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Aerial Archaeology
Research Group
1983 - 2023

September 21-23, 2023 | Zagreb, Croatia

AARG 2023

Conference programme

Wednesday, 20 September	
19:00 – 21:00	WELCOME RECEPTION and registration at Archaeological Museum in Zagreb

Thursday, 21 September CONFERENCE DAY 1		
9:00 – 9:20	REGISTRATION	
9:20 – 10:00	OPENING REMARKS AND AGM	
SESSION 1	PAST – PRESENT – FUTURE?	
10:00 – 10:25	C. Musson	Invited talk: TBA
10:25 – 10:50	R. Palmer	Invited talk: Before the beginning
10:50 – 11:15	C. Stoertz	Invited talk: Once Upon a Time
11:15 – 11:45	COFFEE BREAK	
11:45 – 12:10	S. Evans	A personal reflection on a career in aerial survey
12:10 – 12:35	I. Oltean & B. Hanson	From sky, down to earth: aerial archaeology and Romania after 25 years
12:35 – 13:00	S. Curran	The Hill of Tara: mapping an archaeological complex from above and below
13:00 – 13:25	M. Gojda & J. Unger	2D mapping, photogrammetry-based 3D modelling, and the virtual reconstructions of Czech lowland crop-marked sites
13:30 – 14:30	LUNCH BREAK	
14:30 – 14:55	R. Opitz, R. Bennett & C. Gaffney	Invited talk: Aerial Survey and Remote Sensing in Archaeology: Characterising the Community in 2023
14:55 – 15:20	A. Jarvis	Neurodiversity in Aerial Archaeology: A personal look from a different perspective
15:20 – 15:45	M. Oakey	From APs to Apprentices: The Downs from Above
15:45 – 16:30	COFFEE BREAK AND POSTER SESSION	
SESSION 2	LOCAL SESSION	
16:30 – 16:55	M. Doneus, N. Doneus & D. Cowley	Spatio-Temporal Interpretation of a Dry Stone Walled Landscape on the Island of Cres (Croatia) Using Digital Feature Models from Airborne Laser Scanning
16:55 – 17:20	N. Basuau & G. Benčić	Communication infrastructures and Roman cadastral system: new insights into the agrarian structure of the <i>Parentium</i> colony (Istria, Croatia)
17:20 – 18:00	DISCUSSION & CLOSING REMARKS	

Friday, 22 September CONFERENCE DAY 2		
SESSION 3		AROUND THE WORLD IN ONE SESSION
9:05 – 9:30	A. J. Ortiz - Villarejo et al.	Drone-made orthophotogrammetry, 3D reconstructions, LiDAR, and historical cartography applied to the study of foundation of the "New Populations" in the late 18th century Sierra Morena region, Andalusia
9:30 – 9:55	J.S.P. Eidshaug et al.	Shell middens, Mesolithic house pits, and supra-regional settlement patterns: Breaking new grounds with UAV LiDAR in the high latitude coastal environments of Tierra del Fuego, Argentina and Vega, Northern Norway
10:00 – 10:25	P. Dimitriev	Submerged landscapes: remote sensing data interpretation and changes in the spatial organisation of East Siberian villages
10:25 – 10:50	Z. Czajlik, L. Rupnik & P. Ódor	Aerial archaeology of Hallstatt necropolises in Hungary. New results by using different platforms
10:45 – 11:15	COFFEE BREAK	
11:15 – 11:40	C. Parcero-Oubiña & D. González-Álvarez	The changing face of Iron Age "castros" thanks to new remote sensing findings
11:40 – 12:05	M. Gussone, M. Fowler & A. Schneider	Settlement research in al-Hira, Iraq using declassified HEXAGON satellite imagery
12:05 – 12:30	L. Starková	Dark modernities in Iraqi Kurdistan: pre and post – Anfal settlement pattern of rural areas
12:30 – 12:55	M. Lazzari, A. Oyaneder & I. Oltean	Andean landscape legacies: multi-analytical remote-sensing mapping and assessment of long-term settlement and land use for sustainable futures in NW Argentina
13:00 – 14:00	LUNCH BREAK	
14:00 – 14:25	G. Kierszys	Totalitarianism, fossil fuels and slave labour. The bombscape of Hydrierwerke Pölitz AG
14:25 – 14:50	A. Deegan	Contrary Scunthorpe – the Industrial Garden Town
SESSION 4		TECHNICAL SESSION
14:50 – 15:15	O. Risbøl, W. Verschoof-van der Vaart & K. Lambers	A bio-economic study of proto-industrial wood tar production in Mid-Norway by the use of LiDAR data and Deep Learning
15:15 – 15:45	COFFEE BREAK	
15:45 – 16:10	M. Niculita	Deep Learning identification of tumuli from LiDAR DEMs at regional scale
16:10 – 16:35	Ž. Kokalj et al.	ADAF – a user-friendly tool for Automatic Detection of Archaeological Features
16:35 – 17:00	M. E. Castiello et al.	Pre-Hispanic landscape occupation in Chilean Andes. A Remote Sensing and Deep-Learning coupled approach
17:00 – 18:00	DISCUSSION & CLOSING REMARKS	

POSTER SESSION	
Adrian Şerbănescu	Surveying Rural Roman Settlements in areas with intense agricultural activity
Martin Gussone & Agnes Schneider	Investigations in Late-Antique and Early-Islamic al-Hira, Iraq. Past, Present and Future
Simon Seyfried	New approaches in crop-mark-ology? Adding automation and advanced statistical visualisations to the workflow of the AARG-SEN2 workgroup for the purpose of predicting the appearance of crop marks
Nives Doneus & Martina Blečić Kavur	City of Osor in the matrix of long-distance maritime routes
Aleksandar Stamenković & Darja Grosman	The past from above, western Srem, Serbia
Klara Hanakova	The Results of ALS Prospection in the West Part of the Ore Mountains
Tomáš Kroupa	North-western Brdy Mountains (the Czech Republic): The Landscape of Charcoal and Holloways

