POSTERS

Automatic identification methods of linear and circular archaeological structures via satellite imagery processing

Dorel Micle, Daniela Zaharie & Oana Borlea

Very wide spaces, rough terrain or the lack of visual perspective are the most invoked motives because of which wide areas of a country's territory are not archaeologically investigated, thus creating a multitude of archaeological white spots. The usage of satellite images to identify archaeological sites represents a common practice of this scientific community nowadays, and, more and more often, the problem of automatic processing appears, of finding new methods and techniques of automatic identification of archaeological structures through satellite imagery processing.

Finding the best solutions means to eliminate modern structures and study only the historic ones during the process. Benefitting of an almost total coverage with very good quality satellite images offered by Google Earth of the Timis County (Romania), and also of the richness and variety of noticeable archaeological sites on these images, our team tried to identify some work patterns which are accessible to archaeologists.

Remote sensing techniques proved to be useful in non-intrusive investigation of archaeological sites by providing information on buried archaeological remains. The presence of different remains in the ground can generate different marks identifiable in high resolution panchromatic and/or multispectral images: crop marks, soil marks, shadow marks and damp marks.

Automatic identification of archaeological sites from digital images is a difficult task, since the small anomalies induced by the buried remains are usually hidden by stronger marks corresponding to the structures currently existing on the ground (roads, constructions, trees, rocks etc). Therefore the final identification and interpretation of the marks should be made by the expert by visually inspecting the enhanced image and by corroborating his observations with additional information (e.g. historical maps, current roads network etc). In order to prepare the image for visual inspection we first applied a flow of basic image processing operations: gray scale conversion, histogram equalization, edge detection (Sobel filter), thresholding, inversion and erosion. Having the aim of developing a semi-automatic tool for identification of linear and circular shapes we also investigated some more sophisticated operations. One of these operations is the Hough transform which we applied in order to identify linear structures (e.g. wave like roman fortifications) and circular structures (e.g. burial mounds).

The main problem we encountered in identifying the ancient marks is the fact that they are somewhat obscured by the marks of current land division, roads, contemporary buildings etc. In order to deal with this problem we applied both a supplementary pre-processing and a post-processing step. As pre-processing operation we used the singular value decomposition of the image. By ignoring the components corresponding to the highest singular value(s) (which contain the most important features in the image) we obtained an image where the ancient marks are more visible. In the post-processing step we tried to eliminate the lines detected by the Hough transform which correspond to the current land division by using the remark that this lines are mainly parallel while the ancient mark (e.g. a linear fortification) has a different orientation. Using such operations we successfully identified the location of a linear 'Roman' fortification. The perspectives appear to be promising, so we also want to identify work methods for automatic identification of irregular structures and colors.

The Linear Earthworks System in Timis County (SW Romania, *Banat* region) – a synchronic approach

Dorel Micle, Liviu Măruia, Marcel Török, Adrian Cîntar, Călin Timoc & Andrei Stavilă

Timis County, part of the historic region of Banat, situated in south-western Romania, is traversed from north to south by a system of three linear defense works, constituted by a number of successive ditches and earthworks, known to specialists as „roman earthworks" they have not been dated or ethnically assigned. Having been confronted with this on field, out team has tried during the past two years, through modern techniques and methods, to establish the exact route these defense works follow and to identify their common characteristics, both as far as defense is concerned as well as method of construction and establishing the relationship with the geographic environment. Our research combines methods of geophysical prospecting (magnetic surveying) with topography and archaeological mapping, as well as the processing of satellite imaging, in order to compile an interdisciplinary study of landscape archaeology. Our main objectives were to identify the route of the linear defense works and its features and the relation between the fortifications and landscape.

The research had two parts: 1. field work (archaeological field research, geo-morphologic analysis, archaeological topography, and geo-physical prospecting – magnetometry; 2. laboratory work (the analysis of: topographical and cadastral maps, satellite images, GIS processing).

The final results were the creation of maps with the exact path of the linear fortifications, the identification of construction features, the identification of landscape geo-morphological features on the route of the fortifications using satellite images.

Aerial archaeology and the age of the internet: a survey of free internet-based satellite and aerial imagery for Southern Dobrogea (Romania)

John Gates

The internet marks the greatest revolution in human technology and communication of the modern world. In the age of the internet, information has become widely and freely available to an estimated 1.7 billion people. Its use for investigative archaeological research has proved increasingly beneficial in landscape studies since the availability of free satellite/aerial imagery, but such a resource has yet to be exploited more widely by the archaeological community. The aim of this paper is to investigate its use as a fundamental tool in archaeological landscape studies by presenting the main achievements, and discussing its potential and limitations in the Romanian-Bulgarian border region of Southern Dobrogea.

Using satellite images to identify a possible medieval road in the Vinga High Plains (Banat, România)

Dorel Micle, Leonard Dorogostaisky, Liviu Măruia, Marcel Torok, Adrian Cîntar & Lavinia Bolcu

This poster reports on a study that started with an analysis of satellite images provided by Google Earth on a south – north sector between Beregsău Brook (Nerad, Bega Veche) which flows North of Timişoara and Mureş River as we noticed the trajectory of a possible earth road, not yet archaeologically investigated, and also the presence of two square brick fortifications, quite similar in shape and defensive system, which chronologically fit between the 16th and the 17th century (based on the ceramic materials gathered). One of the fortifications was identified West of the present day village Frumuşeni, Arad County, on the South shore of Mureş River, and the second one is East of present day locality Sânandrei, Timiş County, on the North shore of Nerad Brook. Our team's goal was to certify the presence of this medieval road by studying the available documentary material (written medieval sources, military topographical maps, orthophotograms and satellite images, old historic maps, etc.) but also by field probation through systematic surveys and punctual geophysical prospections, as we tried to identify the route and structure of this road.

Placed in a larger landscape archaeology research, this study can bring multiple information related to economical, political and military context in which the medieval road functioned, and also the possible connection between the two fortifications mentioned above. Also, a medieval rural habitat sectioned by the trajectory of this road analysis can bring out characteristic elements of a stabile and controlled transportation route (post stations, etc.) which can improve historical data related to this period. Our procedure is a technical one, which is based on new documentation means and methods that contribute to the improving of knowledge related to a less studied period – the one regarding the Turkish occupation of the Banat region – through highlighting elements of military architecture (fortifications) and infrastructure (roads).

Sub-canopy archaeological prospection of Chopwell Wood, N. England through multiple-echo discrete-pulse laser ranging (LiDAR)

Jack Landy

Airborne light detection and ranging (LiDAR) is a tool with the potential to detect and aid in the interpretation of topographic features in forested areas. A LiDAR survey was carried out over Chopwell Wood in northern England, a site with known industrial archaeology, to test the feasibility of this tool. Despite the size of the wood (only 3.6km^2), biodiversity is high with large variety in vegetation species and structure, and topography is variable. Consequently this project is the first of its kind to test the effect of multiple crucial factors on high quality terrain modelling in one location and the impact of this on archaeological prospection.

