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Editorial

Education, teaching, etc
In April the AARG Occasional Publication, *Education in Aerial Remote Sensing for Archaeology*, edited by Dave Cowley and myself, was published. The report is downloadable as a pdf document from the AARG website and members were advised of this in April. The volume collated a series of papers dealing with aspects of education in specialist and non-specialist teaching and identified a role for teaching aids. It also contained the report of the AARG/EAA Working Party on Aerial Archaeology. The papers are Euro-wide and deal with the promotion of aerial remote sensing at various levels of education and its integration into landscape archaeology. Although token mention was made to satellite sources there was little real input other, perhaps, than by Stefano Campana at Siena. Most of us do not have the experience (other than using web sites such as Google Earth) of the techniques that the current generation of research students are applying to images. Nor, so far, have we seemed to have much interest in them or tried to relate to people using them. I think many people among us have been seduced by the detail that can be seen in a hand-held photograph taken from 300m and are unable to question whether this level of detail is really necessary everywhere or for every archaeological purpose. Of course it’s not, however nice it is to have it here and there, and if we are working on landscapes rather than sites then vertical aerial photos or satellite images are going to provide the most thorough cover. You only need to look at GE or other similar sites to see how scattered in places is the archaeological stuff – and then to wonder how much chance a low-flying observer has of finding half of it.

It is, therefore, with perfect timing that this issue leads with a paper by Véronique De Laet and Karsten Lambers who are students working with satellite images, computers and GIS. By invitation, they report on the session they organised at CAA and follow that with an excellent discussion about problems, the future and about the need to have some kind of input from what I’ll call ‘analogue interpreters’ – people who have learned or been taught to look at photographs. This, I think, is a major step in the development of photo/image interpretation that we can ignore only if we want to drag what some of you call aerial archaeology further up its cul-de-sac. This is far more ‘the future’ than a handful of people sitting at tables browsing curly photographs. Yes, we still need stereo pairs and the satellite people are aware of that, but interpretation has moved in recent years from paper to screen as most of us (I think) now work. But it seems to be in the GIS world where the enthusiasm and experimentation is active [just read some of the published stuff on satellite uses] and is likely to really change the way that the past is perceived and understood through above-ground remote sensing. There, examination of images will become part of a process of analysis rather than the isolated study that often it has been until now. Several years ago when Dave Cowley (I think it was) and I were asking where the students would come from his answer was that they’re already here but they now call what they are doing GIS rather than aerial photography.

Yes, there are limitations to what they are doing – but many of those seem to be because they have had no training in photo examination. Rather than dabble visually and uncertainly, they have jumped directly to testing and adapting some of the image-processing and analytical methods developed by (usually) other disciplines. Doesn’t this remind you of those

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archaeologists who borrowed models from geographers back in the 1970s…? And it is no bad thing that they are trying these methods. What seems less good is the apparent lack of criticism of some of the methods (eg what I have seen of edge detection) and the courage to admit when something doesn’t work. Worse than that are the few misjudged interpretations that have been made (eg the ‘pyramid’ discovered in Peru) by people who have little experience of visual examination and who cannot see beyond a familiar shape. If archaeologists want to learn what can be seen on satellite images and on aerial photos, I’m in favour of offering them all the help we can. But… (of course there’s a but)… I believe we will need to radically change what we teach and the way we teach if we are to usefully help those people or other archaeologists who are interested in airborne (or higher) remote sensing.

…the but

Over the past several years I’ve become disillusioned by the way a lot of us teach… the same old stuff in the same old order, maybe with a few different pictures thrown in, but always to the same general pattern. I suppose this was highlighted during my involvement in the C2000 training weeks in which the same people insisted on doing the introductory lectures (“because we have got it off to a fine art and we all share the same slides”) which, I thought, didn’t usefully introduce what we were trying to teach and were often using methods and concepts which were irrelevant in the computer age. There are, of course, certain basics which will always be relevant and it is those that we need to keep and develop.

Why do I think we are going wrong? One explanation is to quote one of Roger Mercer’s phrases when we were digging at Hambledon Hill, “Work from the known to the unknown”. So where does our teaching usually start? With the unknown – with aeroplanes, aerial photos and botany. And, if I remember correctly, it never quite gets very deeply into the archaeological sites and landscapes that should be our main interest. As usual, I’ll blame a lot of this on the aerial photographers who seem to think that everything starts with them. It doesn’t – it started 5000 or so years earlier when people began to alter the earth. And there, I think, is where our teaching should begin. Forget different types of photos – they don’t matter – although the philosophy behind taking them is important. And if you must divide photos into types try dividing them into useful ones, useless ones and pretty ones. Forget those pointless positive and negative crop marks, snow marks, frost marks, poppy marks, etc and tell students what is underneath the crops and the soil because that is what they really need to know about. They want to know about archaeology and we – or you – need to escape from your boring aerial box if you want to make useful contact with them. Is it any wonder that real archaeologists don’t think much of you ‘aerial archaeologists’ if we are unable to teach students anything that will be useful to them?

If we move to embrace those computer-literate students who are using GIS and satellite data we must learn about their methods. We will need examples from their work for comparison with what can be seen by an experienced person. We are also back in the objective-subjective debate to some degree because automated methods tend to be seen as objective. Thinking of this almost takes me back to the enthusiasm of student days – and this is something that we have to keep alive in current and future generations. Another big plus is that some of these students are likely to end up in university jobs which will have the benefit of putting remote sensing with people who will use it as one tool in some major investigative research projects.

OK – maybe this has been another Rog rant, but (as usual?) deservedly so. I’ve been working on something that initially I called ‘teaching backwards’ but now I think that it’s others who are teaching backwards. I’ll ask if any of you has considered that there may be other ways of teaching our subject? Can topics be put in a different order so that students may hook on to a few
things before getting confused by verticals, obliques and this-and-that mark? Why assume that
the old way is the right way? And why begin with an observer in an aeroplane when this really
ought to be seen as a last resort that may be used when all other means of collecting data have
been exhausted?

These paragraphs may serve as a warm-up to a session that we are planning for AARG 2010 that
will mix interpretation and teaching. It also leads into the topic of this issue’s Chairman’s Piece –
so you have a year in which to reflect on this and prepare your cases.

New words
The wonderful British heritage organisations, who think that photography is the plural or
collective of photograph, invented a new practically-impossible word this year – or perhaps they know something that we don’t know and there really are
cameras in aircraft that cunningly geo-rectify and stitch together newly-taken vertical photographs
while the aircraft is in flight. The word was deleted from the AARG programme but I am waiting
(and may be counting) to see how many times it slips into the two talks that have been offered to
the Siena meeting. Interestingly, and correctly, all of the non-Brits used the word photographs in
titles of papers dealing with more than one photo. Clearly we need foreigners to teach some of us
proper English….

I also wondered what was so special about orthophotos apart from the fact that they’re likely to be
awkwardly upside down in a GIS. On the plus side, they’ll give us contemporary control data; on
the negative side they provide other sets of photographs that we need to look at now that internet
sources add to the photo collections that interpreters use (or is that a plus). They are also easy to
drape over terrain models, but I would question how many times we can usefully do that. And
those of us who haven’t got taxpayers’ money to spend can see the same photos in, for example,
Google Earth. Those of us who use AirPhoto can save GE crops automatically geolocated for the
price of that program and, if we want to, can drape them over a DTM in the free AirPhoto3D
program where we can have fun flying around them. Great graphics(?) – which sometimes can
help archaeological understanding. Hopefully, all will be revealed about ‘official’ use of this new
photographic technique at AARG 2009 – but for a quick and cheap do-it-yourself method, see the
articles by Irwin Scollar in this issue and AARGnews 37.

This issue…
…also includes a piece written by Øivind Due Trier, Siri Øyen Larsen and Rune Solberg – of
the Norwegian Computing Center – on their results from auto-detection of satellite images.
This follows the thoughtful paper by De Laet and Lambers. We have some uses of NMP data
in Shropshire, UK, from Andy Wigley and a note on uses of remote sensing in India by
Manjil Hazarika who received an AARG bursary to attend the Rome meeting in 2008. And
near the end, Ant Beck reviews and extends from the reprint of Irwin Scollar et al’s 1990
Archaeological Prospecting… the Big Black Book. This issue is ‘thinner’ than usual but
includes some good forward-thinking contributions.

Standing Orders
There remain several members who have not transferred their subscription Standing Orders from
Lloyds to the newer HSBC account. Please check your SO details and amend them if necessary
before January 1. Further details, if necessary, from our Secretary: lidkazuk@amu.edu.pl
Why interpretation?: Chairman’s Piece

Włodek Rączkowski¹

Where are we?
The AARG is changing. Originally a British initiative concentrating mainly on issues connected with aerial archaeology in Great Britain, today it is an international organisation reaching far beyond the British Isles. Although its members are from all over the world it is dominated by Europe. Changes in the AARG concern many aspects which are probably most visible across international activities, in the field of education, the promotion of cultural heritage. Likewise, issues discussed within the ARRG, at the annual conference or on the AARGnews forum are also changing. Some time ago, doubts appeared in our discussions as to the influences of aerial archaeology achievements on general reflection and archaeological practices. We started to notice that aerial archaeology is being marginalised in general archaeological discussion. Many statements within the last decade have included concerns that aerial archaeologists have closed themselves off from other groups (e.g. Bewley and Rączkowski 2002; Żuk 2005), they discuss great discoveries or projects connected to mapping and lose touch with the “real world of archaeology”. The source of these findings was the frustrating observation that such effective material as are aerial photographs themselves, but mainly the archaeological content transferred onto maps, does not encourage archaeologists to fully utilise this potential in the study of the past.

