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Session 5: Posters

The Chalcolithic Paradox of Southern Wallachia

Combined non-invasive techniques for the documentation of cultivation structures in the arid Atacama area (N. Chile)

The potential use of remote sensing applications in Ancient Anaktorion in Western Greece

Further Archaeological Survey on the Hill of Slane, Co. Meath, Ireland

Aerial photography and ancient road networks in Roman Petelia

MATRICS: a toolbox for contrast enhancement of (aerial) photographs

Generating accessible 3D models from complex point cloud data of complex architectural heritage - a new processing pipeline

Can more simply be too much?

The BarrowValley? A review of small cropmark enclosures in south-east Ireland

Evaluating the utility of SfM-derived DEM for the survey of moated sites in Siem

First and Second World War military training landscapes on the Dorset coast: Bovington Camp and Lulworth Ranges

The road system in the Eastern territories during the 6th century reconstructed through the use of satellite images

Using photo3D in Hungarian archaeology

Application of remote sensing techniques in the Shubayqa area of Eastern Jordan

Change detection using airborne lidar and photogrammetry

Hidden Depths and Empty Spaces?

First World War Battles on the Roman Limes from Eastern Transylvania (Romania)

Understanding national discoveries from the 2013 drought

Generation of a 3D model from historic aerial photographs for the digital retrospection of the demolished Breginj

Venues

Conference Venue

Welcome Reception (co-hosted by AARG and ArcLand Europe)

Conference Dinner

AARG 2014 Excursion

Notes
Wednesday 24 September

**Location: Wood Quay Venue, Dublin**

**09:00 - 09:15** Registration

**09:15 - 09:45** AGM (Election of posts), VIPs & Opening of conference

**Session 1: Local Studies (Ireland)**

**09:45 - 10:10** Law Abiding Citizens? - Susan Curran

**10:10 - 10:35** Geophysical Survey in the Brú na Bóinne WHS - Conor Brady & Kevin Barton

**10:35 - 11:00** South Connemara Aerial Survey - Michael Gibbons

**11:00 - 11:20** Tea & Coffee

**11:20 - 11:45** Exploring the hidden depths of Tara’s hinterland: geophysical and landscape investigations in the Meath/north Dublin region - Ger Dowling

**11:45 - 12:10** Big Jobs for Big Data? Issues with the management and maintenance of high-volume research data in Irish archaeology - Mick Corcoran

**12:10 - 12:35** Flights of Discovery: and why we need more of them in Ireland! - Gill Barrett

**12:35 - 13:45** Lunch

**Session 2: Aerial data-to-knowledge 1: Patterns and Landscaping Processes**

**13:45 - 14:15** Pattern and process: aerial archaeology as new landscape archaeology? Dimitrij Mlekuz

**14:15 - 14:40** UAV Photogrammetry – the key to a turn in Icelandic burial archaeology? Gisli Palsson

**14:40 - 15:05** From field-work to...“air-work”: photogrammetric applications in Neolithic landscape reconstruction - Gianluca Cantoro et al.

**15:05 - 15:30** What we do with what we’ve got: (how) can we (and others) do more with our data? - Steve Davis

**15:30 - 15:50** Tea & Coffee

**15:50 - 16:15** The home front from above - understanding and protection of 20th century conflict landscapes in England - Helen Winton

**16:15 - 16:40** Sub-sylvania: the hidden archaeological landscape of the Orastie Mountains World Heritage Site (Romania) - Ioana A. Oltean & Bill Hanson

**Session 3: Public aerial archaeology**

**16:40 - 17:05** Kilberry, Co Meath, Ireland; Community Archaeology Above and Below - Kevin Barton and Justin Kenny

**17:05 - 17:30** Pick your heritage – archaeological work with public data sets - Martin Fera

Thursday 25 September

**Location: Wood Quay Venue, Dublin**

**09:00 - 09:15** Registration, Tea & Coffee

**Session 4: Aerial data-to-knowledge 2: From processes to landscape patterns**

**09:30 - 09:55** Automated detection of abandoned livestock enclosures in remotely sensed images of the Silvretta Alps - Karsten Lambers & Igor Zingman

**09:55 - 10:20** ARCTIS – A MATLAB® toolbox for archaeological imaging spectroscopy - Michael Doneus et al.

**10:20 - 10:45** Assessing archive stereo-aerial photographs for reconstructing archaeological earthworks - Heather Papworth et al.

**10:45 - 11:15** Tea & Coffee

**11:15 - 11:35** An improved approach to the recognition of standing remains - Aude Crozet, Rachel Opitz & Laure Nuninger

**11:35 - 12:00** NMP data in the EngLaID project - Chris Green

**Session 5: Posters (11:35 - 12:00)**

**12:30 - 13:45** Lunch

**Session 6: Innovative trends**

**13:45 - 14:15** Airborne magnetometer and cultural remains – preliminary results from a test and work in progress - Ole Risbøl & Michael Pregesbauer

**14:15 - 14:40** A workflow for (semi)-automatic extraction of roads and paths in forested areas from Airborne Laser Scan data - William Vletter

**14:40- 15:05** PostingNegatives: Evaluating the performance of digitalised aerial archival media in image-based modelling environments - Christopher Sevara

**15:05 - 15:20** Tea & Coffee

**Session 7: Detail and Scale of Aerial Survey Results and Analysis: a debate**

**15:20 - 15:50** Two decades of research and some spots on maps - Chris Cox

**15:50 - 16:20** Levels of survey – is detail an unhealthy obsession? - Dave Cowley

**16:20 - 17:20** Are we obsessed with detail? Or Do we do it because it is useful or because we are able to do it? - Rog Palmer

**17:20 - 17:30** Close of Conference & off to the bar!
Law Abiding Citizens?

Susan Curran
Irish Research Council (IRC)-Funded Postgraduate Scholar, UCD School of Archaeology, Newman Building, Belfield, Dublin, Ireland

Email: susan.curran@ucdconnect.ie

The surviving early medieval Irish law-texts offer a wealth of information about the economic basis of early medieval Irish society, much of which is supported by archaeological evidence (Kelly 2011, 3). Indeed, early medieval settlement archaeology “utterly dominates the record of excavations in Ireland” (O’Sullivan et al. 2010, 7), providing us with an abundance of material with which to work. However, recent years have seen both the emergence of new non-invasive techniques (e.g. LiDAR) and a rise in popularity of more well-known methods (geophysical survey). Taking a number of case studies from the glacial drumlin landscapes of counties Monaghan, Leitrim and Roscommon, this paper will discuss the application of these techniques and their implications for our understanding of the early medieval landscape. Excavation evidence puts the spotlight on individual sites but techniques such as LiDAR allow us to refocus our attention on small-scale settlement patterns, thereby enabling us to engage with early medieval Irish society at a more localised community level.

Session 1: Local Studies (Ireland)

Date & Time of Presentation: Wednesday 24 September, 09:45 - 10:10

Geophysical Survey in the Brú na Bóinne WHS

Conor Brady & Kevin Barton
Dundalk Institute of Technology, Ireland / Landscape and Geophysical Services, Ireland

The Brú na Bóinne WHS has been the site of numerous archaeological investigations over the last number of centuries. Various aerial remote sensing datasets now exist for the area including vertical and oblique aerial photography, LiDAR and satellite imagery. Parallel geophysical survey has taken place on the ground, especially in the last two decades. However, these surveys have been piecemeal and have also been of varying quality and are not integrated with other forms of landscape data for the area. They also have tended to focus on individual features or monuments rather than the wider landscape. The Brú na Bóinne WHS Research Framework document (Smyth 2009) has advocated consideration of large-scale blanket coverage of the Brú na Bóinne archaeological landscape with a range of appropriate sensing equipment in line with best international practice and similar to the work being undertaken at Stonehenge and the Orkney world heritage sites.

This paper presents an overview of legacy geophysical surveys carried out in the past and dwells on those carried out more recently. In particular, projects presented will include a multi-sensor survey in the vicinity of a possible Neolithic passage tomb known as Site E using the Geophysical Exploration Equipment Platform (GEEP), the geophysical investigation of a number of lithic scatter sites, and a geophysical investigations of the mound of Newgrange passage tomb. The case for strategic large-scale systematic geophysical survey of the Brú na Bóinne WHS will be presented alongside other potential applications of new remote sensing and geophysical techniques.

