the Belgian loess belt. Prior geomorphological and palynological research shows that its floodplain geo-ecology underwent a gradual transformation from a marshy wetland environment, characterised by multiple channels, active peat growth and alder carr forest, to a stereotypical alluvial floodplain, characterised by a single-thread meandering channel, clastic overbank sedimentation and open vegetation. This transformation is dated around 5000 to 4000 BP and occurs roughly 2000 years sooner than in other studied floodplains in the Belgian loess belt. This change is linked to the rich agricultural history of the catchment in which increasing deforestation - related to the establishment of new settlements and/or croplands - lead to increased erosion and as such increased sediment input into the floodplains, causing them to transform. A time lag can be observed between the arrival of the first farmers in the catchment in the Early Neolithic and the first signs of change in floodplain geo-ecology. A similar time lag is attested for a short phase after the Migration period in which the floodplain - following a period of decreased human activity - temporarily reverted to its primary wetland state. This is indicative that changes in floodplain geo-ecology only occur when changes in human impact are large enough and reach a certain threshold. The focus of ongoing research, and the main aim of this paper, is to increase our understanding of these interactions by taking a closer look at the human activities involved and to improve upon the resolution of the geo-ecological data and its temporal framework. Archaeological and historical sources are studied and integrated at a catchment scale, to come to quantitative reconstructions of population size and density as well to gain insight in changes in subsistence- and land-use strategies. Additional geomorphic field work and palynological research is undertaken to better understand the attested time lags whilst taking into account within-catchment variability. This interdisciplinary approach will offer us high-resolution insight into the effects of increasing and decreasing human impact on floodplain geo-ecology and as such can have important implications for future floodplain management. By taking into account the past, it will not only enable us to understand how the present-day landscape came about, but it can also learn us lessons to adapt and employ towards a more sustainable future.

Stefan L. SMITH, ANEE, University of Helsinki (Finland)

"Nomadic" Strategies for Sedentary Populations: Prehistoric Anthropogenic Landscape Alterations as Indications of Climatic Coping Strategies Applicable to the Present Day

Keywords: basic resource acquisition, climate change, Near Eastern deserts, current policy, future education

One of the issues beginning to manifest itself due to anthropogenically-induced climate change is a heightened difficulty in the acquisition of basic resources, largely due to the challenges of long-term planning under increasingly unpredictable conditions. Specifically, we are starting to struggle to accommodate the growing uncertainty of year-on-year climate variation, and thereby such critical issues as agricultural yields, water accessibility, and livestock holding capacities. These problems are greatly compounded by the near-absolute hegemony of sedentism in the present day, not simply in terms of habitation, but also labour, financing, and indeed worldview. These deeply ingrained concepts make it particularly difficult to meld this combination of unpredictability and desired durability into workable solutions. When examining past anthropogenic landscapes it becomes clear that this hegemony was neither universally present, nor practiced in a binary dichotomy. Instead, a variety of nuanced relationships with sedentism were often the norm. This did not manifest exclusively in the well-documented practice of seasonal nomadism. In many cases, the sociocultural and environmental pressures of uncertain climatic conditions produced communities that appear to be largely sedentary, but in fact utilised a combination of what are generally considered "nomadic" practices as survival strategies. These manifest themselves in specific anthropogenic landscape alterations, which in many cases are still visible in the present day. This paper will examine these factors using case studies from the author's region of research in the Jordanian, Syrian, and Iraqi deserts. Aerial- and ground-based investigations carried out over the last decade show that this region's prehistoric inhabitants modified a vast landscape in a way that indicates a broad selection of subsistence strategies that defy binary sedentary-or-nomadic categorisations. These appear as widespread stone structures, some of which, such as animal husbandry enclosures and game-catching devices, are traditionally seen as evidence for "mobile pastoralist" lifestyles. Others, such as water-catchment features, indicate a more stationary form of landscape use. Moreover, the substantial extent of all these features, the effort required for their construction, the evidence for their consistent re-use, the wealth of material they present, and the discovery of far-reaching anthropogenic tracks connecting them strongly suggest longevity of occupation. Together, these phenomena indicate nomadic-style extraction of resources combined with sedentary-style forward planning and locationally stable habitats familiar to us nowadays. A number of these strategies could therefore be applied to present-day policies to alleviate the burden of climate-induced resource acquisition problems. These include flexible use of agricultural and pastoral resources, low-level biosensitive landscape modifications across large areas for periodic re-use, and the adaptation of human labour dictated by the climatic conditions of any given year. The implementation of these in turn requires programmes such as micro-financed short-term loans, security measures for resource

acquisition installations during their periods of non-use, and financing for the training of diversified skills. Most importantly, the education of the next generation in the mere existence of these options, as well as the showcasing of their applicability to our lives, could have immense impacts on future attitudes and thus potential for weathering the challenges ahead.