Saturday, 23 September	
9:00 – 16:00	FIELD TRIP - Krapina Neanderthal Museum

ABSTRACTS – DAY 1

Past, Present, Future

Sally Evans	A personal reflection on a career in aerial survey
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This paper presents a personal history of aerial archaeology in England over a period of nearly 20 years, beginning as a keen student attending my first AARG conference in Canterbury 2002, through to the present day and a role as the Aerial Survey Manager at Historic England. Over this period the Historic England team and external contractors have developed and undertaken projects mapping of thousands of kilometres of England: from the Upland Lake District, North Pennines and Durham or the Lowlands of West Wiltshire and Cambridgeshire. Each project has in fact thrown up unique challenges and opportunities in terms of technical approaches, meeting corporate strategy, and fulfilling stakeholder needs. This paper reflects on key moments within this career and identifies and discusses these developments in the practical aspects of the discipline, as well as the challenges of maintaining relevance to the wider commercial and research sectors. From the highs of finally making our data publicly accessible and the lows of maintaining standards. I have witnessed the landscape of aerial archaeology changing rapidly, with new methods, new approaches to the scale of work undertaken, and most importantly changes to the drivers for the work. Against the backdrop of this distinguished history and the challenges facing the Historic Environment sector, the paper also looks to the future and asks questions of the future of aerial survey: What is there to look forward to next, and how do we continue to adapt so that our work is relevant and used?

Ioana Oltean and Bill Hanson	From sky, down to earth: aerial archaeology and Romania after 25 years
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25 years ago the two authors started the first aerial reconnaissance flights dedicated to the discovery of new archaeological information in Western Transylvania, Romania, funded by a small Leverhulme Trust grant. Our work evolved over the years, expanding significantly into new areas of the country and into the application of increasingly diversified technologies. The aim throughout was to increase our understanding of the archaeological landscape and its evolution, and to contribute to key priorities within cultural heritage preservation. This paper will summarise our experiences over the past two and a half decades, outline current priorities and suggest future directions.

Susan Curran	The Hill of Tara: mapping an archaeological complex from above and below
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The Hill of Tara, Co. Meath (Ireland) is one of Ireland's most enigmatic archaeological complexes, featuring a range of archaeological monuments and other evidence from the Neolithic to the Medieval period. Currently on the UNESCO World Heritage Sites Tentative List as one of 'The Royal Sites of Ireland', the site is still a hugely popular destination for the local community and tourists alike. Attempts have been made to map the archaeological remains at Tara for more than 1,000 years (Corns et al. 2008, 34) and since its inception in 1991, The Discovery Programme have conducted significant surveys at the Hill of Tara and its environs which have reshaped our knowledge and understanding of this internationally important archaeological complex. The Discovery Programme's interdisciplinary

approach to investigating Tara has also made a unique and lasting impact upon the practice of archaeological research in Ireland, making use of historical sources, field records, and in particular, the use of new and non-destructive technologies in survey and analysis of this landscape. Since 1992, these techniques have included topographic survey, aerial and ground photography, 3D photogrammetric and laser scan data, LiDAR data, and geophysical survey, in conjunction with documentary sources and excavation.

Now in its fourth iteration, the Tara Research Project is working on collating the wealth of aerial and remote sensing datasets gathered over three decades of research, with a view to producing a more complete map of the archaeological complex which will serve as an important digital resource for future research. This paper presents the range of aerial and remote sensing investigations undertaken at Tara to date, and explores our next steps, particularly in terms of presenting the wealth of material to a wider audience.

Martin Gojda and Jiří Unger	2D mapping, photogrammetry-based 3D modelling, and the virtual reconstructions of Czech lowland crop-marked sites
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The aim of the paper is to present how data acquired in the 25 years long period during aerial archaeological survey of buried sites seasonally displayed through cropmarks have recently been processed in order to become a type of document of the same value as the documents produced by means of archaeological excavation, i. e. large scale maps and plans of the detected and photographed crop-marked sites. A principal attention is given to the application of modern methods of 3D modelling. Representative examples are gradually selected from several hundred archaeological sites hidden beneath the earth's surface and seasonally visible through 'vegetation/crop marks' in order to document the potential of such marks to get an idea of the layout of detected sites (individual features as well as complex settlement areas). A 'flight' over a virtual prehistoric or historical landscape in the form of animated video clips can then present in an attractive way, especially to the general public, the characteristic features of the past landscape.

Rachel Opitz, Rebecca Bennett and Chris Gaffney	Aerial Survey and Remote Sensing in Archaeology: Characterising the Community in 2023
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In 2023, the AARG/ISAP/EAC Working Party carried out an online survey to collect information from archaeological remote sensing and aerial prospection specialists about their needs, priorities, skills and professional activities, alongside information about those of the organisations where they work. The aim of this survey was to begin to build a picture of the state of the profession in archaeological remote sensing and aerial prospection and its contributions to archaeology and heritage management. This presentation summarises the results of the survey, discusses our interpretation of the responses, and highlights key points of interest for the AARG community.

Adam Jarvis	Neurodiversity in Aerial Archaeology: A personal look from a different perspective
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When we think of traditional aerial photography, we think of two methods. The first is vertical photography. Straight forward, straight down and easy to fit into the landscape. The other is Oblique Photography. This is usually more focussed on specific things, slightly fuzzier on the edges and

sometimes requires complicated algorithms to get it to the right place. A perfect metaphor for neurodiversity.

So how does someone with only a college level education, Autism, Dyslexia and Dyscalculia come to thrive in a career that he can't even spell or remember dates in? The answer is technology.

From outside-the-box thinking, my experiences pushing the technology at our disposal to create innovative and streamlined workflows for the whole team, and testing technology from other industries to create new ways of working designed to compensate for human error, this presentation takes inspiration from recent AARG presentations which have passed comment on the limitations of recording methods and data collection practices and will explore the ways that I've adapted and the ways having a brain that works differently can be a benefit to everyone.