The laser scanner employed for this task was the ALTM Optech 33-100 sensor , capable of emitting 100,000 pulses per second and delivering a point density on the floor of >20 points per square meter. A high proportion of these pulses penetrated the vegetation canopy allowing the underlying terrain elevation to be accurately modelled. Non-terrain (vegetation) points were removed from the data with automated processing algorithms and archaeological features identified through exaggeration and artificial illumination techniques. Principal components analysis (PCA) provides a means of highlighting subtle earthworks in a way that would be difficult by ground survey, even on fully cleared terrain. The accuracy of the point classifications and of the final terrain models were assessed against comprehensive field data, collected using terrestrial LiDAR, differential GPS and total station equipment.

Initial results and interpretation are presented with a view to providing classification and feature maps to archaeologists and heritage agencies.

So much to be found! An assessment of the national digital height model in Denmark

Esben Schlosser Mauritsen

In the national Danish aerial archaeological research project ”Prehistory seen from Above” we have made the first systematic experiments with LiDAR scanned height models. This was made possible by a state agreement that secured archaeological museums free access to a full coverage height model of Denmark. The model has already been included in many in the daily work of many local museums. On our project we try to determine the potential in different landscapes across administrative borders, and to estimate what can be gained if the entire country was investigated systematically. The result is so far astonishing. Thousands of monuments seem to remain unregistered. Mainly ploughed over burial mounds from the Neolithic and early Bronze Age, but also hitherto unknown Iron Age fields systems and medieval earthworks can be found. In Southern Jutland and on the North Frisian Islands a new group of linear earthworks has been discovered. They are so far undated but oblique aerial photos of cropmarks taken by the project suggest that they should be dated to the late Iron Age.

An integration of airborne LiDAR and vertical aerial imagery to analyze two Iron Age hillforts in Northern Galicia (Spain)

João Fonte & Luis Gonçalves-Seco

Airborne LiDAR (Light Detection and Ranging) or Airborne Laser Scanning (ALS) is one of the most innovative and promising active remote sensing techniques for Landscape Archaeology. However, it is only by the combination of different techniques in an integrated perspective that we acquire a more complete overview of the hidden archaeology.

In this poster, by an integration of airborne LiDAR and vertical aerial imagery, we investigate two Iron Age hillforts in Northern Galicia (Guitiriz, Lugo, Spain). In particular, we combine airborne LiDAR data - with a focus on local relief models and visualization tools - with current orthophotos and historical aerial photos, namely those from the United States Air Force (USAF) 1950s flight.

With this complementary information we are able to analyse the recent past evolution and alteration and also the morphology of both settlements. In conclusion, we discuss the methodology and the results and we also make some considerations about future prospects.

The potential of archaeological landscape survey through airborne laser scanning (LiDAR) in the Czech Republic

Martin Gojda & Lenka Starkova

The proposed project aims at obtaining and processing archaeological data by means of a special method of remote (airborne) laser scanning, which first found application in archaeological field survey in the early part of this decade (the device used for obtaining the data is most commonly referred to by the term LIDAR). This method has not been introduced to Czech archaeology yet. The aim of the proposed project is to establish the potential of survey by LIDAR technology of the relics of prehistoric, medieval and post-medieval settlements preserved as earthworks in selected areas of the Czech Republic. By this potential we mean, above all, assessing the effectiveness of the process of mapping and complex documentation of areas with archaeological contexts preserved in a ruined form on terrain surface, especially in forested areas (woodlands).

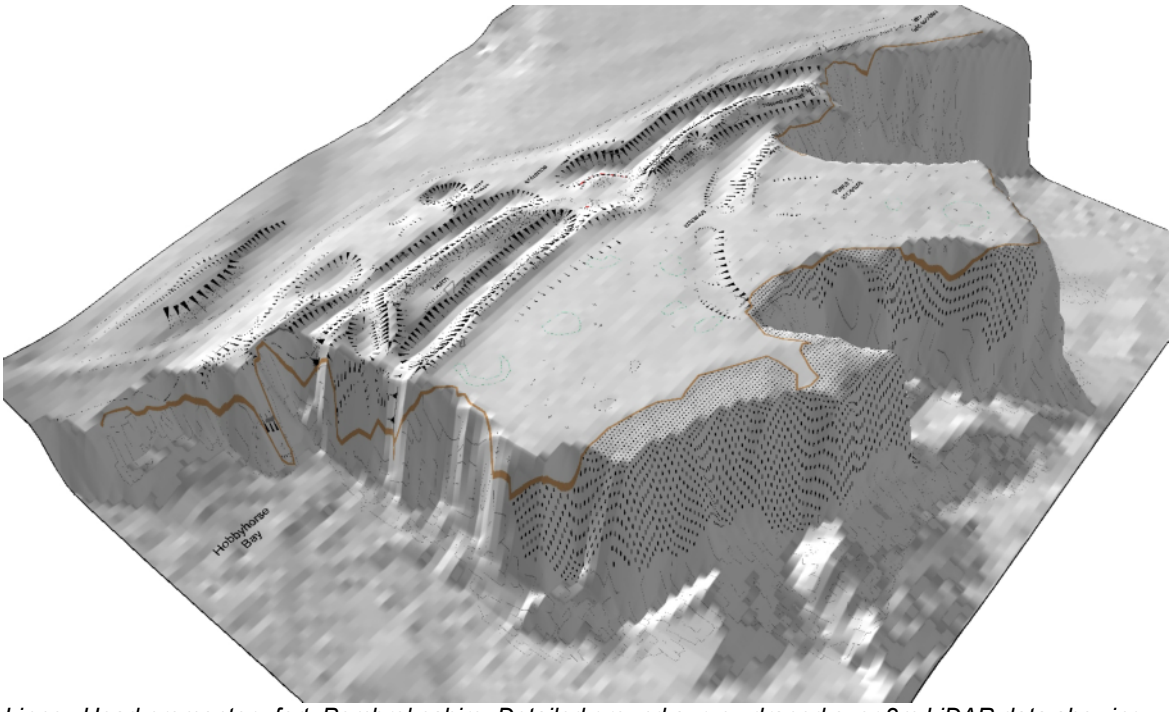
Airborne remote sensing, LiDAR and the coastal promontory forts of Pembrokeshire: A pilot project

Toby Driver **&** Louise Barker

Over half of the 106 coastal promontory forts known in Wales are located upon the dramatic sea cliffs of the Pembrokeshire Coast National Park. These are some of the most impressive monuments in Wales, yet also the most threatened. Their location leaves them continuously exposed to erosion by the sea and weather systems, and current and historical aerial photography clearly shows sporadic collapses. Recording the speed and impact of this erosion has become a priority for archaeologists, but as so few have been accurately surveyed it has been difficult to assess the rates of erosion. In light of this the Royal Commission on the Ancient and Historical Monuments of Wales and the Dyfed Archaeological Trust have recently undertaken a project, sponsored by Cadw, to test the use of remote sensing data for accurately mapping cliff-edge loss, and for producing archaeological plans that accurately show the character and condition of these threatened sites. Linney and Flimston were among a sample of Pembrokeshire forts chosen for analysis. It was hoped that the results would provide archaeologists with a quicker way of obtaining data than the traditional methodology of detailed ground survey, an often time consuming task which – in terms of cliff-edge monitoring – can also be potentially dangerous.