Barbora DOHNALOVÁ et al.

Vegetation Accompaniment of Small Monuments and its Interpretation in Landscape Archaeology

Keywords: small monument, tree, vegetation accompaniment, place, landscape

In the geographical and historical space of Central Europe, small monuments or built artefacts connected with trees are generally considered a typical identification feature of landscape. Besides the connection between the built object and its vegetation accompaniment, the presented paper points out to the significant relation to the specific place and landscape. The text covers a phenomenological definition of such places defining the space (landscape) towards a structural understanding of the relation of place – small monument – tree. Small monuments and trees explain the space that is concentrated within them and their mutual interconnection reflects the character of the landscape, history of the place, perception, and preference of values in the society. On a background of the basic historical excursion covering vegetation as an accompaniment of small monuments, the methodology concentrates on structural investigation and covers the aspects of typology, evolution, and landscape design. In terms of typology the text presents a basic listing of woody species that commonly accompany small monuments in the Czech Republic, and defines the prerequisites of a relation between the individual species to a specific type of built monument. In terms of evolution, basic model situations are outlined that characterise the dynamic of places, small monuments, and trees in the landscape. In the perspective of time, a place in a landscape is understood as a domain of transformations in the relation between the small monument and a tree. The paper characterizes partial principles of this evolutionary dynamics on selected model sites. In terms of landscape character assessment the paper identifies and summarizes key model situations documenting how places with small monuments and trees manifest in a landscape. The presented paper is a result of a long-term continuous research of a collective of authors. It issues from already delivered as well as currently performed field surveys and documentations in an unbuilt landscape and in the countryside of small rural settlements in the Czech Republic.

Emily VELLA, Uppsala University (Sweden)

Introducing Energy Regimes: A novel method for classifying anthropogenic activities in landscapes

Keywords: Energy Regimes, land-use, interdisciplinary, human-environment interactions

Contemporary biodiversity loss and extreme climate events are a driving force for scientific research. Archaeologists can contribute to this research by using the past to better inform the present and the future. Archaeologists are not the only researchers answering the call to action, nor are they working alone. This has led to an increase in multi-disciplinary research between archaeologists, geologists, geographers, paleo-climatologists, palynologists, ecologists, policy makers, and beyond. While this multidisciplinary research can lead to important results on the topic of human-induced climate change, the theoretical frameworks on how to contextualize this research across disciplines has been lacking. We propose Energy Regimes as a framework to facilitate discussions across relevant disciplines. Energy Regimes are a novel way to categorize archaeological sites, cities, regions, and landscapes based on identified energy sources and the resources the energy sources provide. In this presentation, we will present the Energy Regimes framework and categorization system as well as how it can be implemented within archaeological research. We believe that Energy Regimes provides a solution to language and cultural barriers by acting as a classification system for working across disciplines, at a variety of scales, and across time. They are unique in that they are not associated with specific time periods or cultures, and they are scalable to any time or spatial scale.

Bert GROENEWOUDT and Menne KOSIAN

Better than pollen? An experiment to use structural information from archaeological excavations to reconstruct medieval deforestation and inspire future reforestation

Keywords: woodland history, reforestation, charcoal production, tree-trunk wells, spatial modeling