Aerial Archaeology has provided a space to overcome a plethora of obstacles not just for myself, but all members of the team by shifting the focus away from my disabilities and the tedium of recording data, and back to the part of the job we all love: Discovering the hidden landscapes below, from above.

Mathew Oakey

From APs to Apprentices: The Downs from Above

Changing Chalk is a partnership of 10 organisations, led by the National Trust, which is delivering 18 projects that aim to 'unite nature, people and heritage' on the South Downs in southern England. Historic England is a delivery partner for one of these projects – the Downs from Above – which has mapped 193sq km of the South Downs to the north of Brighton from aerial photographs and lidar. The South Downs have a rich and varied heritage. The aerial mapping encompassed a wide range of features from Neolithic long barrows, through extensive later prehistoric field systems to Victorian funfairs. The aerial mapping has created a unique dataset to understand the development of this landscape over several millennia.

Engaging communities

The Changing Chalk project area has some of the most economically-deprived wards in the UK, with high unemployment, and poor physical and mental health. The link between heritage and wellbeing it is becoming increasingly acknowledged in the UK. A key outcome of the Downs from Above project has therefore been engagement of local communities.

All the mapping from the project has been made available via an online GIS portal. As well as allowing the public to explore the aerial archaeology of the Downs, the portal is also interactive. This enables volunteers to add their thoughts, observations and memories to the archaeological mapping, informing future management of this landscape. It is also hoped that the portal will enable us to assess how having access to mapping derived from aerial survey alters people's perceptions of landscape and the values that they place on it.

Historic England is also supporting the partnership through training of local communities in archaeological techniques, including aerial survey. While this will be open to locals who are already engaged in archaeology through volunteering, a key audience for this training will be young people not in education, employment or training (NEETs).

Alternative career paths

A particularly exciting aspect of the Downs from Above project is that it has helped us realise our ambition to support alternative career paths into archaeology. Income from the project has been used to fund a Level 3 Archaeological Technician apprentice who will spend 18 months with Historic England learning skills in aerial survey, geophysics, earthwork survey and excavation. This is the first of three apprentices working in the Aerial Survey team. This includes recruitment of a Level 7 Archaeological Specialist apprentice to undertake Historic England's aerial reconnaissance programme in the north of England.

Local session

Michael Doneus, Nives Doneus and Dave Cowley	Spatio-Temporal Interpretation of a Dry Stone Walled Landscape on the Island of Cres (Croatia) Using Digital Feature Models from Airborne Laser Scanning
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Dry stone walls are a worldwide phenomenon that may shape entire regions. As a specific form of vernacular agro-pastoral practice, they are expressions of the culture and history of a region. Dry stone walls have recently received increased attention in Croatia, primarily due to research in landscape architecture and (historical) geography, though archaeological research on such remains is rare in part due to the challenges of undertaking such work in areas covered by dense evergreen maquis vegetation. Under such environmental conditions, Airborne Laser Scanning (ALS) based digital feature models are the only possibility for large scale documentation. The presentation will demonstrate the complexity of such systems using a case study from the Mediterranean region of Punta Križa, Croatia. Our spatio-temporal interpretation within the framework of GIS and a Harris Matrix reveals a wealth of information on a complex sequence of human activity.

Ninon Basuau and Gaetano Benčić	Communication infrastructures and Roman cadastral system: new insights into the agrarian structure of the Parentium colony (Istria, Croatia)
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Following the deduction of the colonies of *Parentium* and *Pola* in the mid-1st century BC, the landscape of the Istrian peninsula is transformed by an intensive Romanization, mainly characterized by the rise of large agricultural estates and the development of speculative agriculture focused on oil production for export. Ranging from small farms to large *villae*, more than 300 ancient settlements are known on the territory of both colonies (Matijašić 1994; Bulić 2014). In addition, the *agri* of both colonies were the subject of a single and large-scale *limitatio* operation, covering some 1,200 km² and using the classic orthogonal 20 x 20 *actus* centuriation grid. Its "petrification" in the landscape has attracted the attention of researchers since the 19th century (P. Kandler, R. Chevallier, J. Bradford). Recent research has proposed new approaches, combining remote sensing and field verification of structures (Popović et al. 2021).

For the *ager* of *Parentium*, a wealth of documentation from ancient excavations, epigraphic collections, rescue surveys and international programmed excavations, including underwater operations along the coast, has enabled us to build up a detailed knowledge of the distribution and organization of ancient settlements (Benčić 2006 ; Carre, Kovačić, Tassaux 2011). This research has shown that the relationship with the coast is deeply structuring in the morphology of landscapes, and that the location of settlements in the territory is closely correlated with both land and sea traffic (Bulić 2012 ; Marchiori 2013). In 2018, LiDAR data were acquired on the territory of the Tar-Vabriga municipality, which corresponds to the most northerly sector of the colony, today heavily forested and therefore less documented from the point of view of centuriation (sector between Poreč and the Mirna).

The aim of this paper is to describe the first results of the analysis of this data, with a focus on the study of the Roman cadastral system and the communication infrastructures (road network and harbour structures). This work, which is based on a solid collaboration between the *Zavičajni muzej Poreštine* and the *Centre Camille Jullian* and is supported by the *École française de Rome* (VILLAEADRI program) and the *Ministère de l'Europe et des Affaires étrangères* (ISTRIE mission, 2019-2023), is part of a PhD research project. Its aim will be to study the use of the land in ancient times (distribution of settlements, exploitation of natural resources, land development) and the long-term changes of this coastal landscape.