Session 1: Local Studies (Ireland)

Date & Time of Presentation: Wednesday 24 September, 10:10 - 10:35
South Connemara Aerial Survey

Michael Gibbons, Ireland

Over the course of 2013 a limited aerial survey programme was carried out of Ceantar na n'Oileáin and South Connemara (Connamara Theas). The aircraft were provided by the Irish Air Corps at the request of Muintreas. The purpose of the programme was to document the limited number of known archaeological sites and to clarify and document the nature of archaeology of the intertidal zone within the survey area. The project forms part of a larger field and aerial-photographic based survey of the intertidal zone archaeology of County Galway from Killary Harbour to Blackhead being conducted by the author with the support of Muinntreas na n'Oileáin.

This region was one of the least studied on Ireland's West Coast with very few recorded monuments. The survey proved to be very worthwhile, particularly when viewed in conjunction with the results of the winter storms which revealed an array of Late Mesolithic, Neolithic and Bronze Age sites. The survey’s major finding was the sheer scale of the impact on the natural intertidal landscape since the mid-18th century, including the wholesale destruction of coastal peat-bogs and the natural foreshore. The human impact is emphasised by the discovery of a previously unsuspected number of vernacular micro-piers, slip- and cleared-ways as well as local fish traps and stone grids used for kelp farming. Among the larger monuments identified were a number of intertidal causeways and roadways. The early-Christian and Medieval Landscapes were also clarified over the course of the survey. The topographic setting of the area’s known monuments has now been more clearly recorded and a number of previously unlisted harbour features have been identified. Despite the limited nature of the survey, it proved a valuable exercise – the first in a very long time in which Air Corps assets have been used to forward the cause of archaeological research. In spite of the widespread availability of free satellite imagery online, specifically tailored aerial survey in association with field work still have a valuable role to play and oblique imagery continues to provide a valuable perspective missing from vertical satellite photography. The vagaries of tide and time can unite to leave much of an individual survey area covered and inaccessible to available satellite imagery whereas timed oblique photographic surveys have opened up an entire landscape surrounding over forty islands to our inspection.

Session 1: Local Studies (Ireland)
Date & Time of Presentation: Wednesday 24 September, 10:35 - 11:00

Exploring the hidden depths of Tara’s hinterland: geophysical and landscape investigations in the Meath/north Dublin region

Ger Dowling,
The Discovery Programme, Ireland
Email: gerdowling@discoveryprogramme.ie

This paper will explore how geophysical survey and remote sensing (satellite imagery and LiDAR), undertaken in conjunction with a broader program of landscape analysis, are contributing to a deeper understanding of late prehistoric focal centres and social organisation in the wider landscape of the Hill of Tara, Co. Meath. Arising out of the Discovery Programme’s ‘Late Iron Age and ‘Roman’ Ireland’ (LIARI) Project, the present investigations targeted a number of prominent hilltop sites in the Meath/north Dublin region that have long been suspected on the basis of archaeological, topographical and early documentary evidence to have been important ceremonial/political centres in the early centuries AD. Foremost among these are the Hill of Lloyd (Co. Meath), the location of a prehistoric enclosure overlooking the early monastic foundation at Kells; Faughan Hill (Co. Meath), the traditional burial place of Niall of the Nine Hostages; and Knockbrack (Co. Dublin), whose summit is crowned by a prehistoric burial mound and a massive, internally-ditched enclosure.

The discovery through this multi-disciplinary study of additional large-scale enclosures, burial monuments and other significant archaeological features serves to further corroborate the deep historical importance of these sites, and opens up new avenues for exploring such themes as social identity, landscape organisation and the ‘persistence of place’ in the wider ‘catchment’ of Tara.

Session 1: Aerial data-to-knowledge 2: From processes to landscape patterns
Date & Time of Presentation: Wednesday 24 September, 11:20 - 11:45
Big Jobs for Big Data? Issues with the management and maintenance of high-volume research data in Irish archaeology

Mick Corcoran
University College Dublin, Dublin, Ireland

The ever-increasing availability and accessibility of modern remote sensing survey techniques has been enthusiastically embraced by the heritage sector in Ireland. Developments in aerial and terrestrial laser scanning, satellite imaging and geophysical prospection, adopted early-on by initiatives such as the Discovery Programme, have been at the forefront of recent research programmes of varying scales from community projects, to post-graduate research to local authority heritage audits. Whether actively capturing or interrogating existing data, the exploitation of high-volume datasets has resulted in the production of archaeological information on a scale never before seen. However, this boom in information generation has not been adequately met by an appropriately-scaled response regarding the reporting, storing and management of archaeological data on behalf of institutions responsible for the maintenance of Ireland’s built heritage.

Using examples from contemporary programmes, and the author’s own research, this paper will provide an overview of the state of ‘big-data-archaeology’ in Ireland and the issues that may determine the success or failure of the current research boom. Has Irish archaeology fully embraced ‘big data’; in other words, to what extent do the four Vs - volume, velocity, veracity and variety – really apply? What are some of the current strategies adopted by heritage management organisations to create and curate information from high-volume datasets? What is the outlook for archaeological research in the light of an increasing data backlog; and what is required of the heritage sector in order to stay ahead of the curve? This paper will attempt to address these issues and more.

Session 1: Local Studies (Ireland)
Date & Time of Presentation: Wednesday 24 September, 11:45 - 12:10

Flights of Discovery: and why we need more of them in Ireland!

Gill Barrett
UK

A review of the results achieved from a programme of archaeological air survey in Ireland between 1989 & 2000, with particular emphasis on the discovery of c.900 previously unrecorded archaeological monuments recorded as cropmarks in the fertile arable areas bordering the river systems of the Barrow and Nore. Using examples from an air photographic archive of 9000 images, the value of aerial reconnaissance will be demonstrated at a variety of spatial scales, and a case made for further systematic air survey in Ireland.

Session 1: Local Studies (Ireland)
Date & Time of presentation: Wednesday 24 September, 12:10 - 12:35
Pattern and process: aerial archaeology as new landscape archaeology?

Dimitrij Mlekuz
University of Ljubljana and Institute for the protection of cultural heritage of Slovenia, Slovenia

Aerial archaeology played an important role in the development of landscape archaeology. It provided new perspective on landscape and tools (such as palimpsest) for engaging with archaeological landscapes.

However, after O.G.S. Crawford, aerial archaeology and landscape archaeology have parted ways. Theoretical developments in landscape archaeology, especially in 80s and 90s are characterised by discursive and interpretative approaches, treating landscape as a cultural construct and based on ideas of (human) agency, subjectivity, perception and knowledge. Aerial archaeology has been critiqued as observing landscape from elevated position and turning it into a spectacle rather than regard it as an arena for human action, making human beings ant-like figures in the background.

I want to argue we should turn this critique into strength. By building upon the strengths of aerial archaeology – observing from distance, ability to see large scale patterns - we can tackle landscape as an emergent process. Landscape is not a design but has morphogenetic capacities of its own. Landscape pattern can be seen as a growth process, where complex novel and coherent structures, patterns and properties arise during the process of self-organization.

This perspective aligns with the recent developments in philosophy and with social sciences loosely grouped under term post-humanism. Is this an opportunity for aerial archaeology to play more active role in the shaping of discourse of landscape archaeology?

Session 2: Aerial data-to-knowledge 1: From processes to landscape patterns
Date & Time of presentation: Wednesday 24 September, 13:45 - 14:15

UAV Photogrammetry – the key to a turn in Icelandic burial archaeology?

Gísli Pálsson
The Institute of Archaeology, Iceland

Icelandic archaeology has had a strong focus on landscape from its origins in the 19th century, and Viking Age burial archaeology is no exception. Early work by Kristján Eldjárn on burial practices in the mid-20th century laid the groundwork for understanding burial location and perceptions of the ceremonial landscape between the late 9th century into the 11th century. More recently, work by Adolf Friðriksson and others has built on those foundations, providing hypotheses about site location that have been shown to work across several burial sites. These new approaches to Viking Age have undergone some testing by spatial analytical methods, but have not provided satisfactory results. The issue is the lack of detailed and extensive topographical information. This paper presents recent work on using UAV photogrammetry to revisit the spatial models of Icelandic pre-Christian burial practices, and argues that recent advancements in UAV technology offers a relatively widely available method of revitalizing spatial analysis in Icelandic pre-Christian burial archaeology.

Session 2: Aerial data-to-knowledge 1: patterns and landscaping processes
Date & Time of presentation: Wednesday 24 September, 14:15 - 14:40
From field-work to... “air-work”: photogrammetric applications in Neolithic landscape reconstruction

Gianluca Cantoro, Apostolos Sarris, Carmen Cuenca Garcia, Tuna Kalayci, François-Xavier Simon, Jamieson Donati, Meropi Manataki, Konstantinos Vouzaxakis, Vasso Rondiri, Polyxeni Arachoviti, Kaliopi Almatzi, Despina Efstatiou & Evangelia Stamolou

GC - University of Leiden, Netherlands

Aerial Remote Sensing has never been so popular, even from its lowest altitude perspective. The drones (or UAV, or UAS, or RPAS, or … whatever other name one may prefer) have made nowadays a definite impact in archaeological research. It is normally a low cost tool for low altitude aerial photography, regional surveys, excavation documentation, site identification and mapping, and 3D photogrammetry. So are we dealing with a flexible multi-purpose scalable tool in the toolbox of the archaeologist that will solve all his problems and satisfy all research needs. Or not?