Plans for the expansion of the present woodland cover exist all over the world, with climate ambitions (carbon capture, climate adaptation), sustainability, the preservation of biodiversity, and the reduction of recreational pressure among the arguments being cited. As a contribution to the current debate on large-scale reforestation in the Netherlands we have tried to spatially reconstruct the presence and dynamics of woodland in the Dutch landscape during the Middle Ages (AD 500-1500). Traditionally pollen data is used for such purposes. However, due to unfavourable preservation conditions and a lack of research, palynological data post-dating c. AD 1000 are scarce and only allow very general reconstructions. The combination of other potential sources of information (place names, historical references, historical maps, 'ancient woodland' etc.) is likely to produce better results (Groenewoudt et al., submitted). Broadening our search for historical woodland proxies we have now investigated the potential of archaeological data, specifically a) charcoal production sites (charcoal kilns), and b) tree-trunk wells: water wells made of hollowed out tree-trunks. Our analyses of medieval charcoal production sites builds on a recent work (Deforce et al., 2020; Groenewoudt et al., in press). A nation-wide inventory of medieval tree-trunk wells was carried out, resulting in (up to now) 540 specimens from 120 medieval settlement sites. Usually large (oak) trees were used. Our expectation that such trees point to the local presence of (old) woodland was confirmed by the strong correlation with spatial reconstructions based on other woodland proxies. Quickly creating large-scale spatiotemporal reconstructions based on substantial quantities of excavation data has been greatly facilitated by the digital availability of a greatly increasing quantity of excavation reports. This is also a favorable precondition (or even a prerequisite?) for landscape archaeological contributions to current debates concerning environmental change. Groenewoudt, Bert, Koen Deforce, Michel Groothedde & Huub Scholte Lubberink (in press): Conquest and Clearance. Charcoal burning as a prelude to reclamation on new domains along the northern Frankish frontier (8th-10th century AD), Proceedings Journées Lotharingiennes 2020. Deforce, Koen, Bert Groenewoudt & Kristof Haneca 2020: 2500 years of charcoal production in the Low Countries: the chronology and typology of charcoal kilns and their relation with early iron production, Quaternary International 593, 295-305. Groenewoudt, Bert, Gijs Eijgenraam, Theo Spek & Menne Kosian (submitted): Mapping lost woodland: A modelling experiment based on place names as a source of inspiration for reforestation, Rural Landscapes.

Menne KOSIAN et al

Conflicts in landscapes. The potential of HGIS for sustainable heritage management and research in dynamic landscapes and multi-stakeholder environments

Keywords: Historical landscapes, Historical Geographical Information Systems (HGIS), Landscape archaeology, Multi-perspective data integration, Sustainable heritage management and conservation

Wetlands are typically amongst one of the most dynamic type of landscapes on earth. Their distinct geomorphological characteristics make them strongly susceptible for environmental changes such as climate, demography, and economy. Equally, these characteristics have made these areas appealing for inhabitants throughout history and provide excellent preservation conditions. Subsequently shaping these landscapes in unique and invaluable heritage archives reflecting long-term human-earth interactions. Furthermore, these wetlands are increasingly perceived as valuable ecoservice systems for amongst other carbon storage and water management. As a result, interest in these areas is increasingly growing and attracting a wide variety of stakeholders. The precise impact of these dynamics on the heritage contained in these landscapes remains generally unclear and protective measures often strongly differ (i.e., ranging from regional planning restrictions to World Heritage). Most of these protective measures however focus only on one aspect in these dynamic landscapes (e.g., ecological, biological, or cultural) and integrated approaches are generally lacking. This is problematic not only because of the dynamic nature of the landscapes (i.e., cultural and natural processes are strongly intertwined), but equally for local inhabitants. For example, the preservation of archaeological remains, plans for rewilding, or local inundation can clash with the interests of people living and working these areas (e.g., farmers). The same holds true for many coastal marshes, where strictly focusing on preserving natural processes often directly contradicts heritage preservation and economic activities such as fishing and shipping, which often have been at the core of the livelihood and identity of local communities for centuries and helped shape the same landscape. These local inhabitants often have been preserving the precarious balance between natural and cultural factors for ages. Therefore in order to sustainably maintain and developed these landscapes a multidisciplinary approach is essential. An approach integrating cultural and natural, historical and modern-day data and equally taking into account different stakeholders and specific interest groups (e.g., politicians, inhabitants). In this paper we present a recently-developed methodology recently developed specifically aimed at supporting such an integrated approach and facilitating a wide variety of stakeholders. By focusing on two typical wetlands in the Netherlands (i.e., the fenlands of the western Netherlands and the world-heritage site of Schokland) we will present our 'Wetland-HGIS' which is specifically designed to facilitate sustainable management and multidisciplinary research of heritage in dynamic environments. The system uses concepts derived from Historical Geographical Information Science (HGIS) and allows to integrate varying types of data (i.e., natural vs cultural and historical vs modern) and proxies, service a wide variety of stakeholders, and design and execute tailor made queries. We

will show that (1) our approach is highly suited for unravelling the diachronic complexity of landscapes, (2) our method underlines the importance of history, especially in wetlands, for sustainable (re)development of present-day and future landscapes, and (3) the system helps to translate these historical and modern data in to one integrated overview beneficial for policy making and public outreach.