Leaving the ghetto?
Since the time that such comments appeared the AARG has started to take up many initiatives which are aimed at taking aerial archaeological out of the ghetto which it has shut itself into. This includes cooperation with, for example the European Association of Archaeologists (e.g. Bournemouth 1999) and the International Society for Archaeological Prospection (e.g. Vienna 2001). These were attempts to make contact and exchange ideas with archaeologists concerned with different issues and to show them how effective aerial photographs can be. Other activities aimed at solving the “ghetto” problem were attempts at building self-reflection on aerial archaeology and understanding what we do, how and why we do it (e.g. Rączkowski 2002; Brophy and Cowley 2005; Hanson 2008; TAG at Glasgow in 2004). How can we, from today's perspective, evaluate the effectiveness of these activities? Have we been able to demolish the walls of the ghetto? For certain, there's no one straight answer.

So far we haven't observed a sudden increase in interest in aerial archaeology research results. At least one point though is becoming very clear. Many aerial archaeologists participate in numerous conferences dedicated to various problems of different aspects of research into the past and they present the results of their work using aerial photographs (e.g. Limes: International Congress of Roman Frontier Studies; Pathways to Landscapes – session at EAA conference in Zadar in 2007). It seems that more and more aerial archaeologists are interested in conferences on other non-invasive methods (e.g. Archaeological Prospection, Remote Sensing Archaeology). Participation numbers in these conferences show that archaeologists making use of geophysics, satellite images, multispectral and hyperspectral sensors, etc. have

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similar problems to aerial archaeologists – they present the results to other specialists from the same field (themselves), they discuss technological aspects, create their own ghettos. In reality, is cooperation across a wider area of “remote sensing”, particularly in a “landscape studies” aspect, a successful attempt to get out of the ghetto? Increasingly, I am not so sure. Are we not perhaps creating a new, different ghetto – a “remote sensing archaeology” ghetto?

Integration – a solution?

The integration of various methods in the study of the past is nothing new and its roots go back at least to the 20's and 30's of the 20th century (e.g. functionalism – Trigger 1989). Integration in aerial archaeology practice refers to connecting the results of aerial survey with other prospection methods (field-walking, geophysics, LiDAR, multispectral etc.), especially in the “landscape archaeology” field. These two terms: “integration” and “landscape”, have today become the central field of discussion within aerial archaeology. This is evident in the titles of the European projects either already completed (European Landscapes: Past, Present and Future) or underway (ArcheoLandscapes Europe). Within the basic aims of projects from 2004–2007 we can find a point of integration “Innovative surveys using laser technology (e.g. Lidar) and other forms of airborne and satellite remote sensing; testing and promoting the use of these techniques in archaeological landscape analysis and presentation for use in long-term conservation projects.”

2 Spectacular examples of surveys using various methods (e.g. Powlesland 2006) increasingly influence aerial archaeologists' imagination (rather less so archaeologists). This leads to the formulation and realisation of “total archaeology” projects (e.g. Goffredo 2006), referring to the idea proposed by C. Taylor (1974).

So once again the questions arises: is the integration of methods the way out of the ghetto? On the one hand this is one way of putting it, as the need appears for cooperation with representatives of other archaeology subdisciplines. But in practice it just results in the description of the findings of various methods and the use of GIS to overlap them. Surprisingly often these “integrated” surveys are devoid of “interpretation” (unless we also treat the pure description of the results as interpretation).

Why interpretation?

The phrase “interpretation” is in contemporary archaeological language almost as popular as “landscape”, “multivocality” or “integration”. But what does it actually mean in practice? And are we always aware of the consequences which using this term in the narrative carries with it? More and more often I get the impression that it has become a meaningless, trendy term which must be present if the narrative is to have “modern” characteristics or if a project proposal is to be accepted.

So what is so special about “interpretation”? “Interpretation” is the process of ascribing meaning. This phrase and the way it has been understood has been shaped by literature. In archaeology (and not only) it arose as a result of linguistic turn and was contrasted against scientific “explanation” which was required in processual archaeology.

In aerial archaeology practice “interpretation” is everywhere. If we accept its understanding in a post-modernist way then we “interpret” at every stage along the way. Philosophic

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2 http://www.muzarp.poznan.pl/EuLandscapes/aims/description.htm
discussions on the consequence of the understanding of “interpretation” usually refer to texts and their reading. In aerial archaeology we can easily transfer this to photographs (photo-reading) and maps (map-reading). So then, we come across “interpretation” during aerial reconnaissance (current landscape-reading) to understand landscapes and get “proper” shots, when we work with photographs (photo-reading) to understand what is photographed and to map “properly” and also we analyse maps (map-reading) to get meaning of past landscapes. The resulting photo-, map- and landscape readings depend on the context of their reading and the readers themselves. Umberto Eco (1990) commenting on the influence of the reader on the giving of meaning to a narration divides them into two groups: the naïve reader and the critical reader.

Likewise, when I say that every text designs its own Model Reader, I am in fact implying that many texts aim at producing two Model Readers, a first level, or naïve one, supposed to understand semantically what the text says, and a second level, or critical one, supposed to appreciate the way in which the text says so. A sentence such as they are flying planes foresees a naïve reader who keeps wondering which meaning to choose – and who supposedly looks at the textual environment or at the circumstance of utterance in order to support the best choice – and a critical reader able univocally and formally to explain the syntactic reasons that make the sentence ambiguous (Eco 1990: 55).

Why does Umberto Eco's comment seem to me to be of importance in the context of aerial archaeology? It means that in working with aerial photographs and maps we can take one of the two aforementioned options. Of course it is possible to function well in aerial archaeology limiting oneself to the “first level”. But we can only talk about the real development of critical reflex in aerial archaeology in the context of reading at “second level”. If we are continually dealing with interpretation then this issue should be the subject of general discussion. I don't doubt that in everyday practice that's how it is – we consult with those around us what it is we see in the photographs, we consider carefully why it is we see something or not, we try to determine function, the chronology of individual features and their environmental contexts. But how often do we switch from “second level” to “first level”? Are we fully aware of the consequences of our interpretations?

Certosa di Pontignano (Siena) 2009 – escape… interpretation?

This year's Annual Meeting confirms changes in the AARG in the sense of the consolidation of the international, European dimension of our activities. Also, the issue of “landscape” is clearly emphasised. Themes concerned with the integration of aerial photographs and other remote sensing methods appear. In this sense we are still on the road out of the ghetto. Although “interpretation” is missing. Amongst the proposed sessions there was one dealing strictly with “interpretation” – Interpretation, Interpretation, Interpretation… in the 21st century. But those willing to present within this field were few. So I do wonder, what does this mean? Could it be that nobody is interested in photo-reading, landscape-reading or map-reading at “second level”? So therefore are we somehow still psychologically closed?

More questions than answers. Perhaps the coming years of the AARG will bring some answers. For sure new questions will also appear. But this is optimistic – as long as there are questions we have something to think about. I wish all participants in the conference in Certosa di Pontignano a fruitful discussion and more questions than answers. Perhaps some of the discussion and questions will also be related to the themes which bother me?
References


Archaeological Prospecting Using High-Resolution Digital Satellite Imagery: Recent Advances and Future Prospects - A Session Held at the Computer Applications and Quantitative Methods in Archaeology (CAA) Conference, Williamsburg, USA, March 2009

V. De Laet and K. Lambers

Introduction

Over the last few years, a new generation of satellite sensors has provided an unprecedented variety of remotely sensed imagery with a spatial resolution of 1 m and better. These images allow for the first time even small archaeological sites and features to be detected, which is a huge step forward for archaeological prospection: “For three decades archaeologists have waited for a high-resolution satellite capability and the arrival of satellites such as Ikonos and QuickBird signals a new era in research.” (Hung 2006: 680). Since about 2004, when the 1st International Conference on Remote Sensing Archaeology was organised by the Chinese Academy of Sciences in Beijing, specific conferences have helped to promote research in this new scientific domain. These include the 2nd and 3rd International Conferences on Remote Sensing Archaeology in Rome (2006) and Tiruchirappalli (2009), the 1st International Workshop on Advances in Remote Sensing for Archaeology and Cultural Heritage Management in Rome (October 2008), the DECARS meeting in Amsterdam in April 2009, as well as special sessions at AARG, CAA, ISPRS, CIPA, SPIE and other conferences.

Archaeologists have been quick in realizing the great potential of high-resolution digital satellite imagery for the detection and documentation of archaeological sites and features. A growing number of case studies with interesting results have evolved from ongoing archaeological field projects in recent years. While some of these projects have been limited to a visual inspection of images to aid fieldwork, others now go beyond this level by applying advanced methods of digital image analysis in order to extract archaeological information. These methods include, among others, multispectral analysis, image classification, pattern recognition, photogrammetry, and related approaches. However, a systematic evaluation of the potential of these methods, which were usually developed for different kinds of applications in the geo and bio sciences, and the potential of the new data source itself remains a desideratum. At the same time, important progress has been made in the processing and analysis of declassified high-resolution analogue photographs acquired by Corona and other spy satellites in the 1960-80s. Especially when analysed in conjunction with other images, these photographs have proven to be yet another valuable new data source for archaeological prospection.

During the 2009 CAA conference (Computer Applications and Quantitative Methods in Archaeology, see www.caa2009.org) in Williamsburg, USA (the capital of Virginia from 1699 to 1780 and today the nation’s largest outdoor living history museum), we organised a special session that aimed to explore the potential and limitations of high-resolution digital satellite imagery, and of current methods of digital image analysis with regard to the requirements of archaeological prospection. Our session was entitled Archaeological prospecting using high-resolution digital satellite imagery: recent advances and future

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prospects. Preference was given to papers with a methodological focus, addressing specific problems of identifying archaeological features through digital image analysis and showing recent advances and promising research strategies. Overview papers and new case studies complemented this session that brought together specialists from the fields of archaeology, remote sensing, geography, photogrammetry, digital image analysis, and related disciplines. In what follows, we will give an overview of the contents of this session along with some thoughts about the state of the art and the future of satellite remote sensing in archaeology.