ABSTRACTS – DAY 2

Around the world in one session

Antonio J. Ortiz Villarejo, José Miguel Delgado Barrado, José Manuel Valderrama Zafra, Gianluca Casagrande and Juan Manuel Castillo	Drone-made orthophotogrammetry, 3D reconstructions, LiDAR, and historical cartography applied to the study of foundation of the "New Populations" in the late 18th century Sierra Morena region, Andalusia
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Nowadays, in the south of Spain, an I+D+I research project called "The Project of the New Populations of Sierra Morena and Andalusia in a European and Comparative Context: Ideas, Reforms, and Projection (1741-1835) (ProSiMo)" is being carried out with funding from the Spanish Ministry of Science and Innovation. The project aims to understand the process of the formation and exploitation of the Sierra Morena region in the late 18th century through the foundation of the so-called "Nuevas Poblaciones" (new population). To achieve this, the project uses a variety of aerial imagery tools such as drone-made photogrammetry, Lidar data analysis, 3D reconstructions, and historic cartography fused in a GIS environment, as well as historical texts. The main goal of this proposal is to explain the methodology developed within the framework of the ProSiMo project and to analyze the advantages and disadvantages of each technique used. It will also showcase some of the results and conclusions obtained during the development of the project.

Jo Sindre P. Eidshaug , Ole Risbøl, Hein B. Bjerck, Magnar M. Gran, Kristoffer R. Rantala, Angélica M. Tivoli and A. Francisco J. Zangrando	Shell middens, Mesolithic house pits, and supra-regional settlement patterns: Breaking new grounds with UAV LiDAR in the high latitude coastal environments of Tierra del Fuego, Argentina and Vega, Northern Norway
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Despite more than twenty years of LiDAR in archaeology, there are still regions where LiDAR has not been employed and landscape types where relatively few such studies have been carried out, like in coastal environments. Moreover, the use of LiDAR has been biased with regard to chronology and feature category. In Europe, LiDAR has mainly been used to map and study archaeological monuments and features from the Iron and Middle Ages. In 2022, the Norwegian-Argentinean research cooperation Marine Ventures carried out UAV LiDAR surveys in high latitude coastal environments located in both hemispheres. It comprised two case study areas: (1) on the northern coast of the Beagle Channel we carried out a pioneering LiDAR survey of shell middens (c. 7500–recent) in Tierra del Fuego, Argentina, and (2) on the island Vega, Northern Norway, we carried out one of the first studies that used LiDAR to identify Mesolithic house pits (c. 9,500–6,000 BP). We present the results from a comparison of the UAV LiDAR surveys and previous field surveys from both areas. The survey in Tierra del Fuego further served as a point of departure for a supra-regional study of settlement patterns and landscape use along the middle part of the Beagle Channel. Such studies have proved difficult to carry out due to logistical challenges pertaining to the rugged coastal environment, its remote archipelagic location, and the fact that the Beagle Channel is shared between Argentina and Chile. Since we only have LiDAR data from a minor part of the Beagle Channel, we compared the level of information gained from our ground survey (2009–2013), our UAV LiDAR survey (2022), and open satellite data, to assess the applicability of each of these levels. The purpose was to examine if we can

be confident that satellite data provide sufficient information to carry out a supra-regional analysis of coastal settlement patterns in that area. Using satellite data from both Argentina and Chile, we finally present some preliminary results from the study of settlement patterns and landscape use along the Beagle Channel.

In conclusion, the UAV LiDAR surveys conducted in both regions showed encouraging results. While highly applicable for studying the visible shell middens in Tierra del Fuego, the methodology proved surprisingly well for identifying Mesolithic house pits on Vega.

Pavel Dmitriev	Submerged landscapes: remote sensing data interpretation and changes in the spatial organisation of East Siberian villages
<p>The cultural landscape of the rural areas of the Angara Basin (Eastern Siberia) is very complex. According to modern knowledge, the planned colonisation of this area was carried out by the Russian Empire from the 17th/18th centuries. The end of the functioning of rural landscapes (their almost total destruction) was connected with the construction of the Bratsk Dam and the complex of water reservoirs on the Angara and its tributaries in the 1960s.</p> <p>Initially, the rural spatial organisation, development and exploitation of the surrounding resources depended directly on the socio-economic model of colonisation developed in the Russian Empire. The "original" rural spatial organisation was characterised by such features as: location along the transport route (the Angara River), compactness and defensive capability of the buildings, dominance of private property (family farms). The introduction of the Bolshevik ideology in the first half of the 20th century and the associated collective farm system led to significant changes. An important element was the emergence of facilities for joint management of assets and resources.</p> <p>The main aim of this work is to answer the question whether and how remote sensing data can help identify the process of change in the rural landscape. I will present considerations on this problem using the example of a complex of villages in the area of the current Bratsk Dam (Matierikowaya, Moskowskaya, Antonowa, Burnino). In my research, I will use: 1) historical and contemporary cartographic data showing the spatial structure of the villages before the construction of the dam, 2) Corona and Hexagon satellite imagery from the 1960s and 1970s as the main source for the analysis of the destroyed villages, and 3) currently available satellite images allowing to determine the dynamics and nature of spatial changes. A special case in the considerations is the village of Burnino, which was situated on the high bank of the Angara and was the only one that was not flooded by the waters of the Bratsk Reservoir. In this case, modern satellite imagery plays a special role and opens up new perspectives for interpreting spatial systems of already destroyed villages. In the search for an answer to the question posed and in the interpretation of satellite imagery, ethnographic and historical sources are also important, allowing to trace the social changes that caused the physical transformation of the rural landscape.</p> <p>The proposed study will contribute to the understanding of the impact of the socio-political processes of the Russian Empire and the USSR on the rural landscape.</p>	

Zoltán Czajlik, László Rupnik and Péter Ódor	Aerial archaeology of Hallstatt necropolises in Hungary. New results by using different platforms
<p>The aerial archaeological research of Early Iron Age tumulus fields dates back to the period between the two world wars in Hungary. We have aerial photographs both of the mounds of Szalacska and Százhalombatta from this period. The latter site is also unique because its second topographic survey, published in 1986, was based on an archival aerial photograph. Due to its proximity to the Budapest</p>	

airports, the first images of the 1993 Hungarian-French aerial archaeological program were taken of the tumulus field of Százhalombatta and the Iron Age fortified settlement.