Aspassia KOUZOUPI et al.

Was the Anthropocene anticipated by the Long Walls zone?

Keywords: anthropocene, infrastructural palimpsest, landscape archaeology

We argue that the Anthropocene has been anticipated even in distant historic times, if not earlier. More than a geological era, the Anthropocene as a philosophical concept, may include giga-scale structures which have changed the way the Earth's crust was configured, perceived and experienced. The research and observation of the becoming of such archaeological structures in time, is a way to take advantage of the depth of time that has flowed since their creation. The case study focuses on a characteristic example of classic Antiquity, the parallel Long Walls between Athens and Piraeus. When looking at paleo-geographical maps depicting what we acknowledge today as the Piraeus peninsula, we find that Piraeus used to be an island [6800-5400 cal y B.P.]. During classic antiquity, before the Northern Long Wall was constructed, [2450 cal y B.P. alias 5th c. BCE] Piraeus was again almost an island, cut away from the Attica land by a marsh, namely Halipedon. Halipedon was an area heavily modified during the Northern Long Wall's construction, as testified by Plutarch who refers to the expensive, time-consuming task of creating these foundations by the use of huge quantities of gravel and massive stone-blocks. The Southern Long wall was built some decades later, expressing the will of Athenians to make their city a naval node; this was achieved not by moving Athens close to the sea, but by creating an urban di-pole, by linking the historic city with the newly founded city of Piraeus. The Long Walls as fortification structures interrupted the topography which they crossed, being 2 predominantly straight and parallel axes, 6km long. The space they secluded, which was segregated from its rural environment, was a narrow [1 stadium wide] corridor which enabled direct communication between Athens and Piraeus port. Albeit their grandeur as giga-scale structure, the Long Walls double axis did not survive long as a fortification device. For the longest part of their history, they remained deteriorated and practically destroyed: only their foundations survived throughout the centuries, up to modern times. During the 19th century, Athens and Piraeus took again the role of an urban dipole; the newly founded Greek state's capital and its port were connected by 2 major transport axes which duplicated the Long Walls traces. This was the inauguration of an infrastructural palimpsest on one hand. On the other hand, the proximity to the transport axes again resulted in the deterritorialization of the area's rural character, and its transformation into an industrial area. This area today is considered valuable in terms of industrial history, however many among the protected monuments are in a state of abandonment and deterioration. The new face of the Anthropocene in the area takes the form of surface homogenization by logistics, huge commercial complexes,... Our interdisciplinary team comprises archaeologists from the Ephorate of Antiquities of Piraeus & Islands, two GIS specialists and two architects. Our task is to find places along the Long Walls course where traces of the area's rich environmental, anthropogenic, and social palimpsest can be traced.

Tijmen Yvo Christiaan OPSOMER et al.,

Quantification of societal energy consumption during the industrial revolution in northwest Iberia

Keywords: Industrialization, energy consumption

This research quantifies the energy consumption in northwest Iberia over the time period 1801-1920. The study area is made up of four Spanish provinces and four Portuguese districts. The quantification is done using an energy decomposition equation with population, per capita GDP and energy intensity as variables, with the dataset collected from existing literature using datamining and textmining. The main goal is a closer examination of the early industrial revolution and its driving forces. Results show an increase of 87.114 PJ on total energy consumption in the study area, with the majority of that growth coming from the Spanish part. Both countries show very localized industrialization, with Porto as the centre in Portugal and Basque Country in Spain. For the Spanish part of the study area, an increase in affluence is the most important factor in increasing total energy consumption. For the Portuguese part of the study area, the most important factor is population increase. This research underlines the importance of factors influencing energy trends on different scales, namely district and province, country-wide and even worldwide.

Esther RUMORA et al.