Papers presented in the CAA 2009 session
The following eight papers were presented in our CAA 2009 session:

- K. Lambers (University of Konstanz) & V. De Laet (Katholieke Universiteit Leuven): Extracting archaeological features from high resolution satellite imagery: a review of current projects, problems, and promising approaches
- A. Traviglia (University of Sydney): Characterizing Angkorean landscapes: RS based feature detection in tropical areas
- V. De Laet et al. (Katholieke Universiteit Leuven): Very high resolution satellite remote sensing as part of an integrated approach for archaeological prospection at Tepe Düzen (southwest Turkey)
- D. Donoghue et al. (Durham University): The Fragile Crescent Project: the rise and decline of Bronze Age urban settlements in the ancient Near East
- D.J. Tucker (Martin Luther University Halle-Wittenberg): Potential of simple feature signatures for mapping landscapes of mobile pastoralists
- J. Casana (University of Arkansas): CORONA imagery archaeological atlas of the Middle East
- J. Cothren et al. (University of Arkansas): Effects of ground control point accuracy on triangulation and ortho-rectification of large blocks of CORONA images
- T. Kalayci (University of Arkansas): Accuracy of DEM generation from CORONA stereo pair images

A paper given by K.L. Kvamme (University of Arkansas) on Modelling subsurface content through multidimensional remote sensing, multivariate analysis, and raster GIS in a GIS session will also be considered here, as it was closely related to the topic of our session.

In our introductory presentation, we reviewed current projects (mainly by researchers not present in our session), problems and promising approaches of semi-automatically extracting archaeological features from high-resolution satellite imagery and determined promising starting points based on available literature. In our view, a basic research issue in satellite-based archaeological prospection is to what extent methods and algorithms from the field of digital image analysis can assist the detection and documentation of archaeological features. The fact that archaeological remains may take on a near infinite variety of formal and spectral properties complicates their extraction using rule-based algorithms. In spite of these difficulties, case studies from recent years (Altaweel 2005; Beck et al. 2007a, b; De Laet et al. 2007a, b, 2008, in press; Garrison et al. 2008; Lasaponara, Masini 2006, 2007; Lasaponara et al. 2008; Menze et al. 2007; Masini, Lasaponara 2007; Saturno et al. 2007; Schmid et al. 2008; Trier et al. 2008, 2009; Wilkinson et al. 2006) show that, if used properly, image pre-processing and enhancement, multispectral and hyperspectral analysis, photogrammetry, pattern recognition, and related methods can assist the identification of archaeological features to a considerable extent.
A case in point was the paper delivered by A. Traviglia, who applied image processing techniques like vegetation indices, vegetation suppression, and principal component analysis to multispectral and radar data in order to map unknown archaeological sites and structures (often buried or hidden under the forest canopy) of the ancient Khmer landscape in the surroundings of Angkor, such as palaeo-rivers and historical channels. These elements are crucial for a correct understanding of the extension of the Khmer settlement, the water flow system and its redirection, and of the processes which led to the site’s decline and abandonment.

D.J. Tucker’s paper demonstrated the potential, though not yet applied, of simple feature signatures and semi-automated pattern recognition algorithms for mapping the extensive patterns of nomadic activity in the Syrian Desert. Typical recurrent shapes, proportions, and locations of tent sites, dung patches, water retaining walls and radial animal trails provide an excellent starting point for generalised formal descriptions of archaeological features that are a prerequisite for the successful application of rule-based detection algorithms.

Image processing can aid archaeological prospection especially when digital image analysis of high resolution satellite images is combined with other data sources and prospection methods, such as aerial and satellite imagery with different spatial and spectral resolution, digital elevation models, ground-based geophysical prospecting, archaeological fieldwork, etc. as shown in the presentations by V. De Laet et al. and K.L. Kvamme in Turkey and Kansas, USA, respectively (the latter in a session on Cell-based analysis and landscape archaeology: new approaches and new applications). V. De Laet presented a stepwise interdisciplinary integration and back-coupling of high-resolution satellite images, aerial and archaeological surveys, topographic mapping, geophysics, and excavations in order to evaluate the potential of high-resolution satellite imagery to detect unknown archaeological features and to fully understand the nature of the Tepe Düzen site. In his paper, K.L. Kvamme combined different kinds of geophysical survey data, thermal infrared aerial images and QuickBird multispectral images to predict locations likely to contain archaeological features. This fusion of geophysical and optical data provided a suitable basis for unsupervised and supervised image classification that resulted in the mapping of different elements of the historical military installations under study, such as stone and brick walls, pipes etc.

The paper by D. Donoghue et al. demonstrated the value of combining high-resolution optical images with digital terrain models derived from modern and declassified satellite imagery like Corona and Gambit to study large regions. Cold War-era Corona and Gambit photographs from the 1960s and ‘70s have proven to be an invaluable archaeological resource that can never be replaced by new technologies, as they predate important landscape alterations caused by urban sprawl, industrialisation, and farming mechanisation. Donoghue et al. used these multi-source, multi-resolution data to tackle the question of how the processes and patterns of Early Bronze Age urbanisation varied from region to region. The different datasets were not only used to locate features detected during previous surveys, but also to identify unknown features, to extrapolate information to larger areas and to carry out a settlement pattern analysis.

Finally, the University of Arkansas group presented three papers that combined both elements of data integration and advanced processing methods of Corona photographs (see also Casana,
The paper by J. Casana presented the general aims of a two-year NEH-funded project that utilizes newly developed methods that will efficiently and accurately orthorectify Corona photographs of the Middle East and surrounding regions. The final aim of this ambitious project is to create a user-friendly online database (“atlas”) of orthorectified Corona photographs, DEMs and stereo pairs to increase their use in archaeological projects, since the integration of these photographs into such projects has remained quite limited so far. This geo-database covering large areas of the Near and Middle East will become available in the near future at: http://castweb.cast.uark.edu/home/research/geomatics/photogrammetry/corona-satellite-imagery-based-digital-archaeological-atlas-of-the-near-east.html. The papers by J. Cothren et al. and Kalayci et al. discussed the automation of several photogrammetric processing steps to develop and distribute the digital Corona-based archaeological atlas of the Near East. While most previous studies presented rigorous models and methods for exploiting Corona photographs suitable for small areas or a few photographs, these studies discussed several innovative strategies to apply these rigorous methods to more than one thousand overlapping Corona photographs. Such processing is necessary because the spatial distortions produced by the fast-moving panoramic camera and the sparse metadata associated with each mission make these photographs difficult to georeference, let alone to accurately orthorectify. The main emphasis in the paper by Cothren et al. was on the effects of ground control point accuracy on triangulation and orthorectification of large blocks of Corona photographs, while in the paper by Kalayci et al. the focus was on the accuracy of DEM generation from Corona stereo pairs. The generated DEMs will have a spatial resolution of 10 m.

All these presentations clearly showed that methods and algorithms from the field of digital image analysis can assist the detection and documentation of archaeological features. Since most research projects focus on particular case studies, it is not clear, however, to what extent these promising results allow a general judgement of the applicability of digital image analysis techniques to high-resolution satellite imagery under varying environmental and archaeological conditions. A systematic evaluation of data and methods therefore is still a desideratum. In this regard, we outline below some important issues and future perspectives.

Present problems and future perspectives
The CAA 2009 session on satellite remote sensing in archaeology, the available literature on the topic and our own experiences all indicate that important progress has been made in this field in recent years. Nevertheless, some methodological as well as structural problems that hamper a sound integration of high-resolution satellite image analysis into archaeological research should not be overlooked.

Turning first to methodological issues, the technical properties of high-resolution satellite imagery determine the potential and limitations of its analysis for archaeological purposes. There is for example the limited spectral coverage of high-resolution images. The trade-off between spatial and spectral resolution means that high-resolution images usually cover only the VNIR spectrum. They are thus not regarded as truly multispectral by many remote sensing specialists. Valuable additional information from the infrared spectrum can only be obtained at the expense of a loss of spatial resolution that, in our view, is so crucial for its successful application in archaeology. The combination of satellite images of different spatial and spectral resolution with data from other sources in a multi-sensor, multi-resolution approach is probably the best answer to this problem from a methodological point of view, though practical and financial constraints may prevent such an approach. Still, the increased spectral
The capabilities of high-resolution satellite images over typical aerial photographs will significantly increase the possibility to detect specific spectral signatures related to archaeological phenomena. Concerning spatial resolution, another problem that will become more acute in the future with the launch of new sensors is the current 0.5 m limit for non-US-government clients, which to the best of our knowledge will not be suspended in the near future. Finally, archaeological analysis of satellite images has so far largely focused on spectral information, whereas the potential of extracting geometric information through photogrammetry has yet to be fully tapped. Recent years have seen considerable advances in the generation of digital elevation models from high-resolution satellite images (Lambers, Remondino 2008). The resolutions and accuracies obtained are now beginning to enter the useful range for small-scale archaeological applications. This geometric information may in itself reveal the location of potential archaeological features such as earthworks, terraces, barrows and the like, or it may be analysed in conjunction with multispectral image information as an additional channel. The beauty of this approach is that the same images can be analysed twice, once for their spectral content and once for their geometric content. There is a huge potential here for archaeological prospection that is only beginning to be explored.