The complete workflow of a low altitude photogrammetry application, in the framework of “IGEAN-Neolithic Thessaly” project, will highlight potentials and issues related to the use of unmanned platforms. The goal of the research project “Innovative Geophysical Approaches for the Study of Early Agricultural Villages of Neolithic Thessaly” which is implemented under the “ARISTEIA” Action of the “Operational Programme Education and Lifelong Learning” and is co-funded by the European Social Fund (ESF) and National Resources, is the development of methodologies for the registration and mapping of the specific Neolithic settlements through geomorphological and aerial remote sensing approaches. A preliminary campaign has been undertaken in selected number of Neolithic sites where different kind of systematic geophysical measurements were collected simultaneously with UAV photogrammetric sessions. The paper will focus in first results of the photogrammetric campaign, showing achieved goals, UAV performance assessment and lessons-learned during the low altitude aerial survey.

Session 2: Aerial data-to-knowledge 1: patterns and landscaping processes

What we do with what we’ve got: (how) can we (and others) do more with our data?

Steve Davis

UCD, Dublin, Ireland

From a position a decade ago when the main bottleneck in archaeological remote sensing was the acquisition and availability of data, we are now in a position where data are plentiful and often freely or cheaply available. There is effectively a data surplus. How has this impacted what we actually do with our data? While distribution maps are clearly important archaeological tools, how successful have we been at using our now plentiful data to move beyond mapping and into archaeological interpretation? Does our continued focus on bigger (i.e. more area; more ‘features’) and better (higher resolution) necessarily lead to the construction of ‘better’ archaeological narratives? It is intended that this paper leads to healthy discussion on how best to incorporate our data into mainstream archaeological interpretation rather than either an alternative to ‘traditional’ archaeological methods or a specialist appendix.

Session 2: Aerial data-to-knowledge 1: patterns and landscaping processes

Date & Time of Presentation: Wednesday 24 September, 15:05 - 15:30
The home front from above - understanding and protection of 20th century conflict landscapes in England

Helen Winton
English Heritage, UK

The two world wars saw the creation of the concept of the ‘home front’ in Britain with direct effects on most of the civilian population away from the main conflict zones abroad. By the end of the Second World War, the use of land for military purposes is thought to have peaked at about one fifth of the United Kingdom and the remains now constitute a major part of the historic fabric. This paper will explore the use of air photo evidence in the understanding and protection of 20th century military sites and landscapes. It will discuss issues such as assessment of the significance of hidden landscapes revealed as cropmarks, or the ‘lost’ landscapes recorded on historic aerial photographs, which place surviving elements into their original landscape context. Examples will be taken from English Heritage funded projects with an emphasis on work being developed for the First World War centenary.

Session 2: Aerial data-to-knowledge 1: patterns and landscaping processes
Date & Time of presentation: Wednesday 24 September, 15:50 - 16:15

Sub-sylvania: the hidden archaeological landscape of the Orastie Mountains World Heritage Site (Romania)

Ioana A. Oltean1 and Bill Hanson2
1.University of Exeter, 2. University of Glasgow

Built between the 1st C. BC and 1st C. AD, six Dacian fortresses in the Orastie Mountains lie at the core of the pre-Roman Dacian Kingdom famously conquered by the Roman emperor Trajan by AD 106. They were jointly granted UNESCO World Heritage status in 1999 because of ‘their unusual fusion of military and religious architectural techniques and concepts from the classical world and the late European Iron Age’ and their ‘extensive and well-preserved remains standing in spectacular natural surroundings’. The most complex and famous of the fortresses is located on the now heavily forested Gradistea Hill. Known since the early 19th C., this site has so far seen the most intensive excavation within its fortified enclosure and at various points in the extensive, terraced extramural settlement. Based on these investigations, the site now enjoys the largest protected area (17.83 hectares). However, evidence accumulated over the years indicates that ancient settlement spread over a considerably wider area. The deciduous forest, which almost totally covers the modern landscape, hindered data recovery through aerial reconnaissance by the authors between 1998 and 2004. However, the recent availability of LiDAR data extending over approximately 100 sq km now allows us to reconsider the true extent, nature and state of survival of both Dacian settlement and archaeological remains from the Roman conquest in the area of this famous site. This paper will present the new evidence for an extensive ancient settled landscape now hidden under the forests of Transylvania and will allude to some of the benefits and challenges this brings to the preservation of cultural heritage in Romania.

Session 2: Aerial data-to-knowledge 1: patterns and landscaping processes
Date & Time of Presentation: Wednesday 24 September, 16:15 - 16:40
Kilberry, Co Meath, Ireland; Community Archaeology Above and Below

Kevin Barton¹ & Justin Kenny²
1. Landscape & Geophysical Services, Ireland; 2. Kilberry Amenity & Heritage Group, Ireland

The Kilberry Amenity and Heritage Group (KAHG) are actively engaged in researching and presenting their local cultural heritage. Kilberry lies to the west of the Boyne Valley Complex of monuments, some 14 km WNW of Newgrange and 10 km WNW of the Hill of Slane. Like many places on the fringe of the presently defined limits of the Boyne Valley, the Kilberry area has attracted little interest from the academic community. The finding of a well preserved lithic of possible Mesolithic age whilst digging a grave coupled with existing local folklore on the discovery of a souterrain in the field adjacent to the graveyard created local interest in the history and archaeology of the area.

Contact from KAHG has led to a series of weekend training workshops involving ground geophysics to locate the souterrain, fieldwalking for lithics to assess the area around the graveyard, the community to purchase LiDAR data and fieldwalk LiDAR anomalies, involvement of a local pilot and aircraft for aerial photography of a number of targets in the area, a geophysical survey of a barrow and recently the first conference presentation of the work by a member of KAHG. The Group have recently been invited to represent Co Meath in the national ‘Pride of Place’ competition in July and will be running a local event on the work for National Heritage Week in August 2014.

KAHG is a good example of a ‘bottom up’ approach to public archaeology. The group initiated the project and want to carry out original work themselves via training workshops. Given the archaeological and geophysical licensing system in Ireland, there is very little hands-on community involvement in fieldwork with most local groups running lectures, field visits and publishing local studies journals.

Session 3: Public aerial archaeology

Pick your heritage – archaeological work with public data sets

Martin Fera
VIAS - University of Vienna, Austria

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More and more official and commercial web-services continue to provide high quality and high resolution data sets of various types to public: aerial imagery, historic maps and even shaded reliefs of ALS-data. While most of these are not produced, processed and presented with the purpose of being used for (archaeological) reconnaissance, many of them still inherit a lot of information for exactly that purpose.

This paper presents some results of the use of publicly available datasets for the purpose of archaeological prospection. It shows their use as additional sources in running research projects discussing some advantages and disadvantages for different areas, purposes and data types and providers. It investigates if public free datasets can be used as primary sources for large scale investigative projects and where there can be problems with these approaches. Furthermore their use as data providers for teaching purposes, also in regard to different licensing models, was investigated and can be shown exemplary with practical experiences from a course held at the University of Vienna.

Additionally future perspectives for the integration of a broader public are suggested and discussed, considering both the possible benefit of enhanced public awareness and the requirements for protection of buried cultural heritage.

Session 3: Public aerial archaeology

Date & Time of Presentation: Wednesday 24 September, 16:40 - 17:05

Date & Time of Presentation: Wednesday 24 September, 17:05 - 17:30
Automated detection of abandoned livestock enclosures in remotely sensed images of the Silvretta Alps

Karsten Lambers\textsuperscript{1} & Igor Zingman\textsuperscript{2}

1. University of Bamberg, Germany, 2. University of Konstanz, Germany

The automated detection of archaeological sites in remotely sensed data has recently become an important research topic due to the increasing availability of aerial and satellite images as well as ALS and radar data for archaeological research. To efficiently analyse large datasets, automated methods are required to perform routine tasks, such as screening large image data sets for known types of archaeological sites. However, available tools for the automated detection of modern buildings or roads usually fail to detect archaeological sites even if they are partially preserved above the ground. This is because they are often fragmented and of greatly varying size and shape, and the contrast to their surroundings is often very low due to the low height of ruined walls and the presence of random non-archaeological structures of similar spectral properties in their immediate surroundings.