Energy Landscapes in the Rhine Meuse delta

Keywords: Energy landscapes, regime transitions

Through all periods of history, humankind has always had a dependency on energy. Because of technological innovations in energy use and land use, the relationship between humans and landscape has developed extensively over time. Throughout history, several transitions in energy use can be identified; a shift from one primary energy source to another. This research attempts to determine whether coring research can contribute to archaeological research regarding energy regime transitions. The study area for this thesis will be the central part of the Rhine Meuse delta, situated in the Netherlands, also known as the Dutch river area, focused on the Late-Holocene history. Results show that the concept of energy landscape and the behavioral drive energy management provides within society is an excellent framework to study the past, as one of the most important elements in human history is society's relation with the surrounding landscape. Data collected through excavation, laboratory analyses and coring should be examined within a framework regarding humans as managers of energy with an active role in environmental and evolutionary change through time. Researchers studying the spatial dimensions of energy transitions have found the energy landscape concept useful as a way to describe and to understand the role of energy in human-environment relations, with particular emphasis on how energy transitions shape and are shaped by social relations to land in terms of changing land-use patterns and landscape values. Energy revolutions in deep time, like aerobic photosynthesis, and chemotrophy likely had similar planetary scale impacts, through resource exploitation and environmental impact and could potentially serve as natural analogues.

Anco LANKREIJER et al.,

Big questions in the Anthropocene

Keywords: Education, Interdisciplinarity, Anthropocene

Embedding the Anthropocene as a concept in university curricula is essential for preparing students for their future. Different disciplines have vastly different perspectives on the Anthropocene, while the term pops up in different guises across curricula, leaving students with vague notions of what it constitutes. We aim for a course integrating and contrasting these different disciplinary perspectives in order to arrive at a richer understanding of its complexity, at the same time making the Anthropocene tangible and concrete. In our Liberal Arts and Science programme, we offer for the 3rd consecutive year a 6 credits mandatory course that specifically invites students from all disciplines to explore the Anthropocene. We identify three essential concepts that we discuss in-depth from different disciplinary angles. These concepts include Nature, Human and Anthropocene interactions. For each, the teaching team provides foundational disciplinary lectures and an interdisciplinary interaction that synthesizes the different approaches. Guest lectures and field visits complement the interdisciplinary interaction. In particular, we include perspectives from the Social Sciences (e.g. international relations, economics, cognitive psychology, sociology, anthropology), Humanities (e.g. ethics, visual arts, film, history, communication, journalism, critical theory) and Sciences (e.g. earth system science, environmental science, ecology, engineering). The final project for this course challenges teams of students to develop and lead an excursion to a local manifestation of the Anthropocene, incorporating different disciplinary perspectives. This leads to a lasting experience of tangible manifestations of the Anthropocene in their local surroundings, linking global processes to local phenomena, often rooted in historical developments, and connected to deep time processes. Team teaching, involving multiple teachers with different disciplinary backgrounds in one class, leads to debunking of common misconceptions, to a better understanding of different methods and conceptualisations, and to the development of shared vocabulary and collaborative problem solving. Students much appreciate the hands-on project, applying their understanding of the Anthropocene and interdisciplinary cooperation to their local environment.

Anneli EKBLÖM, Uppsala University (Sweden)

The Time Lab

Keywords: Landscape history, biocultural heritage, green economy, storytelling

Long-term perspectives (from millennia to centuries) have a strong bearing on current approaches to the sustainable management of heritage and natural resources; both in terms of ecological knowledge and in mobilising local communities to maintain and innovate rural incomes through continued management of these valuable landscapes. In addition, current rapid changes in climate makes long term knowledge of climate dynamics, interactions between landuse, societal transformation and vegetation change is essential in predicting future outcomes and appropriate landuse adjustments and policy changes. This requires detailed understanding of spatial and temporal representation of used proxies and of the dynamics of different interacting variables. Importantly we also need to find ways to communicate historical knowledge to stimulate debates on present and future landscape management. In this paper, I present example of approaches for historically informed landscape analyses, with new forms and conceptualisations of research from collaborative to action research and narrative approaches.