Concerning the detection of sites and features which is the aim of archaeological prospection, the abovementioned near infinite diversity of their shapes, proportions, locations, and contexts is a huge challenge for semi-automated detection approaches. In a sense, due to their very nature archaeological features may be regarded as “uncooperative”. While pattern recognition has made important progress in recent years in other applications such as the automatic detection of traffic signs, buildings, roads, people, cars and many other objects in different kinds of digital imagery, the intrinsic variety of all these classes of objects is usually much lower than what is observed for archaeological features. In our view, however, this does not mean that semi-automated detection approaches are doomed to fail from the outset. It is interesting to note that many successful detection algorithms in other applications rely on a surprisingly small set of carefully chosen key properties of the objects they are tailored to detect. In archaeology we are only beginning to understand and describe typical features that we encounter in given regions in such terms. There is still a lot of work to be done in the standardised formal description of archaeological features that provides useful information for the design of detection algorithms. The key question will be to what extent such formal descriptions, or models built on their basis, may be generalised in order to detect a variety of archaeological features. Carefully set thresholds concerning shapes, dimensions, spectral properties etc. will be an important aspect here. Most probably generalisation will only work to a quite limited degree, but this is a largely unexplored field that requires comparative methodological studies. In any case it is clear that semi-automated detection will mainly be useful to map typical, recurrent, well-known features (see, for example, Trier et al. 2008, 2009; this volume), whereas the detection of atypical, rare, unusual features will always remain the domain of visual image interpretation (and field observation, which is indispensable in both approaches).

Turning from data to people, there seems to be a divide between different groups within the archaeological community concerned with remote sensing applications. While archaeologists have successfully used aerial imagery for decades, surprisingly often there is little continuity or contact between experts in aerial and satellite-based archaeological prospection. It is true that many experienced aerial archaeologists have embraced the new space-borne data source and are actively engaged in the advancement of its analysis. But at the same time there seems
to be a new generation of archaeologists using satellite imagery who have little or no practical experience in aerial archaeology. There are various possible reasons for this. Aerial archaeology has always been strong in the temperate climate regions of Europe, where archaeological remains often show beautifully as crop, soil, snow or shadow marks and where large image archives exist that can be analysed for archaeological prospection. Satellite imagery, on the other hand, is available worldwide and often constitutes the only suitable image data source in countries where aerial photographs are not available or difficult to access. At the same time, crop and soil marks are of little or no use in many of these countries due to different climatic, geomorphic, vegetational and/or archaeological conditions. Faced with such a situation, it is logical to turn to the sophisticated set of digital analytical techniques associated with satellite imagery that were originally developed for the earth sciences, instead of the proved and tested toolbox of the experienced aerial archaeologist. This may in some instances lead to the proverbial reinvention of the wheel. At the same time, some aerial archaeologists have remained sceptical regarding attempts to detect archaeological features in (airborne or space-borne) digital images through the application of methods and algorithms derived from other imaging applications. While there are perfectly good reasons for this point of view, considering the great diversity of archaeological features and the contexts in which they are found, image processing can at the very least facilitate the visual identification of archaeological features in imagery, even where semi-automatic detection fails. Thus, more cooperation and exchange across the abovementioned divide would certainly be beneficial for both sides. Visual interpretation of imagery based on profound expert knowledge, and advanced digital image processing and analysis are complementary and should both be part of a carefully designed research approach.

Concerning cooperation between the disciplines involved in satellite-based remote sensing archaeology, there are gaps and problems as well. In our view, an important shortcoming of recent studies in this field is that many of them are site-oriented and only a few focus on methodology. This may partly be due to limited resources available for such studies, but, in spite of notable exceptions, a lack of communication between the disciplines seems to be involved as well. This, in consequence, leads to a lack of technological developments tailored to archaeological applications. Among the archaeological community, limited availability and knowledge of data and software is often a problem. Archaeologists therefore need to seek collaboration with remote sensing and digital image analysis specialists. Experts in these fields, on the other hand, often lack knowledge of the nature and contexts of archaeological sites and features. Distinguishing archaeology-related signatures from non-archaeological signatures requires thorough archaeological knowledge and expertise. To use this archaeological knowledge in image analysis, in turn, requires its translation into formal descriptions and models that can be used for semi-automated detection approaches. Thus, a much closer cooperation between both disciplines and some degree of familiarity with key concepts and methods of the other side is needed to foster the integration of remote sensing into archaeological research design.

It is our hope that satellite archaeology at some point will no longer remain in the domain of “technical researchers”. Ideally, remote sensing courses, not only on a theoretical but also on a practical base, should become an integral part of archaeological training, just as GIS courses already have in recent years. New study programs like the MSc in GIS and Spatial Analysis in Archaeology at the University College London, the Master of Geotechnologies for Archaeology at the University of Siena and others are very promising in this regard. To foster
communication between the disciplines, well-established forums like AARG are as important as new initiatives like the EARSeL special interest group on Remote Sensing for Archaeology and Cultural Heritage, the ISPRS working group on Cultural Heritage Data Acquisition and Processing, the IAPR technical commission 19 on Computer Vision for Cultural Heritage Applications, and others. Additional activities such as an online database of algorithms relevant for archaeological applications, a bi-annual newsletter presenting new publications and technological developments, an online discussion forum and presentations at non-remote sensing conferences might complement and connect these activities. First steps have already been taken to create an online database, but much more work needs to be done in the near future. Also, further publications on satellite-based remote sensing archaeology like the books by Wiseman and El-Baz (2007) and Parcak (2009) would be of significant help.

Conclusions
The potential of satellite remote sensing and digital image analysis for archaeological prospection is far from exhausted. Much more testing is required, since the number and resolution of high-resolution satellites rapidly increases, and the application of digital image analysis is still in its infancy. Just as in excavation and aerial survey, remote sensing research must be well-planned and well-executed, using a comprehensive methodology. Digital image analysis can assist archaeological prospection to a considerable degree, but will never lead to a fully automatic procedure, since data manipulation will vary greatly depending on the type of data, moment of image acquisition, atmospheric conditions, type of landscape, site characteristics, and the overall research goals of the project at hand. Field observations, archaeological interpretation and human expertise remain indispensable. Satellite remote sensing projects carried out by archaeologists with backgrounds in both remote sensing and archaeology have much to offer, but satellite archaeology should not be regarded as a substitute for archaeological excavation or survey work. It is but one among a number of tools that archaeologists may want to employ in their research. Besides revealing the presence of (sub)-surface archaeological features (even in areas previously surveyed), satellite remote sensing can place archaeological sites in a much larger context, showing past social landscapes in all their complexity and helping greatly with quality assessment. As S. Parcak states in her new book entitled “Satellite Remote Sensing for Archaeology” (Parcak 2009: 3): “There is much we can miss by being on the ground and by not seeing things from an aerial perspective” (the reverse being true as well). Analysis of satellite imagery may further aid in determining where to excavate and may precede archaeological survey. Archaeologists therefore will need to rethink their surveying and excavation strategies in light of this new information, especially when sub-half meter satellite imagery will become commercially available.

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[internet links accessed 31 August 2009 – Ed]

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Finding burial mounds from space: automatic detection of circular soil marks and crop marks in QuickBird imagery of agricultural land in south-east Norway

Øivind Due Trier, Siri Øyen Larsen and Rune Solberg

Introduction

During construction work, ranging from building new motorways to private houses, archaeological sites are sometimes discovered, thereby delaying work. For motorways crossing through agricultural land, encountering buried remains of cultural heritage occurs frequently in parts of Norway, whereas for erecting a private home, the prospect of finding historical remains seems like a big lottery, with large negative prizes for the few finders.

As an example, a number of levelled burial mounds were discovered when new a motorway section of the E-18 highway through parts of Vestfold County was built a few years back. This delayed construction work by a year. More sections of E-18 through Vestfold are to be built this summer and coming years.

The Norwegian Directorate for Cultural Heritage and some of the 19 Norwegian county administrations see a need to map potential locations for cultural heritage sites. This will help planning authorities to avoid cultural heritage hot spots when future land use is decided. Also, this will add more knowledge about the early history of Norway.

The purpose of this research project is to assess whether automatic examination of high-resolution satellite imagery can be used to locate potential cultural heritage sites, in the guise of soil marks and crop marks in agricultural fields. Although aerial imagery, both oblique and vertical, has been used for this purpose in the past (Wilson, 1982), a systematic county-wide or national-wide flying programme is very expensive. The Norwegian Mapping and Cadastre Authority have a 5 – 7 year cyclic aerial imagery programme for small scale mapping purposes. However these images are usually acquired in mid summer with little hope to find crop marks, which appear most markedly in the late summer or early autumn, not to mention soil marks, which may appear when there is no vegetation on the fields.

Commercial satellites are currently offering high resolution imagery, including:

- Ikonos, has operated since 1999, 1 m ground resolution panchromatic (i.e., grey scale) and 4 m ground resolution multispectral (four bands: near infrared, red, green and blue)
- QuickBird, since 2001, 0.6 m panchromatic / 2.4 m multispectral, four bands
- Kompsat-2, since July 2006, 1 m panchromatic / 4 m multispectral, four bands.
- Worldview-1, since October 2007, 0.5 m panchromatic, no multispectral bands. (Worldview-2, which is anticipated to launch during the autumn of 2009, will provide eight multispectral bands in addition to the panchromatic band.)
- GeoEye-1, since September 2008, 0.5 m panchromatic / 2 m multispectral, four bands.

One may search image archives for existing images of the area of interest and/or order new images.

Several experiments have been conducted during the project so far. One such experiment (Aurdal et al., 2006) focused on detecting crop and soil marks of arbitrary shape in Ikonos and QuickBird images, but no conclusive results were obtained.

Then, archaeologists identified several circular crop and soil marks in the images, which led us to consider methods tailored to detecting circular marks. The experiment described in this paper focuses on detecting circular crop marks and soil marks in 0.6 m resolution QuickBird images.

The rest of the paper is organized as follows. First, the background for the CultSearcher prototype system we have developed is described. The next two sections describe the experimental data set and the various methods we have tested, and then summarize the chosen algorithm. Experimental results are then described. Finally, the results are discussed and conclusions are given.

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Preliminary results from this work have been presented at international conferences (Larsen et al., 2008; Trier et al., 2008). A full-length research paper appears in Archaeological Prospection (Trier et al., 2009).