In this paper we present a new approach to detect a specific category of archaeological sites in aerial and satellite images of the Silvretta Alps on the Swiss-Austrian border, at an altitude of 1500 to 2500 masl. A key aim of our research project in this area is to trace back the seasonal use of the alpine zone for pasture to its prehistoric origins. This requires an inventory of archaeological sites associated with alpine pastoralism, such as abandoned livestock enclosures. Our goal is to develop algorithms that allow a rapid screening of remotely sensed images for candidate sites of this type in order to guide and assist archaeological fieldwork in difficult terrain.

In order to be useful, our approach requires a high true-to-false detection ratio and needs to be computationally fast and easy to use. We base our approach on geometric cues of our target objects, which can be described as linear features meeting at approximately right angles. Since the target objects are located in open grassland, we first filter out wooded and urban areas based on their high texture contrast. We then extract linear features using morphological filtering. In order to identify groups of linear features that meet the geometric definition of our target objects, we define convexity and angle constraints that are used to assign a rectangularity measure to each group. This measure effectively expresses the likelihood of the group at hand corresponding to a target object. The result is a map indicating candidate locations of target objects in our study area and their corresponding likelihood values.

At the current state of our project, our approach yields good results even for incomplete instances of livestock enclosures, e.g. where walls are partially or completely missing. Additional work is required to reduce the number of false positives. Furthermore, we plan to test our approach on data sets from other mountainous areas with similar archaeological features to further improve its robustness. The long-term goal of our research is to provide a method of rapid, efficient and reliable screening of large image data sets for a predefined category of target objects prior to fieldwork.

Session 4: Aerial data-to-knowledge 2: From processes to landscape patterns
Date & Time of Presentation: Thursday 25 September, 09:30 - 09:55
ARCTIS – A MATLAB® toolbox for archaeological imaging spectroscopy

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Imaging spectroscopy acquires imagery in often more than hundred narrow contiguous spectral bands. This offers unprecedented spectral data for archaeological research. To make full use of this relatively new data source and extract useful archaeological information from it, a number of problems have to be solved. Major problems relate to the visualization of the huge amount of available data and the data redundancy. This makes data mining approaches necessary as well as efficient data visualization tools. Additional problems relate to data quality. Indeed, the upwelling electromagnetic radiation is recorded in small spectral bands that are only about ten nanometers wide. The signal received by the sensor is thus quite low compared to sensor noise and possible atmospheric perturbations. The often small instantaneous field of view (IFOV) – essential for archaeologically relevant imaging spectrometer datasets – further limits the useful signal stemming from the ground. The combination of both effects makes radiometric smoothing techniques mandatory.

The presentation details the functionality of a MATLAB®-based toolbox called ARCTIS (ARCHaeological Toolbox for Imaging Spectroscopy), which addresses the above mentioned problems. It helps the image analyst – not necessarily a specialist in remote sensing or in imaging spectroscopy – to maximize the information extracted from the recorded 3D data cube. It is a tool to display hyperspectral data (multilayer TIFF images or ENVI files) in many different ways and to retrieve as many pieces of information as possible from the imagery. As such it was created to test currently available AIS processing practices as well as validate the value of completely new information extraction techniques. Given the fact that many of its residing processing and visualization tools cannot be found elsewhere and commercial software is often costly and less straightforward to use, the toolbox and its source code will be freely available for all interested parties (via download from http://luftbildarchiv.univie.ac.at) under the Creative Commons Attribution 4.0 International License. Together with some test datasets, this open access will enable interested students and remote sensing professionals to become acquainted with AIS, while other scientists can contribute with new algorithms to further expand and even optimize ARCTIS.

Session 4: Aerial data-to-knowledge 2: From processes to landscape patterns

Date & Time of Presentation: Thursday 25 September, 09:55 - 10:20

Assessing archive stereo-aerial photographs for reconstructing archaeological earthworks

Heather Papworth¹, Andrew Ford¹, Kate Welham¹ & David Thackray²

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Archaeological earthworks are vital for the UK cultural identity as well as generating a proportion of the £21 billion annual contribution heritage tourism brings to the economy. However, many are destroyed before they can be recorded for future research due to the intensification of human activity and natural processes. To mitigate this loss, archaeologists need to reconstruct these damaged and lost earthworks, requiring a historic perspective to establish their significance, the economic value of their loss and the rate of their change.

In collaboration with the National Trust this research assesses the ability of archive stereo-aerial photographs (SAPs) and digital photogrammetry to generate metric data, in the form of digital surface models (DSMs), from which to extract earthwork breaklines and profiles and to identify regions of change over time. Two field sites have been chosen on which to test over six decades of SAPs. Flowers Barrow Hillfort, situated near Lulworth in Dorset, UK, has remained in good condition throughout this period, due to the protection afforded it by inclusion within Ministry of Defence land. The Eggardon Hill earthworks, near Bridport in Dorset, UK, were also selected due to the exceptional preservation state of some earthworks versus the plough-damaged remains of others. These sites thus offer an opportunity to rigorously test the reconstruction capabilities of the SAPs.

DSM quality for each SAP epoch has initially been determined by comparison with terestrial laser scanning data. The accuracy with which the SAPs produce archaeological data has been assessed against the only other available surveys of Flowers Barrow and Eggardon Hill: hachure plans and profiles completed in 1955 and 1970 by the Royal Commission on the Historical Monuments of England. These surveys have been utilised to represent the baseline requirement for archaeological earthwork recording, particularly in the case of Flowers Barrow, as the 1970 hachure plan is the only survey to exist of the Hillfort prior to the data created for this research. By comparing the profiles extracted from six epochs of SAPs to those of the 1955 survey, this indicates the suitability of each epoch of archive SAPs for reconstructing archaeological earthworks.

Session 4: Aerial data-to-knowledge 2: From processes to landscape patterns

Date & Time of presentation: Thursday 25 September, 10:20 - 10:45
An improved approach to the recognition of standing remains

Aude Crozet, Rachel Opitz & Laure Nuninger

Université François Rabelais / MSHE Ledoux USR 3124, UFC, Besançon, France; CAST, University of Arkansas, Fayetteville, AR USA / LEA ModelTER / MSHE Ledoux USR 3124; Chrono-Environnement UMR 6249 / LEA ModelTER / MSHE Ledoux USR 3124, CNRS, Besançon, France

This paper presents an improved parameterization of the Multi-Criteria and Multi-Scale Iterative (MCMSI) Approach to ALS point cloud segmentation developed for the LIEPPEC and ODIT projects (Opitz and Nuninger 2013) for the separation of small scale standing archaeological remains from surrounding dense vegetation. The MCMSI approach seeks to resolve a major challenge in the use of airborne lidar for the prospection and study of complex woodland and scrub landscapes: the reliable identification of standing remains. Standing remains represent an essential part of the archaeological evidence, in particular for more recent periods, and the reliable detection of these remains is necessary if ALS is to be used as a robust tool for prospection in support of diachronic, landscape oriented research and heritage management projects. The challenge is notably acute in the Mediterranean where the uptake of ALS has lagged behind northern Europe, perhaps in part because of the difficulty in identifying standing remains. The MCMSI Approach uses open source software e.g. CloudCompare and Meshlab and is based on a set of iterative calculations using three parameters: rugosity, density and normal orientation to segment the point cloud. The initial development of this method used case studies at three sites around Besançon with success on two sites and failure on a third, which presented more complex characteristics, such as very dense and evergreen vegetation (boxwood) and low walls with multiple orientations.

The improved parameterization presented here is derived from systematic tests carried out on ten new sites with a variety of standing structures and complex topographic conditions. The sites were chosen for their challenging characteristics: notably having dense vegetation e.g. box trees, close undergrowth on low standing remains, standing remains of less than 1m in elevation, and remains near or on sharp changes in slope. Tests on these new sites resulted in a revision of the recommended initial and segmentation values for the three key parameters (roughness, density and normal orientation) and the weighting of each of them in the calculations. and the development of a protocol for stopping or continuing iterations based on the results of prior steps in the segmentation process. This experimentation also offers the possibility to run on a site a set of different tests stressing on one or another parameter in order to determine the most reliable one. The weight guidelines were developed based on testing of the influence of each parameter on the segmentation process.

The application of the improved MCMSI Approach to these new study sites resulted in improved visibility and ability to identify standing remains in these complex woodland areas. Further work in simplifying and automating the approach is planned. This methodological development will increase the utility of ALS surveys in tropical forests or Mediterranean scrub and woodlands, facilitating the study of these types of landscapes and further establishing airborne survey as a key tool for diachronic landscape archaeology studies in these environments.