Sjoerd J. KLUIVING, Faculty of Humanities, Department Art and Culture, History, Antiquity, Vrije Universiteit Amsterdam, Netherlands

TERRANOVA from the last and current Interglacial periods into the Anthropocene: an Atlas database drawing lessons from ancient land use for future European landscape management

Keywords: Energy regimes, deep history, sustainable landscape management,

TERRANOVA is a Marie Skłodowska-Curie Innovative Training Networks (H2020-MSCA-ITN) project (2019-2023) training 15 PhD students in a new learning initiative between Humanities and Science: Mapping past environments and energy regimes, rethinking human-environment interaction and designing land management tools for policy. TERRANOVA will produce an unprecedented atlas with layers of reconstructed and modelled land-use and vegetation dynamics, climate change and mega-fauna history in Europe from the Eemian (Last Interglacial) and the Holocene from the start up until the present day. This paper describes the intermediate results of two years of research into Atlas building. Communication and data exchange, as well as the process of atlas generation work flow, have been undertaken, including examples of datasets from deep history, ancient landscapes, energy regimes and climate scenarios. The atlas database implements state-of-the-art standards for increasing the interoperability of spatiotemporal datasets. It is currently formed by four main data types: Archaeological data, Climate data, Land cover data, and Megafauna (i.e. large mammals) distribution. This paper explores the TERRANOVA research and concludes with listing the next steps to stream the Terranova atlas as a tool for communicating the European history of environmental change, including support for future landscape management policies.

Andrea PINTAR et al.

Romanticized Landscapes and Idealized People: Imperialist, Colonialist, and Nationalist Narratives in European/Eurasian Stone Age Archaeology

Keywords: Colonialism, Palaeolithic, Western Europe, Siberia

The Anthropocene considers the ways that humans alter landscapes and ecosystems from either recent times and/or deep past. Hence, palaeoclimatology, palaeoenvironmental studies, palaeoecology, and archaeology are among the best tools to understand long-lasting processes impacting Earth. Debates among landscape archaeologists concerning global environmental change over time can contribute to shape future research agendas and policy frameworks. By doing so, careful examination of the social and cultural context in which research is conducted is too seldom, sometimes leading to a biased understanding of history. Colonialism has impacted cultures and environments globally, and one aspect that is currently being discussed is the (de)colonization of knowledge, especially within academic research. Elements of Western colonialist, imperialist, and nationalist ideology have manifested within (geo)archaeological, ethnographic, and historical interpretations of the past. Therefore, part of the Anthropocene is also analyzing our own behavior and how it impacts research and knowledge. We argue that identifying misconceptions about the deep past might change how we understand and conduct our research, and eventually lead to different approaches in dealing with global environmental changes. In this work, we provide examples of colonialism and imperialism in the interpretations of 1) the *H. sapiens* and *H. neanderthalensis* interactions in Western Europe during the Upper Paleolithic, and 2) the appropriation and interpretation of the Siberian (*H. sapiens*) Palaeolithic-Neolithic trajectory.

SESSION 09: Perspectives through palaeoscience for future environmental sustainability in Europe

Aritina HALIUC et al.,

Bringing pieces together: What multiproxy records from cave sediments can tell us about human dynamics in relation to past environmental changes in the Western Romanian Carpathians?

Keywords: cave sediments, humans, environment, Carpathians

Cave sediments are natural repositories that store geochemical and palaeobiological information and sometimes archeological materials, thus providing evidence of past changes in the environment and clues of human activities over long temporal scales. Caves from Romanian Carpathians hold tracers of early human occupation and past environmental dynamics, but they are still poorly investigated. Thus, the region remains at the periphery of research, missing direct investigations about the timing of ancient human dynamics in relation to past ecosystems. Undisturbed cave sediment records of 128 and 20 cm in length, along with point samples were collected from two caves located in the Apuseni Mountains of western Romania. One of the caves host human footprints dating back to cca 36 ka, whereas the other one is known for its Bronze Age burial site. In the latter, excavation is in progress and the geochronological context of early human settlements has been assessed based on radiocarbon dating of human and seed remains. Surprisingly, the oldest traces of ritual deposits date back to the Middle / Late Neolithic around 7 ka BP. By using a multidisciplinary approach that combines chronology, lithostratigraphy, geochemistry, ancient DNA, and a detailed archaeological survey, this study aims to reconstruct Late Pleistocene/Holocene faunal and human population turnovers within a palaeoclimatic and palaeoenvironmental context at different spatio-temporal resolutions. The preliminary results show that the 128-cm long record goes back to mid-Holocene and the depositional environment is characterised by different phases of sedimentation in response to climate and environmental changes. Multi-proxy analysis is now under investigation and the results will extend the faunal, human, climate, and environmental perspective deeper in time. Exploring such evidence is of cultural and scientific significance especially in SE Europe where early and unique human records are found. Furthermore, it is critical for advancing our understanding of past human dynamics and changes in the environments.