The CultSearcher prototype system
The project was started in 2003 with the overall goal of developing a cost-effective method for surveying and monitoring cultural heritage sites on a regional and national scale. The initial participants were the Norwegian Directorate for Cultural Heritage, the Norwegian Computing Center, the Norwegian Institute for Cultural Heritage Research, the Museum of Cultural History at the University of Oslo, and Vestfold County Administration. Two more county administrations are considering joining the project. The Norwegian Computing Center has been responsible for developing the automatic detection methodology and implementing this into a prototype software system, CultSearcher (Figure 1). CultSearcher leads the operator through the necessary image preprocessing steps, the detection algorithm, and the final verification of the detection result.

CultSearcher is analyzing soil marked and crop marked patterns. Soil marked sites are typically the remains of ditches or pits, buried walls, etc. Crop marks are an indirect effect of archaeological structures. Even if the structures themselves have been removed, the refilled soil often creates different growing conditions relative to the surrounding soil.

CultSearcher aims at providing assistance to the archaeologist in analyzing satellite images. The software finds candidate sites, which the archaeologist then inspects. In this way, the archaeologist is guided through a list of candidate sites, instead of having to manually inspect entire images.

One should note that CultSearcher has some obvious limitations. First of all, there have to be some visual traces of the site in the image. If there is no trace of the site in the contrast-enhanced image, then there is no way to create a detection algorithm that finds it, except by pure chance or prior knowledge. Also, the detection by the computer software and subsequent verification by a human expert does not guarantee that a true cultural heritage site has been found. Some kind of field inspection is always necessary as a final verification.

Experimental data set
The data set consists of two QuickBird images (Figure 2). The image ‘Lågen’ was acquired on April 27, 2005 at 10:45 AM, covering a 70 km² part of the valley Lågendalen in Lardal and Larvik municipalities in Vestfold County. The image ‘Gardermoen’ was acquired on July 29, 2003 at 10:23 AM, covering a 110 km² area surrounding, but not including, the Oslo Gardermoen airport, covering parts of Nannestad, Ullensaker, Hurdal and Gjerdrum municipalities. Both images consist of a four-band multispectral image and a single-band panchromatic image. The panchromatic image has 0.6 m ground pixel size, and covers the visible and near infrared parts of the spectrum. The multispectral image has 2.4 m pixels, and the four bands are: blue, green, red, and near-infrared.

There have been numerous archaeological investigations in both test areas, and the areas are known for their relatively high density of archaeological sites. The Gardermoen area is an undulating glacial landscape consisting mainly of well-drained sandy soils cut by an intricate system of ravines. This fertile area has many agricultural fields in which crop marks have previously been reported. The image acquisition date should be
ideal for detection of crop marks, since this is the time of the year when the crops are in the process of ripening and thus turning yellow.

The Lågendalen area is a distinct U-shaped valley in which the river Lågen has eroded its meandering way through a thick layer of marine clay. The area now consists of agricultural fields and forest. The area includes a known Iron Age grave field at Odberg farm. The date of this image is too early for crop marks to have been fully developed, but soil marks could be expected.

For large-scale use of satellite images for archaeological mapping, one may need to acquire images several years within the expected peak seasons for soil marks and crop marks. This may account for seasonal variations from year to year and from location to location within the region of study, and varying cloud conditions.

Figure 2: The QuickBird images. Left: ‘Lågen’ (July 29, 2003); right: ‘Gardermoen’ (April 27, 2005).

Figure 3: Detail of the panchromatic band of the image ‘Lågen’, with four rings pointed out.
For the current study, archaeologists have identified many circular patterns that are clearly visible in the panchromatic images (Figure 3), but can hardly be seen in the lower resolution multispectral images. These patterns are believed to be the remains of burial mounds. The mound itself has been destroyed, but the circular ditch often remains.

In the two QuickBird images, archaeologists have identified 35 locations with ring marks that they would like the system to recognize. We have visually classified 15 of these as ‘strong’, 10 as ‘fair’ and 10 as ‘weak’ (Figure 4). At a few of the locations, there are two rings located only a few meters apart; these are counted as one ring only, with the understanding that if one is correctly located, then the archaeologist has been directed to an interesting site, and whether one or two rings are marked by the program is not important. Eleven subimages of \( 4096 \times 4096 \) pixels (\( 6 \text{ km}^2 \)) were extracted for the experiments. These subimages included all 35 ring mark locations.

**Methods for detecting ring marks**

As noted above, the remains of burial mounds are often visible as ring marks in the images. In order to detect as many ring marks as possible, while at the same time keeping the number of false positives at a minimum, variations of the following sequence of five methods have been tried out:

- low pass-, band pass- and high pass-filtering in the frequency domain;
- local contrast enhancement;
- template matching;
- feature extraction; and
- decision tree-based classification.

The details of these methods are described in (Trier et al., 2009). The sequence of methods that worked best for the QuickBird images can be summarized with a flow chart (Figure 5).

The first step is in principle carried out by importing the layers corresponding to agricultural fields from a geographical information system. However, since the satellite images were not perfectly co-registered with the digital base map, manual corrections had to be made. The corrected masks were used to limit detections to agricultural fields.

In order to increase the visibility of weak rings, and at the same time reduce the contrast of dominating objects in the images, local contrast enhancement was applied. In brief, this is a way evening out the contrast so that it is constant over the entire image (Figure 6). An undesirable effect is that the local contrast...
contrast is suppressed close to very dark or very bright objects in the image. For example, along a row of trees, the plough furrows have almost been suppressed. Similarly, in the river, there are bands of almost homogeneous grey values along its banks. The river is of little concern to us, but the band along tree rows may make it difficult to detect marks near the borders of fields. However, these undesirable effects seem to be minor. The algorithm detected no true rings unless local contrast enhancement was used.

Ring templates of various sizes (Figure 7) were used in the template matching step. For each ring template, we computed a measure of how well the template agreed with the contrast enhanced image. The measure was computed for all possible ring centre locations. Mathematically, this is called an image convolution, and the resulting image is called a correlation image. A high positive value indicated the possible presence of a bright ring, whereas a high negative value indicated a possible dark ring. Ring candidates are found in the correlation image as the locations where the absolute value is higher than a user defined threshold. Detections from different ring template sizes are merged.

In the validation step, the operator is guided through all the detections, one at a time (Figure 8). Feedback from users indicates that the number of false detections should not be in a higher order of magnitude than the number of true detections.
for the validation step to be perceived as meaningful. If the number of false detections is too large, the operator will lose concentration and make mistakes.

**Experimental results**

The algorithm for ring mark detection, as described above, was applied to the entire data set: eleven subimages which together covered all the identified true rings. Three parameters were varied:

- The correlation threshold.
- Whether band pass filtering in the frequency domain was used or not.
- Whether a normal ring or a thin ring template was used in template matching.

The number of detected false rings varies dramatically with the correlation threshold (Table 1). A reasonable compromise between not detecting too many false rings and at the same time detecting as many true rings as possible, might be when the number of false detections is approximately seven times the number of true detections. In this case, 11 out of 15, or 73%, of the strong rings were detected, and 5 out of 10, or 50%, of the fairly strong rings were detected. This is 16 out of 25 of the strong and fairly strong rings, or 64%.

Band pass filtering seemed to have little effect. If a template with a thinner ring was used, more false detections were made.

The number of false positives can be reduced, at the cost of reducing the number of true positives as well. For example, by reducing the number of false positives from seven times to less than half the number of true positives, the number of detected strong and fair rings decreased from 64% to 32%. On the other hand, even if the correlation threshold is set so low that almost 30 times as many false rings as true rings are detected, many of the strong and fairly strong rings are not detected. Furthermore, none of the weak rings are detected.

**Discussion and conclusions**

The experiments demonstrate that the proposed algorithm is able to detect many circular patterns. Still, many are also missed by the algorithm, and many false detections are made. If the goal is to
detect each and every circular pattern, then the algorithm needs to be improved to be really useful.

For a thorough search in a limited area, a high number of false positives might be acceptable. On the other hand, for a massive search through large areas, e.g., all agricultural fields of Vestfold County, the number of false positives should be kept at a minimum, as long as some sites are detected. The goal of a county wide search could be to develop a ‘frequency map’, which may be used to direct further attention to areas that are interesting to the archaeologists. In this context, it is acceptable to find only a fraction of the true archaeological patterns that are present in the fields, with the following assumptions. The true patterns occur in groups rather than spread evenly across the entire landscape. At least one true pattern should be detected in almost all groups. Only a few detections of false patterns should be made.

Some circular patterns may only be visible from time to time. In order to find these, one may have to process images from several years and/or on more than one day during the expected peaks of the soil mark and crop mark visibility periods. In this perspective, our approach can be used to process large volumes of satellite images that would otherwise not be inspected, thus detecting many new sites.

We have also used the algorithm on Ikonos images, which have a lower resolution of 1.0 m instead of 0.6 m in QuickBird images. The conclusions were that (1) a different ring template shape had to be used, and (2) with the lower resolution, the template matching step is less reliable, so feature extraction followed by a decision tree classifier had to be used to improve recognition performance. The main challenge with this approach is to be able to extract features which are able to discriminate true rings from the false ones.

The system is currently deployed at three user sites, and feedback from the users on performance, precision, and usability will provide important information for the further development of the methods and an efficient graphical user interface. As the interface and underlying software matures we expect to deploy it to a larger number of user sites.

Archaeologists state that the software tool will be helpful for locating potential cultural heritage sites. Although it makes many false detections, it will relieve the operators from time-consuming manual inspection of entire images.