Session 4: Aerial data-to-knowledge 2: From processes to landscape patterns

Date & Time of Presentation: Thursday 25 September, 11:15 - 11:35
EngLaID (Landscape and Identities: the case of the English landscape, 1500BC - AD1086) is a five year project (begun 2011) running at the University of Oxford and which is attempting to understand the development of the rural English landscape from the middle Bronze Age through to the Domesday Book.

English Heritage’s National Mapping Programme (NMP) data is key to the analysis that the EngLaID team are conducting. Our paper will discuss how we have gone about combining different NMP datasets, how we have adapted them for our analytical purposes, and how we are using NMP data to put that analysis into practice.

We will consider issues and processes behind conversion into vector format of scanned hand-drawn NMP data, cartographic issues regarding plans drawn of aerial photograph interpretations, and methods devised for the quantitative analysis of field system boundaries. We will also discuss other ways in which we might be using NMP data in the future.

Session 4: Aerial data-to-knowledge 2: From processes to landscape patterns

Date & Time of presentation: Thursday 25 September, 11:35 - 12:00

Airborne magnetometer and cultural remains – preliminary results from a test and work in progress

Ole Risbøl1 & Michael Pregesbauer2
1. NIKU, Norway; 2. Airborne Technologies/Vienna Institute for Archaeological Science, University of Vienna, Austria; & Ludwig Boltzmann Institute (LBI) for Archaeological Prospection and Virtual Archaeology, Austria

Together with Airborne Technologies who is also a partner in the LBI project, we have covered a forested area of app. 36 km2 here in Norway with airborne magnetometer. The aim was to detect slag heaps connected to Viking Age and early medieval iron production and we would like to present some preliminary results from the test. In June we will do a field verification of some detected anomalies and will hopefully have some interesting results to present. In any case I think this approach using airborne magnetometer as a new potential tool would be interesting for the "AARG family".

Session 6: Innovative trends
Date & Time of Presentation: Thursday 25 September, 13:45 - 14:15
A workflow for (Semi) automatic extraction of roads and paths in forested areas from Airborne Laser Scan data.

William Vletter
University of Vienna, Austria

The possibilities of airborne laser scanning as a tool for visualization of micro topology have been known for some decades. Indeed, in the archaeological field a lot of new features have been detected or re-confirmed. However, the task to map manually the enormous amount of features is time consuming and costly. Therefore, there is a need for automation.

In this paper four workflows are compared for the extraction roads and paths in forested areas from ALS data. Each workflow combines a visualization concept (break lines, openness or intensity) with a software package (STREX, Feature Analyst and eCognition) for extraction. The preferred workflow results in a considerable time gain in comparison with manual mapping. This workflow also stands out when costs and processing time are considered. The advantages and disadvantages of using topology rules to enhance the quality of the outcome of the workflow are also discussed. Next to the application for historic road research, the results of this study contribute to the development of automatic extraction techniques in general. In this regard software packages like eCognition look promising to improve extraction methods.

Session 6: Innovative trends
Date & Time of Presentation: Thursday 25 September, 14:15 - 14:40

Positing Negatives: Evaluating the performance of digitalised aerial archival media in image-based modelling environments

Christopher Sevara
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Historic aerial photographs are a valuable and often under-utilised asset to archaeological research. Recent developments in computer vision related fields such as image-based modelling have provided new tools which can be used to make archival imagery more accessible to a wider range of users.

Previous studies have established the effectiveness of using highly automated image-based modelling applications to recover two and three-dimensional datasets from archival aerial imagery, demonstrating that usable geospatial content can even be extracted from heavily degraded image sets with unknown camera parameters. However, performance of these datasets in such applications can be directly affected by the source media as well as the equipment with which they were digitised. Non-uniform distortion caused by degradation of physical media over time as well as variability in optical and radiometric quality of image scanning equipment can introduce significant error, which can be difficult to correct. While the relative merit of using information derived from negative versus positive prints in aerial archaeological research has often been discussed, a quantifiable gain from using one media type over another in image-based modelling applications has yet to be accurately determined. This paper will present a preliminary study which seeks to address this issue by processing film and print scans of a single WWII reconnaissance sortie conducted over Lower Austria in March of 1945 in order to determine the extent to which both digitising equipment and media type influence the accuracy and usability of digitally derived data products. The results will be used to determine best practices for the use of such datasets in image-based modelling environments. Furthermore, the results can suggest ways in which geometric distortion can be minimised or compensated for when no alternative media are available for a given dataset.

Session 6: Innovative trends
Date & Time of presentation: Thursday 25 September, 14:40- 15:05
Two decades of research and some spots on maps

Chris Cox
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This paper will detail a really effective and efficient use of time and high level Air Photo Interpretation in the context of updating and refining the GIS AP layers in a UK Local Authority HER, and illustrate the discovery of complex and extensive archaeological landscapes in the process.

Between 2010 and 2012, I was commissioned by Hertfordshire HER to update their whole API database from an exceptionally productive digital layer of aerial photographs, directly into their GIS system using the HER database HBSMR and ArcView. This research built on two decades of my own and Rog Palmer’s aerial reconnaissance and mapping in Hertfordshire and the pilot 1994 RCHME National Mapping Programme which was undertaken in Hertfordshire by Vikki Fenner.

The survey recorded results in real time into the HBSMR database, and simply placed spots on the HER map with an associated database entry to indicate the presence of features. No detailed mapping was undertaken. This ‘overview’ approach allowed me to interpret several layers of digital aerial imagery, including FCIR and LiDAR, over a whole county - c.3000 sq km and update and create an immediately useable database record in the live HER for c.£20,000 worth of input from an economically constrained Local Authority. The data has contributed greatly to the planning decisions which can be made by curatorial staff and is available on the HER for consultation by the public, heritage consultants and researchers. I have since applied it effectively in two other projects, for the National Trust in conjunction with some detailed mapping over a smaller area, and for a Local Authority large area mapping project.

Session 7: Detail and Scale of Aerial Survey Results and Analysis: a debate
Date & Time of Presentation: Thursday 25 September, 15:20 - 15:50

Levels of survey – is detail an unhealthy obsession?

Dave Cowley
RCAHMS, Edinburgh, UK

This paper discusses the relationships between broad-brush characterisation at landscape-scale and the nitty-gritty of fine detail through discussion of levels of survey. Such frameworks can provide a context to assess appropriate methodologies and fitness for purpose, and these may help archaeologists adopt a reflexive approach to how they map, in what detail and to what end.

Session 7: Detail and Scale of Aerial Survey Results and Analysis: a debate
Date & Time of Presentation: Thursday 25 September, 15:50 - 16:20
Are we obsessed with detail? Or do we do it because it is useful or because we are able to do it?

Rog Palmer

UK

Archaeological survey, whether from aerial sources or on the ground, serves many purposes from documenting monuments for Cultural Resource Management to informing research-engaged understandings of the past. Unsurprisingly, any survey process is a balance between the level of detail that can be achieved, the extensiveness of coverage, the available data and the tools applied to analysis.

This session aims to stimulate discussion of how we approach levels of detail in interpretation and mapping through presentations that cover a series of inter-related issues.

• How clearly do we define the purpose(s) for which a particular survey is undertaken? Do we have an expectation that work undertaken for one objective can be repurposed? How clearly do we understand the needs of users (other than ourselves?) of what we produce?

• How do we define different levels of survey, from highly detailed understandings of necessarily small areas to generalised characterisation of landscapes? Do we understand the scale at which we are working? How do different approaches to feature identification and characterisation (manual / automated) fit within our survey strategies?

• To what extent are different levels of survey reflected in research on remote sensing – is there an imbalance between academic pursuit of detail and ‘correctness’ and the needs of CRM for broad brush patterns?

• How do we assess the utility of the information we produce – are we generating irrelevant information? Or not meeting requirements because certain types of information are omitted?

• Do we agree that the needs and uses of AP information for heritage management and protection, for example, are not necessarily the same as those of someone undertaking research into changes in settlement pattern and landuse, and that these are different from the needs of someone who will have to excavate?

• How easy do we find it to generalise or are we instinctively drawn into detail? Do we hope to get ‘everything’?

• Do we discuss detail when teaching? Not just the need to perceive detail, but to consider reasons for why the work is being done and to match output to suit those needs.

The debate session will be introduced and summarised by Rog Palmer between which will be two presentations – a case study by Chris Cox and a more general overview by Dave Cowley.