Our systematic research was started in the 2000s as part of larger aerial archaeological topography projects. For a long time, we tried to take advantage of the early summer periods, mainly in line with the ripening of the winter wheat. For long-known sites such as Százhalombatta, Süttő, Sopron, Szalacska, Győrújbarát and Zalaszentő, phenomena related to previously unknown or perished tumuli (encircling ditch and / or body of the mound, in some cases the remains of the burial chamber) were observed. Documentation of previously not or little known Hallstatt age burials / necropolises was successful mainly in the Little Hungarian Plain, but also in some other regions in Transdanubia.

In recent years, major changes were put into effect in the methodology of aerial archaeological photography. Thanks to GPS-based digital map navigation, we can perform high-precision flights that allows capturing uncertainly identifiable mounds not only during periods more favourable for crop marks, but also outside of the vegetation period. We discovered a lot of new marks thanks to the satellite imagery and the systematic orthophoto-monitoring of Hungary (MePAR), on behalf of the European agricultural supporting system. This does not always result in the observation of previously unknown tumuli or parts thereof, but the vegetation marks or blurred soil signals can help to identify areas suitable for geophysical research and / or field walking survey. Archaeological aerial photography has not reached its limits in the research of these necropolises, but provides more and more information for further field research.

César Parcero-Oubiña and David González-Álvarez

The changing face of Iron Age “castros” thanks to new remote sensing findings

At the online 2021 AARG meeting, one of us (CP-O) presented a paper with the promising results of a preliminary exploration of the potential of aerial and satellite imagery, combined with Lidar, for detecting archaeological traces around Iron Age hillforts (castros) in the challenging Atlantic landscapes of Galicia (NW Iberia). A formal project followed that initial attempt, aimed at a more systematic analysis to be developed in a wider area, also comprising case studies in Asturias. This on-going investigation is supported by a larger team and by additional fieldwork stages, including the use of UAVs equipped with different sensors and ground geophysics. After the first months, a significant number of new potential archaeological traces have been identified, including some new sites. Traditionally, most of these castros have been described as small, simple and relatively isolated settlements, belonging to self-sufficient communities completely bounded by the limits of the walls. Settlement architecture would be guided by practical efficiency, with little capacity to invest beyond the functional at least until later periods, under Roman domain. However, these new findings are showing that, in many cases, site architecture was more complex than that. In particular, we will focus on examples of sites with traces of elaborated defended entrances, that can be interpreted as the result of the investment of recurrent social work consumed in the construction of monumental displays aimed to extend the monumentality of the sites to a wider landscape experience.

Martin Gussone, Martin Fowler and Agnes Schneider

Settlement research in al-Hira, Iraq using declassified HEXAGON satellite imagery

The late Antique and early Islamic site of al-Hira, Iraq is located on the west bank of the Euphrates river, south of the present cities Najaf and Kufa. Al-Hira was founded in the 3rd century AD. Following its demise in the 10th century, the site remained mainly undisturbed by building activities until the 1970's/1980's. Since then, the dramatic increase of urban development of the region with housing,

large infrastructure projects and industrial estates caused a substantial loss of the historic settlement, whose original extent is largely unknown to-date.

To investigate al-Hira, the "Hira Survey Project" reassessed (between 2015 and 2018) previous archaeological research and applied different methodological approaches to locate the settlement of al-Ḥīra: field walking, documentation of surface features, UAV surveys and magnetometer prospection.

The present project "Processes of urbanistic transformation in al-Hira" (DFG funded 2021–2025) continues – besides targeted excavations at selected locations to build a stratigraphically assisted chronology – the documentation of surface features and expanded the magnetometer prospection to the South of al-Ḥīra to better understand the structure of the settlement and its architecture as well as its position in the regional and supra-regional context.

Expanding the methodological repertoire with the use of HEXAGON panoramic camera satellite imagery, the aim of the "Hira settlement research with declassified HEXAGON Imagery" subproject is to unravel the palimpsest landscape that holds the key to trace the original extent of the historical settlement of al-Ḥīra (purchase of image scans funded by the AARG Fund). In this talk the first preliminary results of the project are presented, with focus on how to choose the relevant images, how to cope with low spatial resolution and different distortions in the same image for an appropriate georeferencing and how to identify archaeologically relevant features.

Lenka Starková	Dark modernities in Iraqi Kurdistan: pre- and post-Anfal settlement pattern of rural areas
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The Anfal genocide perpetrated by Saddam Hussein government in 1988 represents one of the most important events in the recent history of Iraqi Kurdistan. This topic is still very sensitive for the majority of local people; on the other hand, it needs to be studied as part of a modern social transformation of the Iraqi agricultural landscape. The massive depopulation and continuous destruction of the villages in the rural hinterland of Koya Province was the beginning of a whole complex of changes in the built environment of the villages and the morphology of their hinterland. The paper will present the multi-disciplinary approach of archaeological, anthropological and multi-temporal GIS research of selected sites (destroyed villages) in the hinterland of city of Koya. The primary methodology is based on the processing of timeline maps using KH-9 Hexagon satellite imagery. The re-settlement of the destroyed sites, changes in the land use, and the transition to the standards of the modern housing is viewed as part of the transformation of the agricultural landscape in Iraqi Kurdistan. The historical villages represent a specific category of cultural heritage. It is necessary to develop a proper methodology for the documentation and to open the question of the possible protection and preservation the evidence of such significant and extremely sensitive events for future generations.