For this coastal project LiDAR data was used in conjunction with historic and recent aerial photography and 19th century Ordnance Survey mapping, with plans then taken out on site for verification and amendment. The essential control for this work was a measured ground survey, using a Global Positioning System (GPS). The

cliff-edge shown by the 2m resolution LiDAR (flown in 2004 and still the best available in 2010) for Linney Head Camp was simply not accurate enough, when compared with the ground GPS survey. Higher resolution LiDAR data may begin to achieve better accuracy, however, the cost of might make this prohibitive for all but the most special of cases. For now the job of providing accurate baseline data for future monitoring is best done using traditional methods of measured ground survey. In summary the project has been a valuable way to develop expertise in the use of LiDAR and comparative aerial, map and GIS datasets, to begin to chart cliff-loss and coastal erosion at archaeological sites. It has shown a clear way forward for the future integration of LiDAR data in archaeological projects, but has also shown that traditional methodologies for field survey and site recording remain essential components of coastal archaeological monitoring.



Linney Head promontory fort, Pembrokeshire. Detailed ground survey draped over 2m LiDAR data showing disparity between survey and remote sensing datasets. (Crown Copyright RCAHMW)

The search for Koknese fortress front fortifications

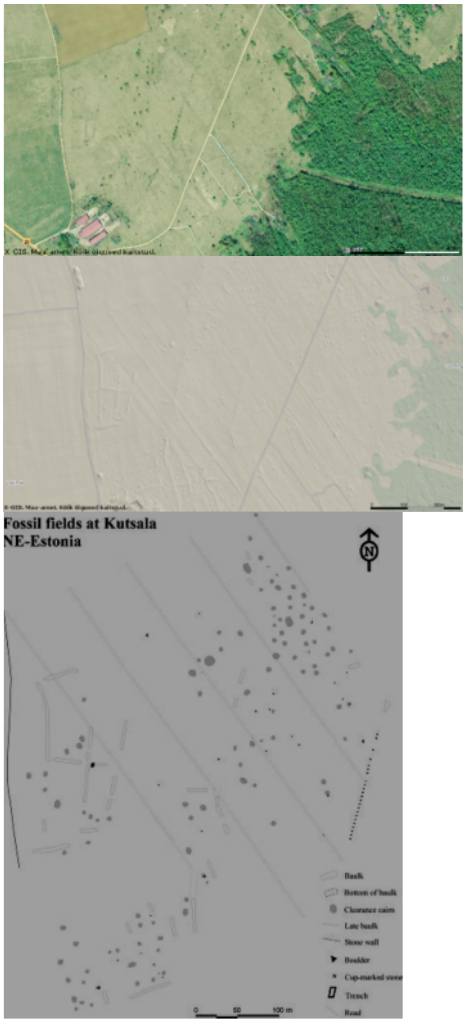
Juris Urtans

Koknese fortress is one of the mighty Latgalian, Livonian, Polish, Russian and Swedish fortresses. In 1700-1701 the fortress was surrounded by *c.* 6 km long front fortifications, which are levelled in the course of the time and now covered with modern buildings, agriculture, motorway, cemetery, etc. Using materials of different aerial fixations, LiDAR prospection, field walking, archaeological test excavation and probably underwater investigations we try to identify and localise the chain of defence system, which was built in very short time by 10,000 men e.g. October 1700 – May 1701.

The potential of using relief shaded LiDAR images in detection and investigation of fossil fields in Estonia

Helena Kaldre

This poster gives some preliminary information connected with the usage of LIDAR images in the investigation of fossilized field systems in Estonia. From 2010 LIDAR elevation data and aerial photographs are available in the Estonian Land-Board Web Map Server. This has opened new possibilities for detecting and investigating ancient monuments. I will look at the potential of these maps in combination with historical maps, aerial photographs and other methods of remote sensing in the investigation of already known fossil field systems and in detecting the new ones.



Towards an Integrated, Multi-method Remote Sensing Strategy for Archaeological Landscape Analysis: the Discovery of the Rosnaree Enclosure, Brú na Bóinne World Heritage Site, County Meath, Ireland