Session 7: Detail and Scale of Aerial Survey Results and Analysis: a debate

Date & Time of Presentation: Thursday 25 September, 15:20 - 17:30
The Chalcolithic Paradox of Southern Wallachia

Cătălin Bem¹, Andrei Asândulesei², Constantin Hâită¹, Carmen Bem¹ (R.N.C.M.N.R) & Vasile Oprîș¹
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The preference calling for wetlands, marshy areas, in opposition with higher zones nearby rivers or lakes comes in opposition with a theory that for Romanian archaeologists has become an axiom. Unfortunately, the axioms in Romanian archaeology continue to have an important share and to dictate the simulacra of some non-coherent researches.

Determining the reasons for choosing the Câlniştea-Neajlov marshes as a “building area” for the greatest North-Danubian tells [Brăniştari, Uzunu, Stoeneşti, Schitu] involves an immaterial dimension of the landscape. Identifying the hidden areas (areas of shadow) of the landscape – physically discreet – is an obligation in any coherent and comprehensive archaeological or anthropological study.

Cartographic and topographic resources and aerial photographs – expressing a clear picture of what was preserved until present – are a decisive contribution to an overall perception of the landscape. To the general vision created by these, we will add information obtained through non-invasive ground research methods – magnetometry, electric resistivity, georadar scanning.

A comprehensive sampling, based on a coherent strategy, as the sum of all non-invasive methods, will firstly provide certainties regarding the dynamics of the natural landscape, prehistoric topography, geomorphology – aquatic dynamics (river channels, swamps, alluvial bars) and the environment – all anchored chronologically through radiocarbon dating and OSL (where the organic matter is missing).

Combined non-invasive techniques for the documentation of cultivation structures in the arid Atacama area (N. Chile)

César Parcero Oubiña¹, Alejandro Güimil Fariña¹, Patricia Mañana Borrazás¹, Pastor Fábrega Álvarez¹, César Borie³, Mariela Pino³, Frances Hayashida⁴, Diego Salazar⁵ & Andrés Troncoso⁵
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The poster will summarize the methodological process for the detailed documentation of a vast complex of late Prehispanic agrarian elements (fields, irrigation canals) in area of the Atacama Desert (northern Chile). As opposed to the usual conditions for prospection in temperate regions, where the visibility of archaeological features is usually poor and confusing, here the extreme dryness of the landscape allowed an extraordinary preservation and visibility of fields, canals and other constructions. The approach was initially based on a combination of visual interpretation of high resolution satellite images (GeoEye 1) and fieldwork for mapping the layout and shape of most of the elements (canals, groups of fields, settlement areas). For the accurate documentation of smaller or densely built areas, an SFM based photogrammetry approach was carried out, based on the use of a low cost UAV (Dji Phantom) and a consumer grade compact digital camera for the acquisition of low altitude aerial images that allowed the generation of 3D models and orthoimages of some areas. Finally, ground based photogrammetry was also used to capture and represent some elements in greater detail.

The potential use of remote sensing applications in Ancient Anaktorion in Western Greece

Christina G. Ntaltagianni

Anaktorion was one of the most important colonies of Corinth situated in 630 B.C in the Ambrakian gulf in Western Greece. The ruins of the city are visible and they have been described by many travelers. The competent Ephorate conducted a survey in order to locate the ancient remains already known and also to uncover new evidence for the city’s topography. Therefore in 1995-7 vegetation was cleared from some parts of the older and more recent fortifications and some trial trenches and surface survey (without remote sensing methods) is being made. According to this we investigate the potential use of remote sensing applications in ancient Anaktorion in order to reveal the settlement’s morphology and its exact topography.
Further Archaeological Survey on the Hill of Slane, Co. Meath, Ireland

Conor Brady & Kevin Barton

Archaeological investigation has been undertaken at the Hill of Slane, Co. Meath Ireland by the Hill of Slane Archaeological Project (HoSAP). A topographically dominant landmark in its local landscape, the Hill of Slane is traditionally regarded as where Ireland’s patron saint, St. Patrick, lit the first Paschal fire and started his mission to convert Ireland to Christianity. It later functioned as an important religious and political centre during the early medieval period. A variety of early historical references as well as a series of topographical features indicate that it is also likely to have been important in prehistoric times.

A range of aerial remote sensing datasets exists for the complex and includes conventional oblique and vertical aerial photography, kites aerial photography imagery, airborne LiDAR and Worldview multi-spectral satellite imagery. A series of complementary terrestrial geophysical investigations have been completed by the HoSAP on a number of discrete features and areas within the complex. Significant additional fieldwork has been carried out recently and it is proposed that the processed results of this fieldwork, integrated with a number of the aerial datasets will be presented.

Aerial photography and ancient road networks in Roman Petelia

Ferdinando Marino & Veronica Borelli

University of Rome “Sapienza”, Italy

The chair of Archaeology and history of greek and roman art led by prof. La Rocca of the University of Rome “Sapienza”, after the first survey campaign carried out in the years between 2010-2012 and included in the ‘Filotteteproject’, now focuses the studies about the eastern Calabria ancient landscape on the analysis of the infrastructural route system of the ancient Kroton region, with a particular attention to the territory around the ancient city of Petelia.

The employed methodology, supervised by prof. Genovese, range from traditional (historical literature and cartography, field survey, etc.) to modern ones (aerial and satellite photography, geospatial analysis, etc.) and led to a narrow range of hypotesis about road network of the roman age. The result obtained reprenents the first step in a large scale application of the same metodology to the whole territory of the Crotoniatisde, which as never been interessed by a similar research.

MATRICS: a toolbox for contrast enhancement of (aerial) photographs

Geert Verhoeven

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A common problem with aerial photographs (and remotely sensed optical imagery in general) is the lack of contrast in the image, in which contrast is defined as the difference between the perceived values of the brightest pixels to the darkest pixels. Often, this arises from the fact that the illumination conditions at the time of exposure were poor or difficult to handle, resulting in an over- or under-exposed image. The latter will therefore not occupy the full dynamic range of the imaging sensor. Even with properly exposed images in good illumination conditions, lack of contrast might occur despite the wide variety of spectral reflectances real world objects display. In this scenario, the limited contrast is often due to the scattering of solar electromagnetic radiation. This phenomenon – often perceived as haze – also reduces the overall scene contrast as do fog, smoke and rain. Additionally, fading of older positive prints and negatives will also decrease local and global image contrast. Furthermore, imaging in small spectral bands or invisible spectral regions (such as the NIR) will almost automatically result in low-contrast images.

To restore and even increase the contrast in an image, several image enhancement procedures can be followed; those specifically dealing with contrast are called contrast enhancement/stretching techniques. Contrast adjustment is not only a common task in digital (aerial) photography, but also in medical imaging or satellite remote sensing. Not only can the result of these contrast manipulations be a more pleasing image, sometimes they can also markedly improve the readability and interpretability of archaeological features, even to such an extent that previously unnoticed features become apparent. Moreover, even imagery that initially displayed good contrast might benefit from some localised contrast enhancements.

In this talk, MATRICS will be presented: a MATlab Toolbox for Relevant Image Contrast Stretching. This toolbox allows the import of both greyscale and colour (three-band RGB as well as indexed) imagery. After import, the user has the option to apply a wide variety of simple and more advanced contrast enhancement methods and compare the resulting image to its initial version. Since different images and applications demand different algorithms, the user can try out all possible approaches until a sufficiently enhanced version has been found that – if needed – has both is global and local contrast optimised without saturating any data. Finally, the toolbox offers a variety of export image formats with the option to embed the initial image metadata as well. To showcase the results one can obtain with MATRICS, a wide variety of aerial imagery will be used, including decently exposed colour photographs encompassing the sensor’s full dynamic range, some shots with poor exposure, digital NIR images and negatives that suffer from film fogging.
Generating accessible 3D models from complex point cloud data of complex architectural heritage – a new processing pipeline

Anthony Corns, Gary Devlin, Patrick Griffin & Robert Shaw
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Generating accessible 3D models from complex point cloud data of complex architectural heritage – a new processing pipeline

As a partner in the EU funded 3D-ICONS project the Discovery Programme is undertaking the 3D documentation of some of the most iconic cultural heritage sites in Ireland. This pan-European project, with sixteen partners from nine countries, aims to establish a complete pipeline for the production of 3D replicas of archaeological monuments and historic buildings, and to publish the content to Europeana for public access. The list of Irish icons range from wider cultural landscapes to small museum artefacts, however this paper is concentrating on the 3D documentation of architectural structures, particularly early Christian churches and structures.

The primary digitisation method is phase-based terrestrial laser scanning, utilising a Faro Focus 3D. This is now a mainstream approach for surveying historic structures, generating precise, high resolution point cloud data, primarily for viewing and interaction in proprietary software applications. Before modelling outputs are derived an initial process of data preparation – cleaning and removing unwanted points such as targets or people from the point cloud is undertaken. The challenge this paper then aims to address is how these complex high volume point cloud data sets can be converted into accessible textured 3D models whilst still retaining the geometric integrity of the original data.