Marisa Lazzari, Adrian Oyaneder and Ioana Oltean	Andean landscape legacies: multi-analytical remote-sensing mapping and assessment of long-term settlement and land use for sustainable futures in NW Argentina
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The south-central Andes region provides an exceptional record of combined high-altitude settlement with the circulation of humans, goods, animals, and plants, which offers a unique opportunity to learn about ancient solutions to the challenges of life in high-altitude environments. Previous archaeological research in the Aconquija Sierra (NW Argentina, South-Central Andes) identified the key elements of the landscape character of the region and its evolution: from scattered village/farm settlement pattern of the Formative period (ca 1200BC-1000) to expansive productive areas of the transition to

the Late Period (AD1000-1436), and the subsequent strategic presence of the Inkas (AD 1436-1536). These maintained a relative architectural uniformity, as primarily conformed by irregular-shaped dry stone-walled structures of various sizes, once used as houses, corrals and cultivation fields. Building on previous work, our paper presents the results of the first comprehensive mapping of archaeological features present on the western slopes of the Aconquijas using interpreter-led assessment of commercial and freely accessible satellite imagery and DSM data. This allowed us to build a model of settlement aggregation patterns and connectivity throughout the region, bring a new perspective to current Andean and upland landscape research worldwide, and highlight the significance of ancient indigenous practices for the sustainability of vulnerable upland landscapes.

Grzegorz Kiarszys	Totalitarianism, fossil fuels and slave labour. The bombscape of HydrierwerkePölitz AG
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This paper presents a case study of the WW2 bombscape of the German synthetic fuel plant HydrierwerkePölitz AG. It is based on the interpretations of intelligence aerial photographs taken by the Eighth Air Force and the Royal Air Force, analysis of airborne laser scanning, fieldwalking as well as various historical sources and reports of eyewitnesses. The synthetic fuel plant was situated in the vicinity of the towns Pölitz and Stettin (Police and Szczecin in contemporary north-western Poland). From the present perspective, it is an especially intriguing example of a place designed as a practical implementation of the goals defined within Nazi ideology. In a relatively limited space existed an industrial plant created with the sole purpose in mind of powering the German war machine. The facility was surrounded by numerous labour camps as its working force consisted mainly of slave labourers forcibly drawn from the occupied territories. The surrounding rural landscape was heavily militarized, with ubiquitous anti-aircraft artillery emplacements, barrage balloons, shelters, and trenches. The holistic picture of this place completes with ruined civilian buildings, destroyed industrial installations, countless bomb craters and a devastated natural environment. The bombscape of HydrierwerkePölitz AG can be considered a true testimony of the totalitarian regime and how it ends. Its relics can be still registered with archaeological prospection methods, helping to narrate and expose the terror of National Socialism.

Alison Deegan	Contrary Scunthorpe –the Industrial Garden Town
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Scunthorpe is a town in north Lincolnshire, a predominantly rural area of England. The town lies just to the south of the Humber Estuary and east of the River Trent. In the early 19th century Scunthorpe was a small farming settlement; by the end of the century it was a significant centre for steel production. The discovery of local iron ores prompted this metamorphosis, and these ores were mined in great swathes that cut across what had been sandy heath and fields. Since the late 18th century landowners in the neighbouring Trent Valley had been making their own mark on the landscape. Deliberate and controlled alluviation, a process known as warping, gradually raised the ground level by many metres to improve drainage and fertility. This process required the construction of enormous earthwork ditches and banks, and then, when the process was complete, their destruction. Historical and recent air photos and lidar imagery reveals much about these two contrasting processes: they can show where tangible remains are likely to survive, and their impact on the survival and visibility of earlier landscapes. This paper will draw on the results of the Scunthorpe Air Photo and LiDAR Mapping Project, which is funded by Historic England.

Technical session

<p>Ole Risbøl, Wouter Verschoof-van der Vaart and Karsten Lambers</p>	<p>A bio-economic study of proto-industrial wood tar production in Mid-Norway by the use of LiDARdata and Deep Learning</p>
<p>The history of wood tar production in Norway goes back to the early Iron Age, but only few examples of production sites are known prior to the Middle Ages (ca. AD 1000). Tar was mainly used for the preservation of boats and buildings (especially wooden churches), although all kinds of utensils and equipment could be tarred to extend their lasting. From the Middle Ages until modern times, the common way to produce tar was in kilns built on flat or sloping, forested terrain. During the production process the tar was led off the kiln horizontally through a drainpipe into barrels. A unique mode of producing tar—and which is in focus in this study—is found in Mid-Norway where a large number of tar pits are found in mires. The placement in mires and the way the production sites were constructed, differs substantially from the customary ones on dry land. The divergence is not confined to their placement in a wet environment, but also in the way the tar was extracted during the process, by letting it run down into a water filled pit beneath a wooden platform on top of which the production took place. This way of producing tar has its roots in the early Middle Ages but increased to large-scale production in this region from the late 16th century and went on for 200–300 years. The large-scale tar production in this period can be linked to extensive timber production and trade in this region, but compared to the latter, tar production has not been studied in detail so far. In this paper we present the results from a study of the spatial distribution and number of proto-industrial tar production pits in Mid-Norway and how their extent can inform about its societal significance. To achieve this, we combined information from cultural heritage databases with LiDAR data and Deep Learning. The outcome of the remote sensing approach constituted the basis for quantifying the total amount of produced tar. This was by no means a straightforward exercise. Consequently, in order to put the figures into context, we consulted written sources and archival data holding factual information about contemporary local tar consumption and external tar trade as a means of comparison. The combined use of remote sensing and written sources has led to an increased understanding of the economical and societal significance of a long-lasting and large-scale tar production in the studied region and time period.</p>	