Acknowledgment

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Preliminary results from this work have been presented at international conferences (Larsen et al., 2008; Trier et al., 2008). A full-length research paper appeared in Archaeological Prospection (Trier et al., 2009).
Inspiring Google Earth Precise Positioning

Irwin Scollar

INSPIRE (Infrastructure for Spatial Information in Europe) is a new European Union Directive now in force.

“In Europe a major recent development has been the entering in force of the INSPIRE Directive in May 2007, establishing an infrastructure for spatial information in Europe to support Community environmental policies, and policies or activities which may have an impact on the environment. INSPIRE is based on the infrastructures for spatial information established and operated by the 27 Member States of the European Union. ....

Legislation


....


See: http://inspire.jrc.ec.europa.eu/

An example of the use of the data for archaeological air photographs:

The French national mapping service IGN (Institute Géographique Nationale) has implemented a highly useful web site following the INSPIRE directive

http://www.geoportail.fr/visu2D.do?ter=metropole

which among many things also offers detailed data without charge from over 85,000 primary and secondary triangulation points as well as data from a large number of precision reference points and GPS monitoring stations. These may be used for automatic calibration and georeferencing of Google Earth imagery using the tools already available in the author's AirPhoto program (see AARGnews 37, 2008, pp.15-22). Using this data, precision of 25 cm/pixel in a Google Earth result is readily achieved. The Géoportail site also shows cadastral survey field boundaries if desired, but these are not visible in Google Earth.

The overview maps and orthophotos of the Géoportail site permit displaying the points as little red triangles when the appropriate categories are selected. The orthophoto can be enlarged to display the triangulation point nearest to an area of interest to which an oblique archaeological image is to be transformed.

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The selected point can then be displayed in detail:
and its content with the precise trig point coordinates from three of the available grid systems shown:

The appropriate grid must be chosen in AirPhoto. For France, there are three major grid systems, the oldest dating back to the 19th century and completed between the two world wars is the Nouvelle Triangulation de la France or NTF. Most paper maps still use it. In AirPhoto’s Google Earth “Find in Grid” dialogue, the coordinates can be entered by copying them directly from the Géoportail web site and pasting the numbers into the fields as shown.

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The NTF divides France into four zones from north to south, so the zone number must also be specified or the values are ambiguous. A “flying height” which will show most of the area around the trig point nearest to an archaeological site should be chosen between 1000 and 5000 meters so that the image will include the trig point and the archaeological area. AirPhoto’s GE implementation then displays the area centred precisely on the coordinates coming from Géoportail and calibrates the image automatically with the chosen grid. The coordinate value entered in the dialogue box is itself the main calibration point thus making it unnecessary to visually identify the trig point in the GE image. In the example, it is hidden under a tree (see below) Four further calibration points are added automatically to the corners of the image.
When calibrated, the Google Earth image can be used as if it were a map.

Triangulation points may be of several different types, with church towers being one of the favourites in France. Since an orthophoto is not truly vertical with respect to a tower, the central calibration point may be displaced by many meters from the visual tip of the tower itself. In the following two pictures, two trig points were automatically selected, one given by a plinth near the entrance of the church, the other by the spire. Accuracy is of the order of several centimetres in the first, less so in the second.

The calibration of the GE image is correct in either case if the automatic search method has been used. It is wrong by quite a large amount if a calibration point is placed manually on the tip of the church tower. This illustrates the general inadvisability of using elevated objects like roofs or tall building as control or calibration points with manual entry for rectification. The oblique image can then be transformed to the GE image, checked for goodness of fit.
The NTF grid uses Paris instead of Greenwich as the zero of longitude. Google Earth uses an approximation to the WGS84 (World Geodetic System) lat/lon grid with Greenwich, so the image should be aligned to the chosen grid after transformation before writing the grid to the image.

This result would not have been quite so easy to obtain in but a few minutes if it weren’t for the high precision data for trigonometric points available on the IGN Géoportail site as a result of INSPIRE. Fortunately too, Google Earth has acquired its geo-referenced orthophotos from IGN, so precision is higher than in other countries where the GE imagery may come from less accurate sources.
All EU countries are required to offer all of their data on the Internet by 2019. As an example, Belgium has already done so for its 19,000 trig points with its Lambert 1972 and 2008 grid data, see:


For the UK, the link below may be used until the Ordnance Survey implements the INSPIRE directive.

http://benchmarks.ordnancesurvey.co.uk/

This link requires using the 1:50,000 LandRanger map numbers for searching for all trig points in a 40x40km square. It offers precise data on over 21,000 trig points. The LandRanger map numbers can be found with the interactive map at:

http://leisure.ordnancesurvey.co.uk/products/paper-maps/

Epilogue:

I am fortunate in having lived long enough to see the beginning of the process initiated by INSPIRE. In a few decades, there will never again be an excuse for being unable to locate and map archaeological sites from the air precisely. It makes what is being done currently at a number of official agencies responsible for aerial archaeological mapping truly look like they have painfully achieved the ancient state of the art as it was in the mid-1970s.

Irwin Scollor, Remagen 20.08.2009
Using the results of the National Mapping Programme in England: some examples from Shropshire

Andy Wigley

Shropshire has long been known for the rich opportunities it provides for the aerial archaeologist; both in terms of cropmarks in the river valleys and earthworks on the higher ground. Several decades of reconnaissance by Jim Pickering, Arnold Baker, the Cambridge University Collection of Aerial Photographs, and since the mid-1970s by Chris Musson and others, have generated a large collection of images. Transcription of the then available cropmark evidence was initiated by the Air Photography Unit of the Royal Commission on the Historical Monuments of England (RCHME) in 1977-8. Staff at the Shropshire Historic Environment Record (HER) continued to plot cropmark evidence and further surveys were undertaken by Rowan Whimster in 1980-5, subsequently published as part of The Emerging Past (Whimster 1989), and Arnold Baker (1992).

In the early 1990s the Archaeology Section of the former Hereford and Worcester County Council undertook the Marches Upland Survey (Dinn and Edwards 1999). Given the quality of the earthwork archaeology in the uplands of the Welsh Marches, RCHME undertook the Marches Upland Mapping Project as part of their wider National Mapping Project (NMP) to supplement to the results of the Marches Upland Survey. The project encompassed the western part of Shropshire and Herefordshire, from Oswestry in the north to the River Monnow in the south (See Fig. 1. for extent of the coverage in Shropshire). The methodology followed standard NMP practice of the time and involved the production of a graphic record at 1:10,000 scale together with a supporting computer database (MORPHE) and map note sheet (Stoertz 1993). Whilst the results have not been formally published, a copy of the project archive relating to Shropshire was deposited with the Shropshire HER upon its completion. Over the past decade this archive has provided an invaluable resource to researches and historic environment

Fig. 1. Map showing NMP map sheet coverage for western Shropshire.

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2 RCHME merged with English Heritage on 1 April 1999.
3 Formerly known as the Sites and Monuments Record (SMR)
managers working in the county. These uses to which it has been put can be summarised under the following headings:

**HER Enhancement**

Following the acquisition of the copy of the NMP archive for Shropshire, work on the incorporation of the underlying data into the Shropshire HER began in 1998 when the author undertook a student placement. This comprised the systematic identification of ‘new’ sites and the generation of basic HER records and GIS polygons (within the limitations of the GIS system available at the time).

The subsequent development of the digital technologies available to HER staff\(^4\) has enabled the underlying computerised MORPHE database to be converted to GIS point data and further integrated with the HER datasets. In addition, in 2004 the HER Officer secured permission from English Heritage to scan and digitally register the NMP map transparencies, enabling them to be displayed alongside other GIS data (see Fig. 2). This in turn has allowed more representative GIS polygons to be generated for sites and features mapped by the NMP.

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\(^4\) Principally the adoption of ExeGesIS HBSMR HER database system and ESRI ArcView and latterly ArcGIS GIS systems

**Management of the Historic Environment**

As an integral part of the HER, the results of the NMP provide a vital evidence base for those managing change to Shropshire’s historic environment. For example, the NMP mapping often provides the best indication of the character and extent of many archaeological features in western Shropshire. As such, it can provide vital information for the planning archaeologist seeking to assess the likely impact new development.
Much of western Shropshire is rural and sparsely inhabited and farming remains the predominant land use. Agriculture therefore frequently represents the principal threat to the resource. However, since the launch of Natural England’s new Environmental Stewardship Schemes in 2005 the result of the NMP have provided extremely useful for those us providing HER information and advice landowners and farmers applying for Higher Level Stewardship (HLS). It has, for example, been particularly useful for indicating where earthwork features such as ridge and furrow or relict field boundaries might be present. The cropmark mapping has also proved useful for providing management advice for below-ground archaeological features.

In addition, polygonised GIS data for the ridge and furrow derived from the NMP mapping was recently been provided to Natural England to assist with their strategic HLS targeting work. It is also being used review and improve the HER GIS polygons as part of Shropshire Council’s contribution to the Select Heritage Inventory for Natural England (SHINE) initiative. The resulting data will be loaded into Genesis, Natural England’s in-house GIS system, and used by their Land Management Advisors to conduct HLS pre-application assessments of farm holdings and pro-actively seek applications for high interest holdings.

Research

The information that NMP provides about the character of the archaeological resource in the western parts of Shropshire is also of use to researchers. For example, the NMP data provides vital information about the distribution of Late Neolithic and Early Bronze Age funerary monuments. The mapping of later Bronze Age, Iron Age and Roman cropmark sites provides important information for those investigating the form and distribution of settlements and organisation of the wider landscape in these period (e.g. Wigley 2002, 2007). This is particularly important, given that these periods remain under research in Shropshire.

For later periods, it has significant potential to inform our understanding of the organisation of the medieval and post-medieval agricultural and industrial landscapes, particularly on the higher ground. Because it covers both the uplands and the river valleys it allows the different character of the archaeology in these zones to be compared and the factors which have affected the survival of prehistoric archaeological features to be considered. Analysing the information generated by the NMP is therefore likely to provide researchers with means of targeting future programmes of fieldwork.