Piotr KLAPYTA et al.,

Late Pleistocene glaciation in the Eastern Carpathians – a holistic view

Keywords: glaciation, glacial cirques, equilibrium line, Carpathians

The Eastern Carpathians (EC) are the most extensive (600 km long) part of the Carpathians, but only 1.6 % of this area rises above 1500 m asl which mostly was enough high to support Pleistocene glaciers. Landforms of former glaciation are preserved here in 14 isolated mountain massifs that stretch over 300 km in the territory of Ukraine and Romania from the Polonyna Rivna (1480 m asl) in the NW to the Gurghiu Mountains (1775 m asl) in the SW. Here we present the first complete inventory of glaciation in the EC based on geomorphological mapping of glacial cirques (N=214) and maximal moraines together with GIS-based glacier reconstruction, and AABR 1.6 ELA calculation of 147 former glaciers. On the base of the EC glacier dataset, we propose a quantitative approach to define three distinct stages of glacial landscape development, which is based on the relationship between the glacial ELA and mountain hypsometry. The comparison between spatial trends of LGM ELA and modern temperature-precipitation ELA (tpELA) in the study area gives insight into the pattern and magnitude of atmospheric circulation and dominated moisture advection during the full glacial conditions in Central Europe.

The EC were occupied by relatively small cirque and cirque-valley glaciers, with a mean area of 1.04 km² and a mean length of 1.81 km, developed mainly on poleward slopes. Only in the strongest glaciated massifs (Chornohora, Rodna, Svydovets) glaciers were developed on both poleward and equatorward slopes. The spatial distribution of LGM ELA and cirque floor altitudes show a steep NW-SE rise of 600 m over a distance of 300 km (2-2.5 m/km) which mimics the pattern and magnitude of the modern climatic (temperature-precipitation) ELA (2.4 m/km) reflecting the importance of moisture advection by the west and northwest winds from the European Lowland and Pannonian Basin. The exceptionally low LGM ELA position in the Ukrainian Carpathians can be explained by the regional topographic predisposition for orographic induced precipitation which plays a crucial role in glacier mass balance in windy and dry LGM climate.

Carmen-Andreea BĂDĂLUȚĂ and Gheorghe BĂDĂLUȚĂ

The archaeology of climate change: The Eastern Carpathians case

Keywords: climate, archaeology, environment, Eastern Carpathians, Late Holocene.

Current climate change is causing environmental transformation at an alarming rate, both at the local, regional and global level. This represents a major challenge for the social, economic and political systems. However, people have successfully faced and adapted to these changes since the past. The natural archives and archaeological records can provide the complex image of the interaction of climate, environment and human systems. The Eastern Carpathians shelter a multitude of natural archives like ice caves, tree rings, speleothems, lacustrine and fluvial sediments, peat bogs and/or guano deposits, which are hosting important proxy records of past climate and environmental changes. Also, the archaeological data indicate that the Eastern Carpathian represents the cradle of European civilization. In this study we will present climatic (e.g., temperature, moisture sources) and hydroclimatic (e. g. floods) changes in the Eastern Carpathian during the late Holocene and the interaction of the human system. The results of the past climate change, environmental transformation and human impact and mobility can provide valuable lessons for the future.

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Anișoara FILIP et al.

Context for human habitation dynamics over the Holocene in the north-eastern Romanian lowlands provided by Dersca-Lozna palaeoenvironmental archive and morphometric analysis

Keywords: lake sediments, climatic oscillations, historical agriculture, human habitation dynamics

Humans have always impacted on global land cover and climate for millennia and the climate and environmental conditions have always been main factors for human settlement dynamics. This study focuses on a potential record of environmental history derived from the investigation of sediments recovered from the Dersca peatbog (47.938167 N, 26.260835 E) that could explain the context for human habitation dynamics over the Holocene in the north-eastern Romanian lowlands, an area that has been heavily impacted anthropologically. The core presents a continuous peat profile from the last 9000 cal. yrs. BP. Archaeological studies carried out in the area (8km buffer around the core site) contributed to reconstruct the human habitation dynamics. The archaeological sites were grouped based on relevant factors into categories such as slope, proximity to major waterways and relief, underlining the evolution of preferred environmental conditions for settling. It is known that human communities had some specific factors in mind when settling in an exact spot that changed throughout the time periods. The main results of spatial distribution analysis converge to conclude that: as the population number grew, the number of sites and the altitude range increased, there are 3 main areas with high density of identified sites, the sites expansion follows the accessibility of the valleys, the spatial distribution analysis of the sites located in the present floodplain is problematic. The preliminary results of the morphometric analysis of the peat core suggest significant changes that have occurred throughout the Holocene: the sediment density values closely match the humidity rates, with a clear beginning of peat accumulation (density values decrease) that matches the oldest identified sites and noticeable oscillations until 3300 yrs. BP, when the density values start to increase, suggesting more intense agriculture development. Increased anthropogenic pressure is reflected in a series of distinct layers in the core that correspond to the Medieval Warm Period, but the environmental factors that created them remain to be solved. We suggest that there is more to be derived from the archaeological and paleoenvironmental perspective, as the preliminary data does not indicate a strong overall trend, but rather potentially significant trends for smaller regions inside the buffer zone (8km).