<p>Mihai Niculita</p>	<p>Deep Learning identification of tumuli from LiDAR DEMs at regional scale</p>
<p>Archaeological topography identification from high-resolution DEMs is a method successfully used in archaeological prospecting of wide areas. The preliminary results are based on a methodology through which burial mounds (tumuli) from LiDAR DEM scan be identified. This methodology uses geomorphometric and AI statistical methods to identify accurate burial mound candidates. Peaks, defined as local elevation maxima, are found as a first step. In the second step, local convexity watershed segments and their seeds are compared with the positions of local peaks, and the peaks that correspond to or have in the vicinity of local convexity segments' seeds are selected. The local convexity segments corresponding to these selected peaks are further fed to a Deep Learning ANN algorithm with shape descriptors and descriptive statistics of geomorphometric variables to build a model for the classification. Multiple approaches were tested to tune and select the proper training dataset, settings, and variables. The validation of the model was performed on the full dataset where the training was performed and on an external dataset in order to test the usability of the method for</p>	

other areas in a similar geomorphological and archaeological setting. The validation was performed by comparing manually mapped and field-checked burial mounds from two neighbour study areas of 100 km² each. The results show that on both datasets, the accuracy is 100%. The method shows great promise to be used for burial mound detection in wider areas by delineating a certain number of tumuli mounds for model training. The method was applied to the whole North-eastern Romania (18 000 sq km), and the resulting inventory of burial mounds was presented to archaeologists and national authorities and is currently under validation.

<p>Žiga Kokalj, Nejc Čož, Anthony Corns, Susan Curran, Dragi Kocev, Ana Kostovska, Ivica Dimitrovski, Steve Davis, John O’Keeffe and Robert Shaw</p>	<p>ADAF – a user-friendly tool for Automatic Detection of Archaeological Features</p>
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The need to use machine learning (ML) in archaeology is constantly increasing with the rapid development of image analysis techniques and the increasing availability of high-quality airborne laser scanning data (ALS, lidar). The tool for Automatic Detection of Archaeological Features (ADAF) has been developed to provide user-friendly software that uses ML models (in particular convolutional neural networks) to enable the automatic detection of archaeological features from ALS data. The software requires minimal interaction and no prior user knowledge of ML techniques, greatly improving its accessibility to the archaeological community. The underlying ML models have been trained on an extensive archive of ALS datasets in Ireland, labelled by experts with three types of archaeological features (enclosures, ringforts, barrows). The core components of the tool are the Relief Visualisation Toolbox (RVT) and the Artificial Intelligence Toolbox for Earth Observation (AiTLAS), both of which are actively used in the field of aerial archaeology. RVT is indispensable for processing input data (for training and inference) by converting digital elevation models into ML-friendly visualisations, while AiTLAS provides access to the ML models. We have conducted a series of experiments with different visualisation methods and different ML architectures for object detection and semantic segmentation to find the optimal configurations for the software.

<p>Maria Elena Castiello, Juergen Landauer, Thibault Saintenoy and César Gonzalez-Perez</p>	<p>Pre-Hispanic landscape occupation in Chilean Andes. A Remote Sensing and Deep-Learning coupled approach</p>
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During the late pre-Hispanic times (fifteenth to sixteenth centuries AD), the western Andean slopes of 18°S have seen the development of a complex settlement system, extending between the altiplano of Caranga and the coast of Arica. In particular, the Arica highlands (located between 3000 and 4000 m. a.s.l.) seem characterized by an architectural homogeneity of stone structures, such as large housing complexes associated with corrals, terraces and small structures, generally located at high altitude, with perimeter walls, which is why they are sometimes described as “pucarás” and have been identified with the living signs of an imperial agricultural landscape. However, due to the region’s difficult terrain, traditional archaeological surveys and post-processing works are more labor-intensive here. Extensive surveys are rather an exception and the manual check of the available satellite data for the area, although already approached with good results, is, as well, time-consuming and expensive. Thus we still miss a comprehensive and more extensive overview of the socio-spatial configuration of the Arica Highlands in the Pre-Hispanic times. Aiming to face such challenges, this study outlines a workflow method based on Artificial Intelligence technologies such as Convolutional Neural Networks to speed up and automate the detection of

unknown, complex archaeological objects based on high resolution satellite images (WorldView2, Pleiades). A systematic procedure, that combines Remote Sensing, with a rich geospatial archaeological survey database, and a Convolutional Neural Network algorithm has been developed and trained on the Azapa upper basin, an area of ca. 21x10 km². It has been then tested on the extended Altos de Arica region (ca. 1000 km²), which helped to strengthen the algorithm results and to identify and reconstruct the pre-Hispanic settlements occupation over the entire study area. The results obtained, as an accurate probability map for anthropic, stone signatures across an area that covers ca. 1000 km², have been evaluated, compared to previous field survey data, and discussed in relation to the general interpretations concerning the trajectories of human occupation in the study region. Remote sensing combined with Deep Learning can provide an effective way to expand investigation areas and detect new sites in areas difficult to access, as the Chilean Andes, with an unprecedented level of detail, that has at the same time, major implications for understanding the archaeological significance of less explored and marginalized regions.

Poster session

Adrian Șerbănescu	Surveying Rural Roman Settlements in areas with intense agricultural activity
<p>Modern province of Dobruja (South-East Romania today) is a region with rich historical background that flourished during the Greek and Roman periods. The catalyst behind it is the foundation of three Greek colonies during the 7th-6th century B.C. – Histria, Kallatis and Tomis. More followed during the subsequent centuries. Starting with the 1st century B.C. Roman influence in the region grows and the area between the Danube, Black Sea and Danube Delta is incorporated in the Roman Empire during the next 200 years as part of Moesia Inferior and later becomes Scythia Minor.</p> <p>Within this context, the presentation focuses on the changes that occur in the rural landscape of Histria with the annexation of the region in the Roman Empire. In the Histrian territory, along with the already-existing chora, a new administrative unit appears: regio Histriae and new rural settlements are established. Starting with 2020, we have surveyed using geophysics three such settlements identified prior through field-walking (Panduru, Beidaud and Ceamurlia de Sus).</p> <p>We will be looking at the freely available aerial images and compare them to geophysical data and assess the current situation and information that can be inferred about the landscape and the changes that occurred during the first centuries after the Roman annexation of the region.</p> <p>Two of the surveyed sites (Panduru and Ceamurlia de Sus) are situated in areas heavily affected by modern agriculture, especially mechanical activities involved in cultivating crops. The third site (Beidaud) is situated further inland, on a higher plateau (Casimcea) and, due to the geographical setting, was used throughout history mostly as grazing land for sheep and goats. Thus, comparing the geomagnetic and GPR data collected on all three sites provides a clearer picture of the conservation state of each site. While identifying the sites on aerial image data sets can sometimes offer information on size and possible structures, and geomagnetic surveys gives an idea where clusters of anomalies from said structures as well as possible new ones are located, the actual footprint and conservation state needs further investigations using GPR/ERT and even old fashioned Earth Resistance.</p>	