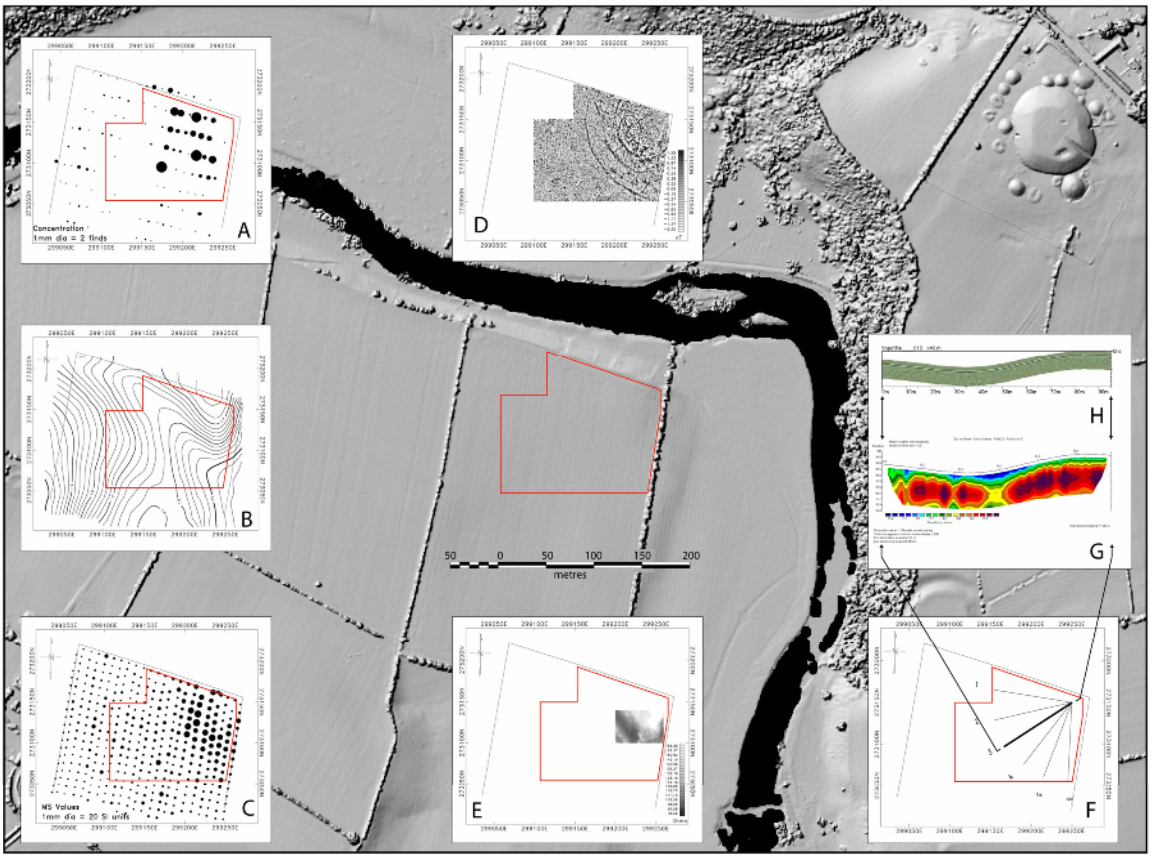
Kevin Barton & Conor Brady

Historically for site discovery and delimitation aerial photography, and latterly LiDAR, has been used in the Brú na Bóinne World Heritage Site, an internationally significant archaeological landscape known for its many Neolithic passage tombs and other monuments. The landscape is largely composed of the floodplain and terraces of the River Boyne which are farmed in a combination of pasture crops and tillage for cereals.

In the case of Rosnaree, the site was first identified as a large, dense scatter of worked lithics (chipped stone artefacts, primarily flint) in the NE corner of a tillage field (Fig 1A). The lithics suggested intensive activity, possibly involving residential settlement, broadly dating to the Neolithic (4,000-2,500 cal BC). There was no evidence for the site from legacy aerial photography or in a more recent LiDAR survey.

Multi-method geophysical and topographical survey (Fig 1B to H) funded by the Heritage Council has revealed the presence of the enclosure which has a complex set of internal features and is likely to be multi-phase. The enclosure is multi-vallate and measures *c.*110m N-S by at least 160m E-W. Unlike the passage tombs, the Rosnaree site is located on the southern side of the River Boyne, at a highly significant location within the Brú na Bóinne complex. It marks the point at which the river begins to delineate the famous 'bend' of Brú na Bóinne and is located directly to the SW and across the River Boyne from the Knowth passage tomb complex. It sits on a hitherto unremarkable low knoll on the first gravel terrace above the river. Because of its close association with the lithic scatter, it appears that the enclosure is likely to date from the Neolithic period. Reviews of the evidence for Neolithic enclosures in Ireland suggest that although there are some similarities to Neolithic enclosure sites identified elsewhere, there are no close parallels. The strategic location of the site, the presence of the animal bone in some quantity as well as a human tooth and a greywacke slab (the preferred stone type used in the construction of many of the passage tombs) all point to a complex set of functions for this site likely to include both a residential habitation element and a more ceremonial element. This is the first site of its kind to be identified in the Brú na Bóinne area and is additionally significant as it positioned on the S side of the River Boyne

Investigation of this site potentially addresses some of the key research questions identified in the Brú na Bóinne World Heritage Site Research Framework; developing new and refined methodologies in searching for new sites - in particular those related to settlement, the scale of operation of the monument complex, the changing environment and the significance of the River Boyne itself. What can we learn from lithic scatter, remote sensing and excavation data from this site that can assist us in a larger scale evaluation of the archaeological potential of the Brú na Bóinne World Heritage Site?

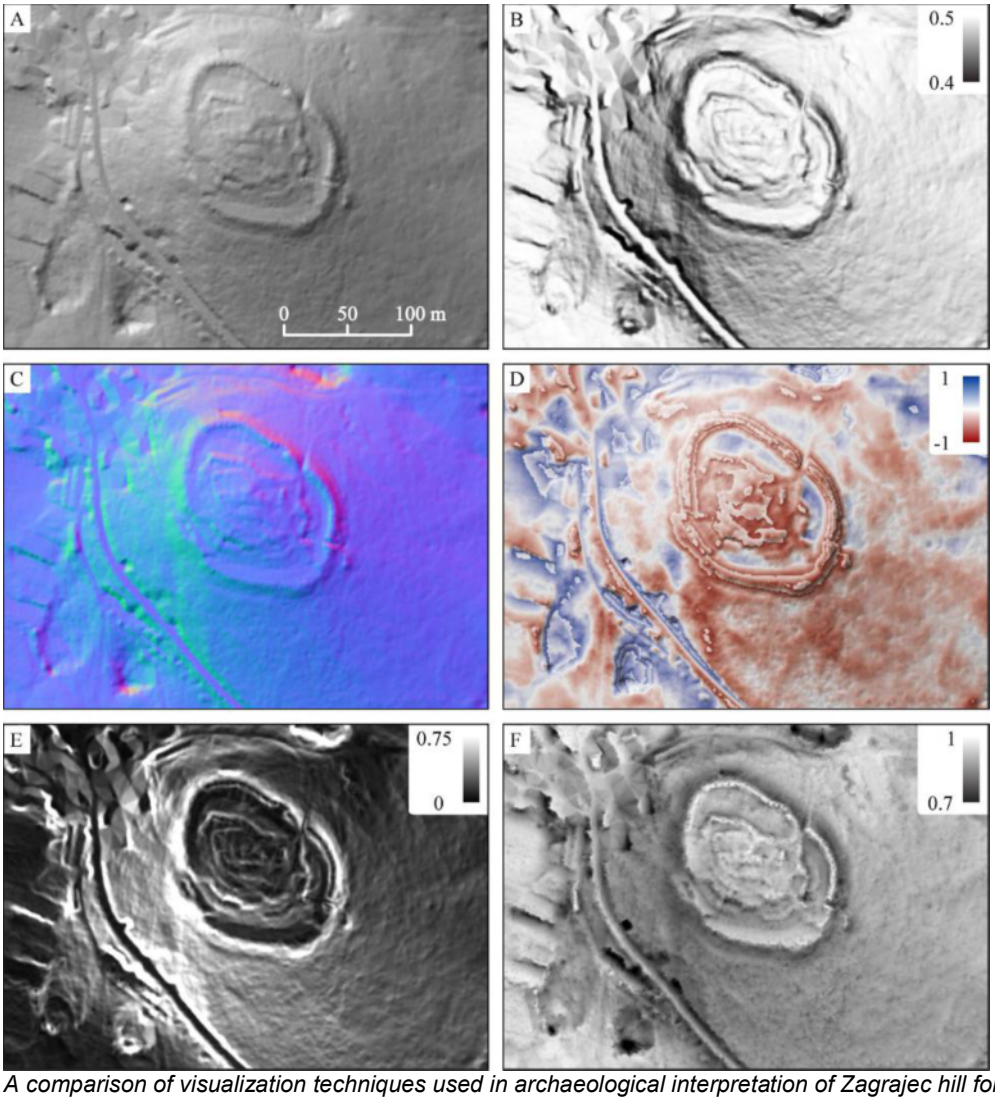


***A:** Proportional symbol plot of lithics density recorded during initial field walking survey. **B:** micro-topography (contours at 0.2m intervals). **C:** Proportional symbol plot of reconnaissance magnetic susceptibility data. **D:** Magnetic gradiometry plot. **E:** Earth resistance plot. **F:** Location of transect used for electrical resistivity tomography and ground penetrating radar profiles. **G:** Electrical resistivity tomography pseudosection. **H:** Ground penetrating radar section. The background for this image is from a recent LiDAR survey of the Brú na Bóinne World Heritage Site (courtesy of Meath County Council).*