Traditionally procedural modelling is used to produce photo-realistic models of heritage sites. However, due to the irregular and organic geometry of the architectural heritage commonly found in Ireland; where straight lines and flat planes are the exception, procedural modelling is not suitable. A possible solution to provide online access to the detailed laser scan survey data is the use of proprietary web based scan viewers (Leica truvue, Faro scene), however these provide access to the data only from fixed scan positions. Additional web based point cloud viewing tools (Potree) do allow for a fully navigable 3d point scene however the viewed dataset is often a much inferior product compared to the original point cloud.

This poster highlights the development of a pipeline for the detailed surfacing and texturing of scan data to produce a lightweight 3d model which enables the public to interact with a photorealistic model based upon accurate survey and texture data. Several stages of the pipeline are explored including:

1. Meshing and subsequent mesh cleaning of scan data (Geomagic Studio)
2. Retopologising and simplification of mesh models producing lightweight models with detailed normal maps (3DS Max, Mudbox)
3. Production of HDR panoramic images (Gigapan Pro and PTGui)
4. Projection and painting of spherical panoramic images (MARI)
5. Online Publishing of lightweight model with annotations

Can more simply be too much?

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Crawford once said: “It is usually imagined that the camera, when fixed in an aeroplane, records marks on the ground which are invisible to the eye of an observer. That is not so. The observer can see these marks more plainly than the camera, for he sees them in color.” (Crawford and Keiller, 1928: p. 6) Although the greyscale-or-colour debate became irrelevant decades ago, the basic concern about the current line of digital imagers (with full frame and smaller sensor formats) lies in the never-ending increase of generated image pixels. Although Nikon and Canon claimed that the megapixel race ended years ago, the reality is that newer camera bodies still feature sensors which generally have higher photosite densities, thus producing larger images with more and more megapixels. Not only do these big files task the hard- and software processing ends much more (although the simultaneously increasing computing power of hardware should make up for this), the question really is whether this bunch of data points makes for better aerial images from which more archaeological and georeferencing information can be extracted? In other words: do the smaller ground-sampling distances (GSDs) that one can theoretically achieve with current digital still cameras also translate to real-world aerial images with more resolved detail or does the standard oblique reconnaissance approach imposes a GSD threshold above which it becomes impossible to extract more information from an aerial image. In an attempt to answer this complicated issue, this talk will thoroughly assess the theoretical spatial resolving power of the Nikon D800(E), Nikon D7100, Sony NEX-5N and Ricoh GR imaging sensors and verify how this metric translates into the spatial resolution observed.
in their respective images. Therefore, the influence of lenses, shutter speed, aperture and ground-to-air speed on the final limit of resolution will be explained and quantified. Controlled terrestrial and airborne tests with several hardware setups will provide the imagery to illustrate these findings and allow a few essential conclusions to be drawn:

• Is it beneficial to take the 36 megapixel D800 in the air (from a spatial resolution point-of-view) at all? In other words: can one really see a gain in spatial resolution over 24 megapixel imagers such as the full frame D610 or the APS-C D7100 or are physical factors simply limiting the archaeological details that can be resolved from the air in a typical archaeological, observed-directed reconnaissance flight?

• Does one need to invest in highly expensive glass when shooting with a D800-like camera to make the purchase of such a camera worthwhile? Are zoom lenses still a valid option when they have to be mounted in front of high-end multi-megapixel imagers?

• To what extent are motion blur, diffraction and noise impacted by such high megapixel counts and – related to this – should one reconsider his/her whole photographic strategy and shooting technique to take advantage of this type of digital cameras for hand-held aerial imaging?

In summary, this talk will try to answer to what extent and at what price the common archaeological oblique reconnaissance approach can still take advantage of the resolving power of current imaging sensors embedded in still cameras. Is there something like a hardware combination (body and lenses) with an optimal cost/benefit-ratio or should one always aim for the sensor with the most megapixels? In case of the latter, what are the implications on the optics and photographic technique that can be used?

The Barrow Valley? A review of small cropmark enclosures in south-east Ireland

James Redmond
University College Dublin, Ireland

Aerial photography based research by Dr. Gillian Barrett and the Archaeological Survey of Ireland in the 1990’s led to the identification and documentation of hundreds of cropmark enclosures throughout the valley of the River Barrow in south-east Ireland. Though greatly varied morphologically, many small circular examples have been tentatively interpreted as remnants of barrow-type funerary monuments characteristic of the late prehistoric period.

These sites represent a potentially significant addition to the record of human activity in the area yet their typological designations have not been subjected to further study. This poster reports the preliminary results of a research project which aims to re-assess the Barrow Valley cropmarks through analysis of monument classifications and a review of data from recent development led archaeological investigations in the region.

Evaluating the utility of SfM-derived DEM for the survey of moated sites in Siem Reap province, Cambodia

Kasper Hanus, Emilia Smagur, Jarosław Żralka, & Wojciech Ostrowski

(KH, ES, JZ - Institute of Archaeology, Jagiellonian University, KH - Department of Archaeology, the University of Sydney, WO - Department of Photogrammetry, Remote Sensing and Spatial Information Systems, Warsaw University of Technology)

The archaeological landscape of northwest Cambodia, beyond the borders of the Greater Angkor, is poorly recognized, however, the results of selective site-scale research has proved that this area was inhabited since the Neolithic Period. Studies of the aerial images taken during the World War II on, adjacent to Cambodia, Thai region of Khorat has revealed an extended settlement pattern, as well as the potential of aerial photographs for archaeological survey. Acknowledging the achievements of research on Khorat we attempt to reconstruct the settlement network of NW Cambodia. The research method which allowed us to identify potential sites was interpretation of the satellite images and aerial photos. However, difficulties with archaeological prospection in the tropics, highlighted by the experience of Nakum Archaeological Project in Guatemala, required unconventional research routine during ground survey.

Our paper attempts to describe our approach toward a ground-truthing of potential sites recognized on satellite images. Due to the aims of our projects we narrowed the definition of the site to the settlements only; the isolated shrines, water tanks etc. were not taken into account. The determination if identified feature is an archaeological site was based on two factors. The first factor is the presence of pottery shreds. However, due to the particularly fast geomorphological processes in the monsoon climate zone the shreds are very often buried deep under the surface (coring on some of the sites shows that cultural remains could be covered with 2-3 meters of soil). The second factor, more serviceable during ground truthing, is the presence of the topographic features of the site, especially the mound formed by the accumulation of cultural remains over the centuries of occupation. Numerous sites were surrounded by moats, which are still visible in the landscape. Therefore, we were looking for the solution, that allowed us to quickly determine the topography of a potential site. Due to the limited time and resources it was not possible to obtain detailed map with
First and Second World War military training landscapes on the Dorset coast: Bovington Camp and Lulworth Ranges

Krystyna Truscoe
Cornwall Council Historic Environment Projects Team, UK

The extensive military training area of Bovington Camp and adjacent Lulworth Ranges was recorded during by the Cornwall Council Historic Projects Team during the Wild Purbeck National Mapping Programme and the Dorset Rapid Coast Zone Assessment projects. The training area was originally established in 1899 and was in use during both the First and Second World Wars, during which time it was gradually increased in size. In June 1916 the training camp of the Heavy Branch of the Machine Gun Corps was moved to Bovington and Lulworth with the aim of creating a single centre of excellence for the development of armoured fighting vehicles. This is still the camp’s role, now as the British Army’s Centre of Excellence for Armoured Fighting Vehicle (AFV) training. The Lulworth military firing ranges cover an area of approximately 2,830 hectares and form part of the AFV Gunnery School. One famous resident of Bovington Camp was T E Lawrence, who enlisted in the Tank Corps at Bovington Camp in 1923 under the name “T E Shaw”. The 1916 move to Bovington Camp was motivated partly by the need for more space to undertake tank training exercises, which involved a variety of obstacles that the tank crew might meet during warfare. A replica of a section of the Western Front was created on Gallows Hill so that the crews could practice driving across barbed wire between the British and German lines. Many old trenches and shell holes had been left by the infantry, dating from the early life of the camp, which were also utilised as tank training obstacles. The trench system on Gallows Hill, the army camp, and the earlier trenches and shell craters were recorded by the Cornwall Council Historic Projects Team from photographs from the 1930s and 1940s. The mapping exercise, in assessing the information from all the available historic photographs of this fascinating site, helps us to understand its extent and provides an insight into how tank crews were prepared for trench warfare.