Discussion

The NMP project has significantly increased the number of known archaeological sites and greatly enhanced our knowledge of the richness and diversity of the archaeology of western Shropshire. As such, it has provided a vital source of information for the HER and heritage managers and researchers alike.

Work to fully integrate the data into the HER is ongoing, as resources permit. For example, full records have yet to be generated for all of the ridge and furrow identified in the NMP.

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5 Natural England assumed responsibility for administering the Environmental Stewardship Schemes from the Department for Environment, Food and Rural Affairs after its formation in October 2006.

6 Given the date range of aerial photographs used in the NMP project, it is usefully necessary to use recent digital aerial photographs held within Shropshire Council’s GIS system to check whether earthworks are still likely to survive as upstanding features.
survey. Work to fully integrate the MORPHE data into the HBSMR\textsuperscript{7} database is also underway. Similarly, participation in the SHINE initiative has provided the necessary impetus to review and improve the HER polygons with the aid of the NMP mapping.

In addition to this work, a number of wider issues and challenges remain for the future. For instance, the existing NMP mapping only provides partial coverage of the most productive cropmark areas within the county. Whimster generated rectified plots for a significant part of the county beyond the Marches Upland Mapping Project study area. However, he was only working with photographs taken up to 1981. A substantial proportion, if not the majority, of the known cropmark sites were discovered after this date as a result of Musson’s campaigns. As a result there is a significant deficiency of up-to-date and accurately rectified cropmark plotting in Shropshire. This problem is particularly acute for the dense cropmark landscape around Wroxeter, where HLS and other initiatives now provide a significant opportunity to safeguard the below-ground archaeology for future generations.

In addition, to the main cropmark areas, the existing NMP coverage does not cover the whole of the Shropshire Hills Area of Outstanding Natural Beauty, as highlighted in English Heritage’s new policy on designated landscapes (English Heritage 2009). Extending the coverage to the rest of the AONB would help to inform both strategic policy and day-to-day decision making.

Finally, Shropshire Council is currently working on a three year English Heritage funded historic environment aerial survey project. This will generate a substantial new body of oblique digital photographs for the county. Flights are also being targeted in a way that will enable the results to contribute to other projects and initiatives, such as Heritage at Risk. This is likely to result in further requirements for accurately rectified plots of the features, sites and landscapes that have been photographed.

References


\footnote{\textsuperscript{7} Historic Buildings, Sites and Monuments Record}
Aerial Archaeology and Remote Sensing in Indian Archaeological Research

Manjil Hazarika¹

Aerial archaeological research has yet to gain its momentum in India. The long term history of almost 145 years of archaeological investigation in India has yielded sites covering a large temporal span of continuous human occupation from the early Palaeolithic stage to late Medieval period. These include sites with evidence of Palaeolithic and Mesolithic hunting-gathering cultures, Neolithic-Chalcolithic food producing cultures, Bronze Age civilizations at Indus valley with cities like Harrappa and Mohenjodaro, Megalithic ruins, Early Historic and medieval sites with fortified cities, towns and the emergence of states and several of the Buddhist, Hindu and Muslim art and architectures splendours. It is observed that most of the archaeological research so far in India has been confined to using traditional methodological approaches. Recent developments in the field of aerial survey and remote sensing have hardly been used in archaeological prospection and research or in the field of cultural heritage management.

Research at the Neolithic site of Budihal of Gulbarga districts of Karnataka is one of the very rare attempts that used aerial survey in prehistoric research. Moreover, there has been sporadic use of aerial photographs to study the sites of Taxila, Mahenjodaro and Rehman Dheri (now in Pakistan), Sisupalgarh in Orissa, Hampi in Karnataka, Inamgaon and Walki in Maharashtra, etc. The famous medieval capital city of Vijayanagara was studied by Raj et. al. (2005) using remote sensing data and the researchers have identified different activity areas of the ancient capital city. The use of the aerial photographs taken in 1968 revealed brisk agricultural activity and other areas of archaeological importance. The site of Dvaraka, mentioned in the Hindu epic Mahabharata has been studied by Thakker (2001) using satellite images on which he identified rectangular structures with linear features (outer wall) with four different villages at four corners. These features correspond with the descriptions in the ancient texts of India.

Interpreting historical geography is one of the main thrust areas of importance in historical archaeology of India. Starting with the Veda’s, many ancient texts, epics, and several religious and secular texts mention various historical cities, villages, and sites of historical importance and archaeologists have been trying to correlate the names with the modern-day sites and landscapes. In the course of time, many rivers have shifted their course and buried archaeological sites. Others, which are very important for understanding Indian archaeology are presently under water due to sea level changes. There are very few examples of using remote sensing, satellite data and aerial photographs to identify sites for research into the historical geography in India.

Attending the 1st International EARSeL Workshop on Advances in Remote Sensing for Archaeology and Cultural Heritage Management, held at CNR, Rome during 30th September to 4th October, 2008 was very educative and fruitful for my understanding of the recent developments in these fields. The Workshop, with presentations by 244 authors from 25 different countries included several papers on Indian archaeology. These have strengthened our knowledge about various applications of aerial photographs, active airborne data, remote

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sensing, GIS, GPR, magnetic and electrical tomography in archaeology. The widespread uses of these methods to explore, identify and understand archaeological sites and to manage cultural heritage sites were discussed and illustrated with high-resolution datasets. One of the interesting aspects of the workshop was that it has covered not only sites from several countries worldwide but also covered various cultural stages of Palaeolithic, Neolithic, Bronze Age civilizations, early historic cities and even modern day heritage properties. The use of space imagery in archaeological exploration of the region of Talakadu, 3D perspective views of the site of Badami, GIS and remote sensing of Indian archaeological sites, multisensor satellite data for understanding settlement patterns and for finding the lost course of the river Saraswati were some of the important Indian examples in papers presented at the Workshop.

Considering the importance and usefulness of the aerial photographic and remote sensing data, much wider applications of these methods are expected in the near future. These will not only help to identify areas of archaeological interest but will also assist in the monitoring and management of the cultural heritage of India. In this regard, the forthcoming International Conference on Remote Sensing in Archaeology to be held in India shall generate more attention towards the applications of these methods among the archaeologists from India and abroad working in Indian archaeology. We look forward for more widespread use of these non-destructive and economic technologies for better understanding of India’s past and rich cultural heritage.

Finally, I thank the honourable authorities of AARG for their kind support and granting me an AARG Student and Early Researcher Grant to attend the 1st International Workshop on Advances in Remote Sensing for Archaeology and Cultural Heritage Management that was held at CNR, Rome, Italy between 30th September and 4th October, 2008.

Bibliography


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Cropmarks

Interpreted by Rog Palmer

**RapidEye**
A German company, RapidEye, uses satellites to record the ground during the growing season to monitor crop growth. This information is then transmitted to farmers (once they have registered and paid) and can then be used to adjust fertiliser, etc. The fact that these images are taken during the growing season suggests there may be something of archaeological value on them although their resolution is 5m/pixel. There trial area seems to have been France so it's a pity we haven’t got any French AARG members who may usefully follow this up.

I doubt whether the AARG aerial photographers will be at all impressed or interested, but there is probably huge potential here for showing natural features and indicating – in real time as they say – where crop-marked archaeological things may be visible for those planning higher resolution cover.

[http://www.rapideye.de/](http://www.rapideye.de/)

**Altinum**

*Science* published a note about the discovery of Altinum (a Roman harbor on the inner margin of the Lagoon of Venice) at the end of July 2009. This was recorded in considerable detail on visible and NIR verticals taken during a drought in July 2007 and has since been mapped. AP and map are in *Science* along with supporting data that include comment on the climate and other meteorological readings in summer 2007. The *Science* article now needs registration to access, but there is good cover, with illustrations, at National Geographic News:


**Macedonian Archaeological News**
...is an electronic newsletter produced by the Cultural Heritage Protection Office of the Republic of Macedonia and the Institute for Social Sciences and Humanities Euro-Balkan. Its basic purpose is to inform the public in Macedonia and worldwide about current archaeological research undertaken in Republic of Macedonia. The first issue is goodie-orientated.

[http://www.mav.mk](http://www.mav.mk)

(all accessed 4 September 2009)
Archaeological Prospection and Remote Sensing: Standing the test of time?

Review article by Anthony Beck


The archaeological remote sensing bible is back! Is it bigger? Is it brighter? Is it better? Well… no; but it is cheaper. CUP have released a paperback edition of the original 1990 publication. This provides an opportunity to review this book in the light of the changes that have occurred in the nearly two decades since it was first published.

This book focuses on archaeological prospection using remote sensing techniques (ground based and aerial sensors). It is euro-centric in nature with the majority of examples derived from the UK, France and Germany. Archaeological residues are treated as physical phenomena which have varying degrees of positive or negative interaction with their surroundings. The nature of this interaction may, or may not, be detectable by a specific sensor. The understanding of how deformation processes produce detectable contrasts form the basis of the book. Inevitably, this process-driven approach is not for the mathematically shy.

The first two chapters introduce archaeological prospection and how it is affected by changes in soil and climate. This is augmented by chapter seven which discusses the magnetic properties of soils. Chapters three through five deal with aerial photography, digital image enhancement and image rectification. The emphasis is on film photography (and thus ignores wavelengths above 930nm) and the rectification of oblique images taken with non-metric cameras (i.e. handheld cameras. Chapter ten tackles thermal prospection. As well as providing a theoretical and mathematical grounding, which include, diurnal thermal variations, it describes the ARIES scanning radiometer and highlights the rectification problems associated with an airborne scanning system. Unfortunately, the discussion of aerial scanners, which employ wavelengths outside the optical component of the electromagnetic spectrum, focuses solely on these thermal wavebands eschewing the near and short-wave infrared. The remaining chapters deal with geophysical survey. Chapters six, eight and nine respectively discuss resistivity, magnetometry and electromagnetic techniques and will not be discussed further. As a reference book it succeeds in collating material previously published in English, French and German. It is still, therefore, an essential reference for those engaged in archaeological prospection.