Support of lidar advanced data visualisations in past cultural features recovery in vegetated areas: past water streams, bronze age hill forts, past settlements, WW1 trenches and shell craters

Žiga Kokalj, Krištof Oštir, Tatjana Veljanovski & Andrej Kobler

Relief visualisation is becoming a strong support in spatial data interpretation, and especially in archaeological interpretations. Its main advantage is that it can simplify and enhance interpretation of features. The poster aims to present a set of lidar data visualisations, both traditional and novel. Analytical hill-shading, micro-relief topography, derivatives of hill-shading from different directions (hill-shadings range, mean of hill-shadings, hill-shadings PCA), composite of hill-shaded relief and elevation differentiation, composite of hill-shaded relief and nDSM, composite of DOF and nDSM, and a sky view factor are presented. The performance of this set of advanced visualisations is shown for different applications: past water streams, Bronze Age hill forts, past settlements, WW1 trenches and shell craters.



A comparison of visualization techniques used in archaeological interpretation of Zagrajec hill fort, near Komen, Slovenia, a known but un-excavated site. ***A:*** *standard analytical hill-shading (45° sun angle 315° azimuth),* ***B:*** *the mean of analytical hill-shading from 8 directions,* ***C:*** *a RGB composite of the first three components of the principal component analysis of analytical hill-shading from 8 directions,* ***D:*** *trend removal and height coding by modulo distribution > (+/- 1 m),* ***E:*** *Sobel edge detection,* ***F:*** *sky-view factor (10 m search radius in 16 directions).*

Advancement of relief interpretation with sky-view factor in rendering details of past settlement structural elements

Žiga Kokalj, Klemen Zakšek & Krištof Oštir

A poster presents an archaeological application of a novel relief visualisation technique that is based on diffuse surface illumination – a sky-view factor. The sky-view factor estimates the portion of the sky visible from a certain point. Using sky-view factor as alternative method of relief mapping demonstrates how some problems with directional light in hill-shadings may be overcome when observing linear features that lie in the direction of the light source and how several structural features of past buildings can be revealed in settlement observation better then with basic hill-shading approach. The poster presents how different

computational parameters, such as distance and number of directions to compute the horizon elevation angle, influence the interpretability of archaeological features.

Visualisation tools for ALS Data

Nina Heiska, Jakob Ventin & Ilari Kurri

The visualization of airborne laser scanning (ALS) data is an essential task in the exploitation of point clouds. This summer several free software will be surveyed to evaluate their performance and versatility to visualize and manipulate point clouds. Previously LAStools by Martin Isenburg has been tested to create for instance hillshade images for archaeological purposes in Finland. However, now the end results of various software will be studied and visually compared with one another to discover the possible differences created by software. It is hoped that new alternatives will be discovered to replace expensive software products. Free software in combination with free or low-cost national Lidar data sets will further increase the use of airborne Lidar data in many applications including archaeology. This project is financed by the National Land Survey of Finland to offer more and various types of software solutions for their clients.

A “Task Force” in aerial imagery in the Public Service of Wallonia: A renewed approach in the management and analysis of aerial Imagery for archaeological purpose in The Walloon Region.

Claire Goffioul, for the Aerial Imagery Working Group (SPW)

Established in October 2009, this group includes the public officers (agents) who have or have had activities in the field of aerial imagery, whatever the vehicle and method used. Its purpose is to enable and promote an optimal integration and an efficient exploitation of aerial imagery. This initiative is part of a general framework approach aiming to apply non-destructive methods of investigation wherever possible in conjunction with the cartography of archaeological heritage and geomatics methods of analysis, and in a perspective of synergy within all the branches of the Public Service of Wallonia. This paper will present the objectives and actions of this young group, hoping to generate feedback and perhaps collaborations.

Air photographic analysis and mapping of the Roman town at Aldborough, North Yorkshire

Tara-Jane Sutcliffe

The Roman town of Isurium Brigantum lies beneath the small medieval village of Aldborough in North Yorkshire. The former glory of the town is attested by the partially extant remains of an impressive defensive circuit and a fine collection of mosaic floors. In recognition, the site is protected as a Scheduled Ancient Monument, partially under the guardianship of English Heritage. This withstanding and despite limited excavation, the detail of this once important administrative centre is surprisingly little understood. As a result, an air photographic analysis and mapping project was undertaken of the town and its immediate hinterland, drawing upon a rich history of aerial reconnaissance spanning 1927 to 2010. The results will be presented as a poster to the members of AARG, from whom all comments are most welcome.

NMR 20982/3 11-FEB-2010 Dave MacLeod (c) English Heritage.NMR

Reconstructing a ritual landscape from the air

Peter Halkon

Re-examination of cropmark data from Cathy Stoertz's "*Ancient Landscapes of the Yorkshire Wolds*" together with new data generated by the presenters own aerial photography has shed new light on a remarkable and under investigated ritual landscape on the edge of the Yorkshire Wolds escarpment, overlooking the Vale of York. Within a 3x3km landscape block are a neolthic long barrow, two cemeteries of Bronze Age round barrow cemeteries, the Arras Iron Age square barrow cemetery, all almost eradicated by the plough. The integration of crop mark and GIS data demonstrates the close link between topography and the siting of monuments here. Route-ways between upland and lowland are of particular importance and burial monuments seem to have been positioned with these in mind. In the later Bronze Age/Iron Age the linear earthwork systems here all seem to control access. This presentation aims to explore this landscape in the light of an excavation undertaken in September 2009 on a large early-mid Iron Age enclosure directed by the writer and Dr Helen Woodhouse first revealed through aerial photography.

the DART Project

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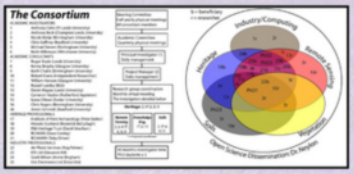
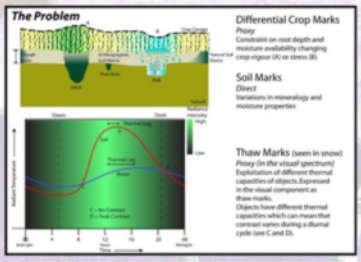
Detection of Archaeological Residues using remote sensing Techniques (DART) is a three year, £815,000 Science and Heritage funded initiative led by the School of Computing at the University of Leeds. The Science and Heritage programme is funded jointly by the Arts and Humanities Research Council (AHRC) and the Engineering and Physical Sciences Research Council (EPSRC). To examine the complex problem of heritage detection DART has attracted a consortium consisting of 25 key heritage and industry organisations, academic consultants and researchers from the areas of computer vision, geophysics, remote sensing, knowledge engineering and soil science.