Martin Gussone and Agnes Schneider	Investigations in Late-Antique and Early-Islamic al-Hira, Iraq. Past, Present and Future
<p>The late antique and early Islamic al-Hira, close to the present cities of Najaf and Kufa in southern Iraq is an important archaeological site. Its investigation is a collaboration of the German Archaeological Institute, Technische Universität Berlin, Museum for Islamic Art Berlin and the Iraqi State Board of Antiquities and Heritage as local partner. The field surveys to identify the location and to estimate the extent of the presumed settlement of al-Hira were complemented by large-scale UAV and magnetometer surveys (2015 to 2018).</p> <p>During the field seasons 2021 to 2023 the documentation of building structures continued with the combination of the magnetometer prospection with the results of the UAV surveys. Magnetic susceptibility mapping has been added to the toolset to increase the understanding of the magnetometer data. The development of a reproducible semi-automated workflow for its classification is in progress.</p> <p>An important addition to the understanding of the site and the structure of the historical settlement is the analysis of legacy remote sensing data. Currently the evaluation of previous aerial and satellite imagery is in progress (Corona, GeoEye, and local overflights from the 1970s). The recently acquired Hexagon images (courtesy of the AARG Fund) are providing groundbreaking insights into the structure and extent of areas of al-Hira, which are lost due to the expansion of modern settlement, infrastructure development and waste disposal.</p> <p>Combining legacy data of the past, present remote sensing methods, traditional survey methods for ground verification and future semi-automated analysis approaches offer a panoramic view to unfold the urban landscape of the Late-Antique and Early-Islamic al-Hira.</p>	

Nives Doneus and Martina Blečić Kavur	City of Osor in the matrix of long-distance maritime routes
<p>The project focuses on the Iron and Roman Age town of Osor at the meeting-point of northern Adriatic islands Cres and Lošinj, Croatia. The role as a maritime node since the Iron Age emerges from spectacular finds, as these include a whole range of goods originating from the Pannonian Plain to Greece. 100 years of tradition also produced numerous interpretations, although hardly any details are known about the coastal setting and the navigability around the city.</p> <p>Therefore, the project addresses the question of whether the maritime role of the city, as indicated by trade goods, can be supported by its landscape context. Not only the procurement of trade wares but also the city layout and the use/change of the surrounding landscape bear witness to how the city sustained itself in the maritime world of prehistory and the Roman period. The project will develop a combined approach that can do justice to the cultural, landscape and marine aspects of the site across the border between the land and the sea. Provenance studies are the starting point for analyses of the material evidence of the trade and related “visibility” of Osor on maritime routes. The backbone of the landscape-based approach is the use of airborne laser scanning, airborne laser bathymetry, terrestrial and underwater geophysical prospection and geoarchaeological research for data acquisition behind vegetation, sediments and seawater. New results will provide detailed evidence of the coastal and marine conditions that would have affected the navigation and allow for a fact-based discussion of the extent to which human intervention in the landscape was needed to support Osor's role in the region. Finally, provenance analyses of traded goods will place the city of Osor in the matrix of regional and transregional maritime networks.</p>	

Klara Hanakova	The Results of ALS Propection in the West Part of the Ore Mountains
<p>This poster will introduce the results, which were acquired on the basis of my master's thesis. Part of the thesis dealt with the analysis of Airborne Laser Scanning data with the aim of discovering medieval or post-medieval surface relicts in the western part of the Ore Mountains. Through the remote sensing propection, many convex and concave relicts were found, interpreted as charcoal kilns, deserted settlements (single houses and even whole villages), mining areas, etc.</p>	

Simon Seyfried	New approaches in crop-mark-ology? Adding automation and advanced statistical visualisations to the workflow of the AARG-SEN2workgroup for the purpose of predicting the appearance of crop marks
<p>As a member of the AARG-Sentinel2 working group with a keen interest in geospatial computing and remote sensing, I am looking at ways to automate this process. Only freely available data and software will be used, and in the medium term the project should be accessible to everyone as an open source/open access project. Furthermore, statistical visualisation possibilities are to be presented, which are to enable the condition of the crops with regard to the occurrence of crop marks. The programming language R will be used with the help of various packages. The aim of this submission is to give an overview of the work done so far, the functionality and the possibilities for further development. This automation project, just like the basic idea of the "AARG-Sen2 working group", should contribute to more efficient aerial archaeological flights by identifying regions and time by means of sentinel satellite images that show crop marks with a high probability. This theoretical method will be illustrated in 2023 in different regions in Germany by means of self-collected aerial archaeological images of different sites in different crops.</p>	

Tomáš Kroupa	North-western Brdy Mountains (the Czech Republic): The Landscape of Charcoal and Holloways
<p>The poster deals with the topic of non-destructive archaeological survey of north-western Brdy Mountains in the Czech Republic. The main method used for this kind of landscape research was the propection of LiDAR data. This allowed the detection of many old holloway roads and relicts of so-called „forest industries“ – mainly charcoal making. The high densities of charcoal burning platforms and old roads and paths documents well the industrial use of the examined landscape around the settlements with iron smelting and metalworking history.</p>	