What has happened since 1990?
The edition is not revised, which begs the question of what has changed in the past two decades. Developments in sensor systems, Global Navigation Satellite Systems (GNSS: such as GPS) and software tools have fundamentally impacted on the collection, rectification and analysis of imagery. Technological innovations, such as the web, and open data initiatives have enabled access to a wide range of data and imagery. However, has this impacted on the usefulness of this book as a reference resource?

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The increase in the spatial and spectral resolution of modern sensors means that the boundaries between site and landscape prospection is blurring. The book focussed on the site rather than landscape level as the majority of data was collected at this level. This is no real detriment. However, the use of multi-source data for prospection will become increasingly popular. This is where lower spatial, and higher spectral, resolution imagery is used to characterise a landscape which provides a framework for the structured application of finer spatial and lower spectral resolution imagery. This kind of knowledge led approach is particularly beneficial in environments outside northern Europe with less well developed management frameworks. Airborne Laser Scanning (ALS) systems were developed after the publication of this book and have had a profound impact on archaeological prospection, particularly survey under heavy vegetation.

GNSS and inertial systems mean that the majority of modern vertical survey imagery is rectified during post-processing. Even the tilt, pitch and yaw anomalies from scanning systems can be corrected. If rectification is required then it is normally just a simple procedure to improve local positional accuracy. However, the same can not be said for oblique imagery. GPS tracks can help in the coarse location of an oblique photograph which aids in the subsequent rectification to a base map. Orthorectification of obliques is still an issue, however, a number of software packages can undertake orthorectification. In addition there are a greater number of free or cheap elevation data sets to aid the rectification process.

The majority of data are now collected digitally (imagery as opposed to photography) so scanning is not an issue. However, those who use archives still scan photographs. Geometric issues aside, the spatial and radiometric resolution of desktop scanning hardware has improved dramatically. The ability to scan photographs at greater than 8bit (256 different grey levels) is significant. If the human eye can perceive approximately 60 shades of grey (p. 135) then some of the subtle archaeological content in the image may be missed by visual inspection alone. Especially when one is dealing with the 11bit (2048 different grey levels) in QuickBird satellite imagery. Mathematical manipulation is required in order to extract archaeological subtleties embedded in the image structure. Radiometric resolution is, in my experience, poorly understood by the archaeological community. It is important that users think of the ‘image as numerical data’ particularly if they conduct mathematical image manipulation.

Software for the preparation, management, analysis and visualization of spatial data has improved dramatically in the intervening period (see AARGnews 36, March 2008). However, one the major benefits of the software developed by Scollar and colleagues is that it is non-profit. AirPhoto, the aerial photographic image rectification software is still available as part of the Bonn Archaeological Software Package suite. Another popular low cost system is Aerial5 developed by John Haigh. In addition there are a range of commercial application including ERDAS Imagine and ESRI ArcGIS. However, in the interim the Free and Open Source Software (FOSS) community has flourished and developed a range of different packages. This includes GRASS, originally developed by the US military, and a number of data serving systems, such as GeoServer. Most of these packages offer similar functionality, the major difference is ease of use and cost. Image analysis is slightly more sophisticated. However, this is due to the accessibility of more imagery. The availability of multi-spectral and multi-temporal imagery mean that mathematical analysis occurs between as well as within bands.
The web has changed the way we work. There has been an explosion of data and imagery that is freely or cheaply available. Raw satellite and aerial imagery of archaeological relevance can be easily downloaded, processed and analysed. On-line geo tools, such as Google Earth, have changed the way many people perceive and consume spatial data (however, as degraded data, the archaeological utility is reduced\(^2\)). Open data initiatives, such as Open Street Map, have changed the way that people collect, collaborate and think about national and international data. We do live in interesting times. However, the issue here is about data re-use. Much of the data on the web is either difficult to locate or deposited in a way that is inconvenient for users to consume. Leaving aside the latter point, it is important that appropriate metadata is produced that will facilitate resource discovery once deposited. Although the authors do not explicitly address metadata they did highlight the need to generate a processing audit trail (p. 203).

**So, do you need this book?**

To summarise, ALS has been developed, georeferencing has got easier, metadata is really important and software and hardware have improved. However, in my view the treatment of sensors and rectification is secondary to the treatment of the physical processes that lead to the identification of archaeological anomalies. The technical software, processing, hardware and data developments can be understood by picking up any recent remote sensing textbook. The focus on process and its impact on prospection means that this book is still fresh and relevant. This provides the framework for a deductive approach to archaeological prospection. It is important that researchers carry on this tradition so that there are more books “written for those trained in the physical sciences which provide detailed information on the theory and practice of archaeological prospecting” (Scollar et al., 1990 p.xiii).

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Other books of interest?


This volume is based on Peter Halkon’s PhD thesis and has three main stated objectives. First, Halkon aims to examine the development of a 20 x 30 km landscape block that takes in the catchment of the Foulness Valley, East Yorkshire (northern England), from c. 800 BC to c. AD 400. Secondly, to test results gained from an earlier study of an 8 x 8 km block and thirdly to place the Iron Age and Roman archaeology and environment of the Foulness Valley in a broader British and European context.

The study adopts a traditional empirical approach, the author declaring his scepticism of theoretically-driven approaches at an early stage, and this is reflected in the structure of the volume. Thus, it is no surprise that early chapters deal with environmental background (Ch 2) and archaeological methods (Ch 3), followed by heavily descriptive sections on results of aerial survey (Ch 4) and surface artefact collection (Ch 5). More discursive commentaries on the character of the archaeological remains follow, covering chronology, spatial distribution and relationships of recorded features to soils, palaeo-environment and topography (Chs 6 and 7). In a penultimate chapter (8), the landscape and economy of the study area in the Roman period is discussed, while the conclusion (Ch 9) summarises the main results and, in a rather cursory manner, sets some of the results in a broader context.

PhD theses that are published relatively fully have a tendency to be rather hit-and-miss and this volume is no exception. Halkon evidently knows his area very well and there is a vast amount of information packed into these pages, but in many places a hard edit and trimming of extraneous material would have strengthened the volume considerably. The presentation of survey data (aerial and artefact collection) is a recurrent challenge and one that Halkon meets with varied success. There are many distribution maps and examples of landscape mapping as should be expected in an avowedly empirical study. However, some maps are over busy and almost impossible to read – generally in the view of this reviewer, distribution maps with more than three symbols are illegible – while in other cases complex mapping has been reduced to virtually vanishing point. The effective presentation of survey data, especially in a digital age, is always going to be a struggle for printed media, which by definition render what could be interactive material in a static way. The delivery of interactive digital data is one of the aims of a supporting website: [http://www.ironmasters.hull.ac.uk/](http://www.ironmasters.hull.ac.uk/). This allows layers and symbols to be switched on and off, letting the user create bespoke distribution maps. Some of the data is rather coarse grained, in part due to concerns of the county archaeologists and land owners over detail available to illicit metal detector users, but also to ensure that even users with slow computers (the site was built in 2004) could access the site (P. Halkon pers. comm.). It would be unfair to identify the delivery of survey data as a weakness of the volume as it is a perennial problem, and one that, without sophisticated digital delivery, will probably not be solved in print.

There is much to recommend this volume. The importance of integrating aerial survey data, geophysical survey and artefact distributions from surface collection is ably demonstrated.
For a British reader with an interest in the Iron Age and Roman periods, this detailed study of an area with a full archaeological record is informative, while the evidence for iron working and the palaeo-environment, especially the impact of changing sea levels, has much broader pan-European relevance and deserves to be widely read.

Dave Cowley


In Chapter 8 the author quotes from a *Code of Ethics* of the American Society of Photogrammetry and Remote Sensing. Number 5 is “Undertake only such assignments…for which one is qualified by education, training and experience.” Parcak would have done well to have been guided by this and left the writing of this book to someone who knows the subject more thoroughly. There are too many factual wrongs to list and the book contains little guidance about using satellite images in archaeological projects. Most illustrations (almost all of which are from Google Earth and many of which are gratuitous and uninformative) are upside down, she knows nothing about scales and very little about aerial photographs. The sad thing is that this is written by a university lecturer, published by a supposedly-reputable company, and is likely to become the text book for the current generation of students. Do not waste your money buying a copy.

Rog Palmer

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**Information for contributors**

*AARGnews* is published at six-monthly intervals. Copy for *AARGnews* 40 needs to be with me by **February 14**. Editorial policy (for want of a better word) tends to be that if I am sent interesting contributions they go in up to an issue limit of about 50 pages. Vague instructions for contributors are in the AARG website.

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The Aerial Archaeology Research Group

The Aerial Archaeology Research Group (AARG) provides a forum for the exchange of ideas and information for all those actively involved in aerial photography, photo interpretation, field archaeology and landscape history. This also includes the use of aerial photography in defining preservation policies for archaeological sites and landscapes.

Since its foundation in 1980, AARG has actively encouraged such exchange through its annual conference, specialist meetings and, more recently, through the biannual publication of its newsletter, AARGnews.

Membership of AARG is open to those interested in aerial archaeology as well as its active participants. All applications for membership, subscriptions and changes of address should be sent to the Secretary:

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Anyone wishing to apply should write to Dave Cowley, RCAHMS, 16 Bernard Terrace, Edinburgh, EH8 9NX, Scotland (Dave.Cowley@rcahms.gov.uk) with information about their interests in archaeology and aerial archaeology, as well as their place of study. Annual closing date for applications to the annual AARG conference is 31 May, other meetings for which bursaries may be available will be advertised on an ad hoc basis.