Enhanced knowledge of archaeological residues is important for the long-term curation and understanding of a diminishing heritage. There are certain geologies and soils which can complicate the collection and interpretation of heritage remote sensing data. In some of these 'difficult' areas traditional detection techniques have been unresponsive. DART will develop a deeper understanding of the contrast factors and detection dynamics within 'difficult' areas. This will allow the identification of appropriate sensors and conditions for feature detection. The successful detection of features in 'difficult' areas will provide a more complete understanding of the heritage resource which will impact on research, management and development control.



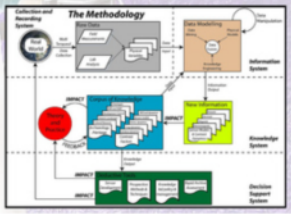
Aerial and geophysical survey have substantially increased our understanding of the nature and distribution of archaeology. However, there is variable understanding of the physical, chemical, biological and environmental factors which produce the archaeological contrasts that are detected by the sensor technologies. These factors vary geographically, seasonally and throughout the day, meaning that the ability to detect features changes over time and space.

DART will address these issues by increasing the understanding of the dynamic interaction between soils, vegetation and archaeological residues and how these affect detection with sensing devices. This requires understanding how the archaeology differs from, and dynamically interacts with, the localised soils and vegetation and how these differences can be detected. Data fusion techniques will be utilised to determine the factors that lead to contrast detection, the impact these factors will have on the sensor spectrum and the nature of any contrast dynamics. This knowledge will be distilled into domain ontologies which will become the core reasoning framework for decision support tools

Detection techniques rely on the ability of a sensor to measure the contrast between an archaeological residue and its immediate surroundings or matrix. Detection is influenced by many factors – changes in precipitation, temperature, crop stress/type, soil type and structure and land management techniques. DART will increase the foundational knowledge about the remote sensing of sub-surface archaeological remains. This will increase the understanding of how archaeological residues can be detected and the impact that physical, chemical, biological and environmental processes have on the detection process.

The programme of research has been designed specifically to identify contrast factors that may allow the detection of archaeological residues (both directly and by proxy) using sensing devices. To determine contrast factors, samples and measurements will be taken on and around different sub-surface archaeological features at different times of the day and year to ensure that a representative range of conditions is covered. Field measurements will include geophysical and hyperspectral surveys, thermal profiling, soil moisture and spectral reflectance. Laboratory analysis of samples will include geochemistry and particle size. Models will be developed that translate these physical values into spectral, magnetic and electrical measures in order to determine detection parameters. This will allow DART to address the following research issues:

- What are the factors that produce archaeological contrasts?
- How do these contrast processes vary over space and time?
- What processes cause these variations?
- How can we best detect these contrasts (sensors and conditions)?



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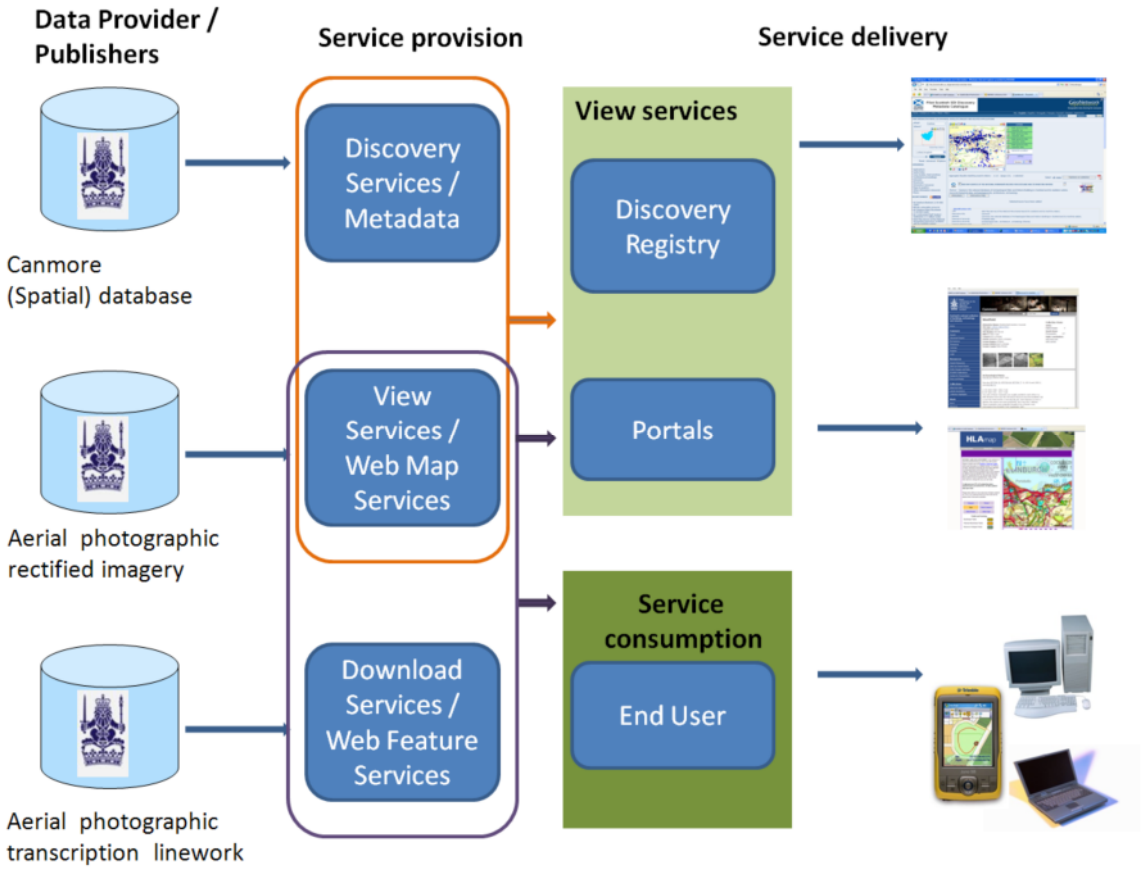
the DART Project