The road system in the Eastern territories during the 6th century reconstructed through the use of satellite images

Lucia Marsicano

The present work follows a Thesis in Medieval Topography discussed at the university “La Sapienza” of Rome. The aim of the research is to reconstruct the road system and to identify the tracks used by the Byzantine army during the Persian war in the 6th century. The starting point of the research is Procopius “Wars” in which there are many information about the armies movements and the distances covered. The analyzed area coincides with the Eastern Limes a large and geomorphologically diversified region; moreover for political and military reasons it was impossible to find an useful cartography. The use of the satellite images allowed to analyze in details the territory to localize the toponyms mentioned by the author and to make assumptions about the road system.

Using photo3D in Hungarian archaeology

Máté Szabó, András Balogh, & Kinga Kiss
University of Pécs – (Aeroart Ltd.)

Despite the great potential lying in the photo3D technology, its utilization in archaeological researches has just recently begun in Hungary. In our researches, which investigates Roman villas and their landscapes, we have been utilizing this method for several years. At the beginning we only used it as an auxiliary and supplementary method of the documentation, but today we even utilize the photo3D technology to completely replace various phases of the archaeological field recording. Furthermore, the development of RPAS (Remotely Piloted Aircraft Systems) tools has also brought about the widespread usage of aerial photo3D surveys. The RPAS technology proved itself extremely useful not only in the archaeological documentation, but also in the field of landscape archaeology, due to its cost-effectiveness and the precise and detailed data provided by this method. The automatization of the surveying and procession of the data is already at an advanced stage, but it is still basically in the testing phase. However, these promising developments could be overshadowed by the recent Hungarian legislations, but hopefully it will not hinder the possibilities of the archaeological utilization of RPAS. With our poster, we would like to highlight some of the results of the application of the aerial and terrestrial photo3D technology in the research of the Roman villas in Pannonia.
Application of remote sensing techniques in the Shubayqa area of Eastern Jordan

Olivia Mavrinac

A poster is offered which presents the Eastern part of Jordan, in the Shubayqa area, where we are trying to map a large area of burial cairns with the use of field survey, remote sensing and satellite imagery.

Change detection using airborne lidar and photogrammetry

Ralf Hesse

The potential of high-resolution digital elevation models (commonly based on airborne lidar) for the monitoring of archaeological sites and landscapes is commonly taken for granted. However, while the general approach for DEM change detection – subtracting one DEM from another – is very simple, its practical application faces some challenges. Repeated lidar surveys will increasingly become available in the future, but intercomparability issues may limit their applicability for the monitoring of archaeological sites and landscapes. DEMs derived from airborne lidar acquired over a single area commonly differ in terms of laser scanner type (single/multiple return, full waveform), scan angle, laser point density, actual vegetation cover, vegetation filtering and other processing steps, as well as the spatial resolution of the rasterized DEM. Georeferencing errors can have a pronounced effect on change detection results. Multiple DEMs may not be available for the desired monitoring period, and the high costs for commissioning multiple lidar surveys may be prohibitive for archaeological projects. To extend DEM change detection into the pre-lidar past, to increase the temporal resolution and to reduce costs, terrestrial laser scanning as well as photogrammetric (structure-from-motion) approaches can be applied. However, the intercomparability of DEMs derived from airborne lidar and from photogrammetry is limited by the impact of vegetation cover or DEM generation.

Hidden Depths and Empty Spaces?

Susan Curran

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Traces of early medieval settlement (AD400-1100) can be found throughout the Irish landscape, most commonly in the form of ringforts, crannógs (artificial islands in lakes) and ecclesiastical sites. The remains of such sites are often visible to the naked eye and can be easily recognised and recorded without the aid of advanced aerial reconnaissance or geophysical survey, indeed more than 45,000 recorded Irish ringforts were identified in this manner. However, with the application of LiDAR data in archaeological research, it has been possible to identify ‘new’ early medieval sites, thus challenging our perception and understanding of the Irish early medieval settlement landscape. This poster will display the work that was undertaken during my MA thesis (2012) which uncovered more than 100 ‘new’ potential early medieval sites. In addition, it will outline the research I am currently undertaking to build upon these findings with a view to re-assessing our understanding of early medieval Irish settlement through the application of remote sensing techniques and the inclusion of new case study areas.

First World War Battles on the Roman Limes from Eastern Transylvania (Romania)

Szilamér Péter Pánczél1, Máté Szabó2 & Márton Futó3
1. Mureş County Museum, Romania, 2. University of Pécs, Hungary, 3. landscape architect

The Aerial Archaeological Archive of Pécs (University of Pécs, Hungary) with the collaboration of several Transylvanian museums has begun in 2008 a vast aerial survey of the Eastern limes of Roman Dacia. Parallel with the reconnaissance of Roman remains, other archaeological and historical evidence of land use from different periods – for example military trenches from the First World War – have been identified. Thus, besides taking aerial photographs of these sites, we decided to examine these structures in order to understand better the battles which took place in the region in 1916.

A further interesting point in the research is represented by the fact that the military trenches of WWI and the Roman remains on the foothills of the Carpathian Mountains run along the same line, situation which is most probably caused by the everlasting strategic value of a mountainous terrain. Hopefully, the mapping of the ancient remains and the analysis of the various historical sources of the battles of WWI will help us understand better these connections.
Understanding national discoveries from the 2013 drought

Toby Driver
Royal Commission Wales, UK

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The summer of 2013 saw some astonishing sites emerge across Wales where more famous or oft-recorded cropmarks were not seen, demonstrating beyond doubt the need for repeated archaeological reconnaissance across even well-studied landscapes. The weather for the year was one of extremes and contrasts, from heavy winter snowfall to a record summer drought. Rather than a ‘stamp collecting’ ethos, many of these discoveries have changed our understanding of regional archaeological landscapes around Wales and instigated new research projects or further thematic research with the discovery at their core. Further significant discoveries in landscapes already scoured by decades of aerial archaeology show there is still more to do.

Despite limitations of coverage inherent in the practice of oblique photography, the ability to get airborne as and when weather and drought conditions dictated once again meant that archaeological aerial reconnaissance provided the only record of these important discoveries. The Welsh Government did commission pan-Wales vertical aerial photography for the summer of 2013, between May and July, which might have provided an invaluable complementary record. However, full national coverage was never achieved while the final survey date of 14th July fell right at the start of cropmark visibility across Wales, in an unusual season where cropmarks only developed in significant numbers in the last two weeks of July.

Generation of a 3D model from historic aerial photographs for the digital retrospection of the demolished Breginj

Žiga Kokalj & Tatjana Veljanovski
Research Centre of the Slovenian Academy of Sciences and Arts, Slovenia

The article describes a generation of a three-dimensional model of the village Breginj from archival aerial photographs, and analyses the conditions that allow this type of reconstruction. The model is based on a series of aerial photographs that were captured shortly after the first earthquake in May 1976, and a Structure-from-Motion (SFM) method. SFM requires a relatively extensive overlap of several images – a hindering circumstance in our case because the six photographs were acquired consecutively in a single flight line. Particular attention is paid to the importance and potential of such reconstructions in light of the contribution to the conservation of the architectural and cultural heritage, and more specifically to the capacity and potential of digital retrospective of settlements and landscapes that are now gone.
Venues

Conference Venue 09:00 - 17.30 Wed 24 - Thurs 26 September

ARRG 2014 will take place at the Wood Quay Venue. This building an imaginative and exciting development which houses the City Wall Space. This is a spectacular state-of-the-art conference, meeting, exhibition and performance facility featuring a stretch of the original Hiberno Norse (Viking) City Wall dating from 1100AD. The venue can hold a capacity of 120 people and has full AV and wireless internet facilities.

Welcome Reception (co-hosted by AARG and ArcLand Europe) 19:00 - 22.00 Tues 23 September

The ARRG 2014 Welcome Reception co-hosted by ArcLand and AARG will take place at The Crypt at Christ Church Cathedral, Dublin.
Conference Dinner 18.30 - 20.00 Thurs 25 September

The ARRG 2014 Conference Dinner will take place at The Portrait Gallery, Dublin Castle.

AARG 2014 Excursion 08.30 - 17.00 Fri 26 September

Coach Pickup outside Dublin Convention Centre, North Wall Quay (see map below) @ 08:30
Morning Excursion - Brú na Bóinne World Heritage Site including Knowth & Newgrange Tour or Landscape of Dowth Tour
Lunch - Slaine, Co. Meath
Afternoon - Hill of Tara Archaeological Complex, Co. Meath

Coach will be returning to Dublin via Dublin Airport for those who wish to be dropped of to catch their flights.

The Excursion is supported by

Dublin Castle, Dame Street, Dublin 2