Ancuța PETRAȘ et al.,

A review of charcoal as a fire proxy over the late Holocene in Romania

Keywords: charcoal, wildfire, late Holocene, Romanian Carpathians, peatbogs, anthropogenic activity.

Fire is an important disturbance mechanism that can change vegetation and destroy the ecosystems. The Romanian Carpathians are the richest biogeographical regions in terms of biodiversity indicators and the largest remaining old-growth forests in Europe. The paleofire records can provide information on how ecosystems will be impacted by fire regime changes responding to anthropogenic climate change. The anthropogenic activities such as land-use change, forest clearance and mining, may induce changes in fire regime and increase wildfire risk, thus threatening sensitive landscapes. Peatbogs are sensitive to local environmental changes they are ideal archives for recording charcoal fluxes resulted from vegetation burning.

Sedimentary charcoal is a robust fire proxy, recent improvements have contributed to more detailed reconstructions of fire changes. Measurement of sedimentary charcoal particle shape attributes has appeared as a promising method for characterizing burned fuel types in the paleofire record.

These reconstructions were carried out to understand the complex interactions between climate, local environment and vegetation, including the effect of perturbing factors such as wildfire.

Our study aims a review of charcoal proxy to reconstruct fire history in relation to anthropogenic disturbances and climate variability, over the late Holocene in Romania. In Romania, there are studies that have focused on reconstructing the activity of vegetation fires on an extended time scale. Most of the studies have concentrated either on the impact of changing fire regimes in vegetation composition or on the use of fire by humans since the Bronze Age to keep high-altitude grasslands open.

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Gheorghe BADALUTA et al.,

Erosion, landscape change and anthropogenic intervention in the Transylvanian lowlands during the Holocene

Keywords: erosion, landscape, human impact, Transylvania, Holocene

Climate changes mean we are witnessing an increase in extreme climatic events (e.g., droughts, torrential rain and flooding) that will intensify soil erosion and consequently lead to landscape change. One of the key factors influencing erosion is agriculture, which extended in the lowlands of Transylvania in the middle of the Holocene.

Lakes represent one of the landscape's best natural archives so that lake sediments can provide a continuous record of processes and impacts that occurred over time at the catchment level. Here, we present the erosion patterns reconstructed based on the Țaga lake sediment sequence and relate these changes to the human transformation of the landscape.

For this purpose, a 7.15m long lake sediment core was analyzed for sediment geochemistry, particle size, and mineral magnetic properties to define erosion patterns, depositional characteristics and lake-catchment interactions. Additionally, the resources of the National Archaeological Database, historical data, as well as published quantitative reconstructions of past vegetation and fire regime dynamics were added to assess the development and impacts of the human communities on the environment of the study area.

Our results indicate that there were three major intervals characterized by high erosion, namely prior to 4200 cal yr BP, between 3800-3000 cal yr BP and over the last 1800 years. These intervals were separated by two stable episodes around 4000 cal yr BP and between 3000 – 1800 years ago.

While the first interval with elevated erosion levels was associated with natural factors, such as climate variability and/or channel instability of the river on which the lake was formed, the most recent two erosional intervals correspond to progressive anthropogenically-induced deforestation, the extension of agricultural land and finally direct intervention in the water body. Interestingly, the two low erosion episodes also appear to have been influenced by natural factors (e.g., NAO modes).

The lacustrine sediments of Lake Țaga represent an example of environmental change in an area with a long history of human habitation and will provide an essential supplement of information about the history of this area.

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