making the intangible tangible

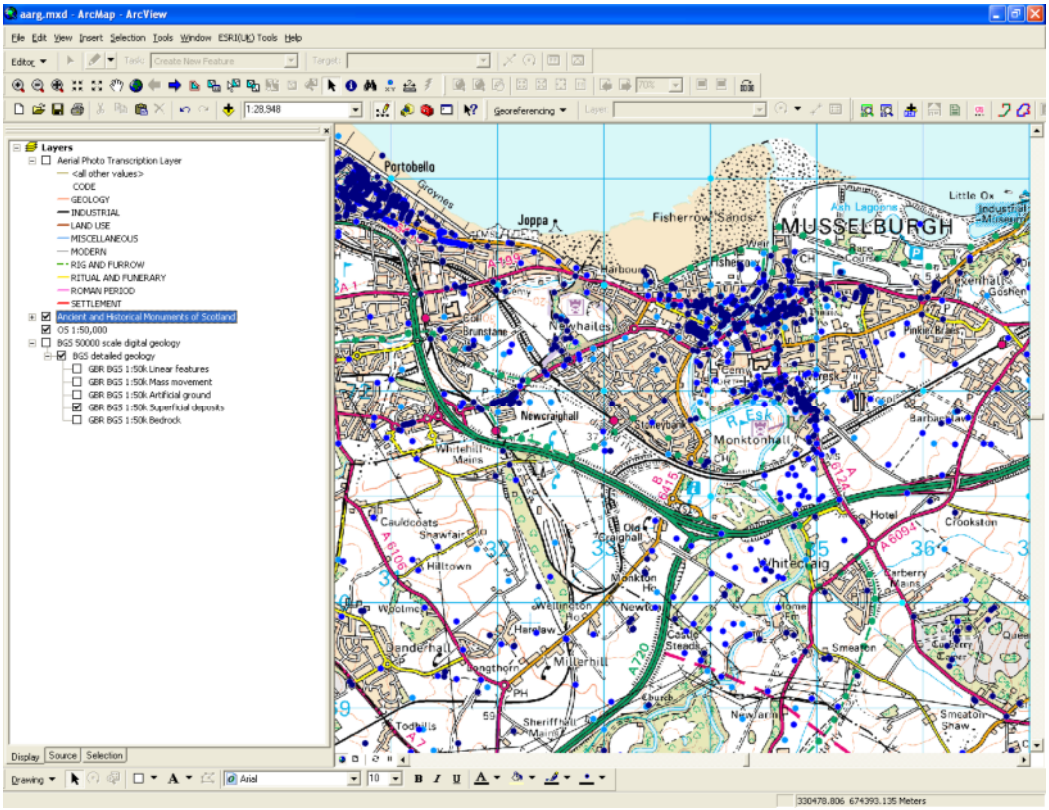
INSPIREd delivery: the development of web map services for aerial photographic transcriptions at RCAHMS.

Mark Gillick, Peter McKeague & Alistair Wilkie

The INSPIRE Directive was adopted by the European Community in May 2007. INSPIRE establishes the requirements for an infrastructure for Spatial Information in the European Community. It aims to ensure interoperability of information across regional and national boundaries for public data. To achieve this public bodies, and those holding public information, are required to adopt common Implementing Rules. The rules cover Discovery Services (metadata), view services (Web Map Services - WMS) and download services (Web Feature Services - WFS) for 34 information themes including Protected Sites. Both the United Kingdom and Scottish Parliaments adopted the INSPIRE Directive in late 2009, with a view to developing the requisite services over the next decade. Scotland is also developing its own Spatial Data Infrastructure (SDI) to provide the framework for managing the discovery and use of Geographic Information from public authorities across the country. Developing the Scottish SDI will help overcome barriers to data sharing, and meet strategic objectives. In particular the SDI will ensure that everyone can use the most up-to-date and accurate geographic information about Scotland, delivered with the best use of resources.



The development of a Spatial Data Infrastructure will enable the online delivery of information from data providers to public portals and consumed as Web Map and Web Feature Services.

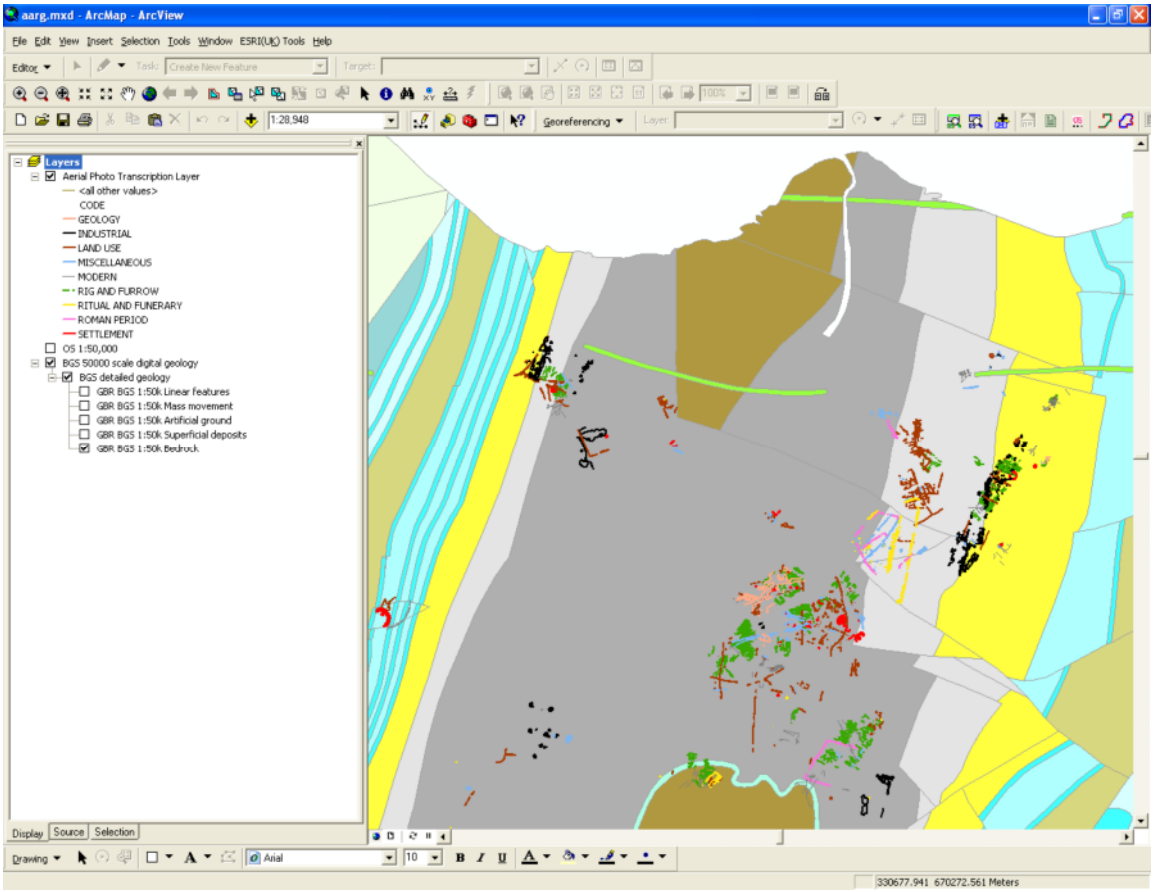


RCAHMS: site locations from Canmore provided as a WMS to a desktop GIS

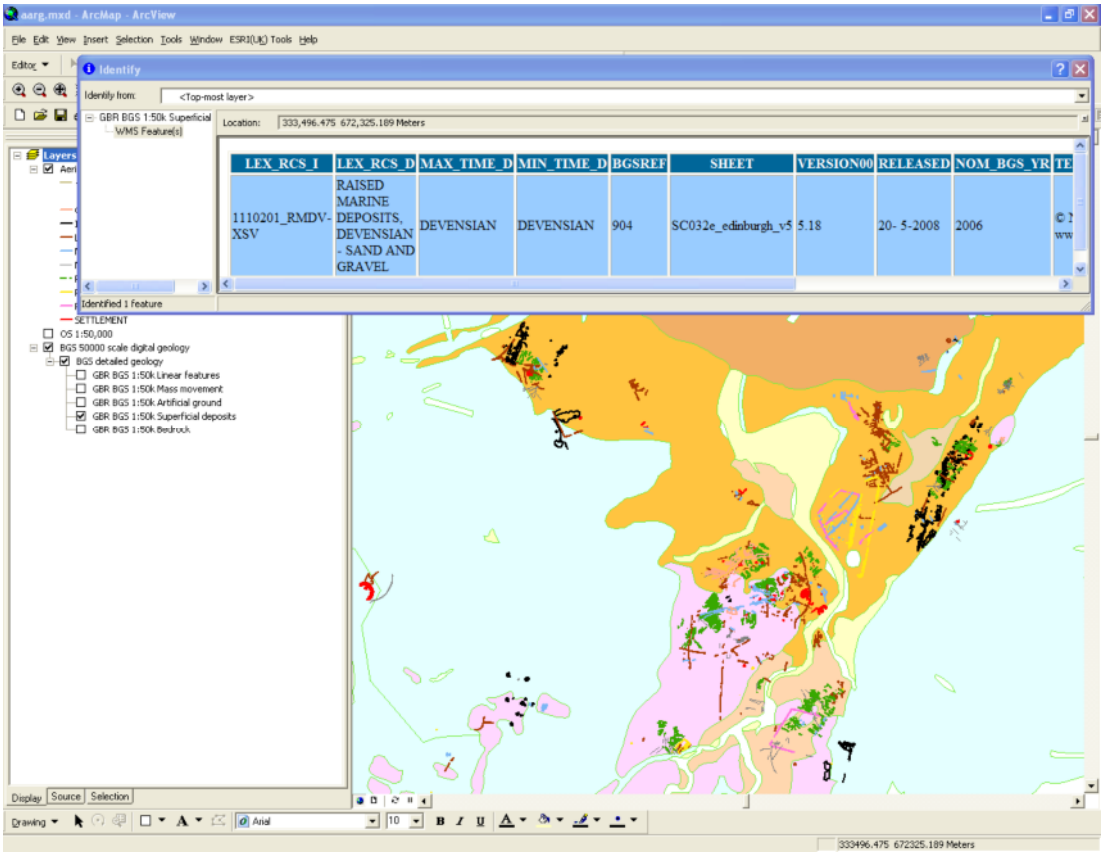
As curator of the national record of Scotland's archaeological and built heritage RCAHMS holds information relevant to the INSPIRE Directive Protected Sites theme. Information from RCAHMS is published through its online searchable database 'Canmore'. Using guidelines produced by The Scottish Government, RCAHMS released its first WMS in May 2010. The published WMS provides the user with a spatial view of information from Canmore. The user can identify individual features in the map and see limited associated information, such as the record number, the site name and classification.

Work is currently underway to develop further services to publish the results of the RCAHMS Aerial Photographic Survey mapping programme. This will allow both the interpreted transcriptions and geo-rectified digital copies of the original oblique photography to be disseminated. At present transcription information is only easily accessible to staff at RCAHMS through display in their desktop GIS and, as such, the data is not regularly consulted by either the public, or professional archaeologists, undertaking desk-based assessments or fieldwork under contract.

The benefits of presenting transcription information as WMS are clear. The aerial photographic transcriptions will be added to Canmore as part of a planned overhaul of mapping on the website, to provide better public access to spatial information. Whilst there will inevitably be concerns by some over the misuse of sensitive information, there is also an expectation of open access to information created or collected through the public purse. The WMS will be available for professional users to add to their own desktop GIS and view against their own data holdings. Online delivery of the aerial photographic transcription information to professional users will ensure it is used much more effectively in consideration of planning and other assessments.



Screenshot showing RCAHMS aerial photographic transcription information displayed against the 1:50,000 solid geology relief map supplied through a WMS from the British Geology Survey.



The WMS publishes a picture of the information held by the source organisation. In this example, where the RCAHMS transcription data is displayed against the British Geological Survey superficial geology deposits, the user may query the map to identify particular deposits. However, users are currently unable to perform more complex tasks such as changing the colour of the map display, selecting features from the WMS, or complex analysis of vector data against the WMS. This functionality will be available once associated WFS are developed in 2011-12.

Further information

EUROPEAN UNION 2007. Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE) http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2007:108:0001:0014:EN:PDF (accessed 14 August 2010).

SCOTTISH GOVERNMENT 2005, One Scotland, One Geography http://www.scotland.gov.uk/Resource/Doc/57346/0016922.pdf (accessed 14 August 2010)

SCOTTISH GOVERNMENT 2010 One Scotland: One Geography: One Information Network: Creating Scotland's Spatial Data Infrastructure: Cookbook 1 - How to serve a Scottish SDI and INSPIRE conformant Web Map Service. http://www.scotland.gov.uk/Publications/2010/05/06161701/0 (accessed 14 August 2010)

SCOTTISH STATUTORY INSTRUMENTS 2009, Environmental Protection. Public Sector Information. The INSPIRE (Scotland) Regulations 2009 No.440 (Edinburgh). http://www.opsi.gov.uk/legislation/scotland/ssi2009/ssi_20090440_en_1 (accessed 14 August 2010)

Metadata

Pilot Scottish Spatial Data Infrastructure Metadata catalogue http://scotsdi.edina.ac.uk/geonetwork/srv/en/main.home (accessed 14 August 2010)

Existing Web Map Services

British Geological Survey http://www.bgs.ac.uk/data/services/wms.html (accessed 14 August 2010)