

EUROPEAN LANDSCAPES

past, present and future

Culture 2000 Project Ref. No. CH-A2-UK-2077

FINAL REPORT

1 October 2004 – 31 October 2007



Through satellite imagery, airborne survey, fieldwork, geophysics and excavation, the aim of the project is to promote the exploration, public appreciation and conservation of heritage sites and landscapes across Europe.



Education and Culture

Culture 2000



ENGLISH HERITAGE

EUROPEAN LANDSCAPES: past, present and future



Co-organisers

English Heritage, Project Sponsor

University of Ghent

State Authority for Culture and the Preservation of Monuments, Mecklenburg-West Pomerania

Cultural Heritage Service Baden-Württemberg

Baranya County Museum Authority, Pécs

University of Foggia

University of Siena

Co-partners

University of West Bohemia, Pilsen

National Heritage Board of Estonia

Helsinki University of Technology

Institute for Landscape Management,
University of Freiburg

Agency for Euromediterranean Cultural Heritage
and the University of Salento, Lecce

Department of Lithuanian Heritage Protection

Adam Mickiewicz University, Poznań

Poznań Archaeological Museum

Institute of Archaeology and Ethnology,
Polish Academy of Sciences

Institute for Cultural Memory, Bucharest

Institute of Archaeology,
Slovak Academy of Sciences



Education and Culture

Culture 2000

Acknowledgments



The Culture 2000 project could not have been conceived or carried out without the unstinting assistance of the Aerial Archaeology Research Group and its members across Europe. Particular thanks go to Rog Palmer from the UK, Otto Braasch and Klaus Leidorf from Germany, Darja Grosman from Slovenia and Michael Doneus from Austria who have all contributed without charging for their time.



Representatives from all of the project co-organisers and co-partners, on the steps of the National Museum in Prague on 24 October 2007 following the project's final event, organised by English Heritage with the help of Dr Martin Gojda and his colleagues in the Czech Republic.

All participants would like to record their thanks to Chris Musson who from the project's inception until its completion, has made an enormous contribution without remuneration to ensure the smooth running of the project and the furtherance of its aims; without his efforts, along with those of Bob Bewley and Sarah Prince within English Heritage, the project would not have happened and would not have reached such a successful conclusion.

This report has been compiled and edited by Chris Musson and Pete Horne
December 2007

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CONTENTS AND PROJECT PARTICIPANTS

- 1 CONTENTS AND PROJECT PARTICIPANTS
- 2 SUMMARY AND OVERALL ASSESSMENT OF PROJECT RESULTS
- 4 DEVELOPMENT AND PROGRESS OF THE PROJECT

Reports by co-organisers* and co-partners

6	BELGIUM*	University of Ghent
10	CZECH REPUBLIC	University of West Bohemia, Pilsen
14	UNITED KINGDOM*	English Heritage
18	ESTONIA	National Heritage Board of Estonia
22	FINLAND	Helsinki University of Technology
24	GERMANY*	State Authority for Culture and the Preservation of Monuments, Mecklenburg-West Pomerania
28	GERMANY*	Cultural Heritage Service Baden-Württemberg
32	GERMANY	Institute for Landscape Management, University of Freiburg
34	HUNGARY*	Baranya County Museum Authority, Pécs
38	ITALY*	University of Foggia
42	ITALY*	University of Siena
46	ITALY	University of Salento, Lecce acting for the Agency for Euromediterranean Cultural Heritage
50	LITHUANIA	Department of Lithuanian Heritage Protection
54	POLAND	Adam Mickiewicz University; Poznań Archaeological Museum and the Polish Academy of Sciences
58	ROMANIA	Institute for Cultural Memory (CIMEC)
62	SLOVAKIA	Slovak Academy of Sciences
66	EXHIBITION	Czech National Museum, Prague, Oct 2007-Jan 2008
68	WHAT ELSE?	Spin-off activities and associated events

SUMMARY AND OVERALL ASSESSMENT OF PROJECT RESULTS

Pete Horne, Bob Bewley and Chris Musson, for English Heritage

Aims and objectives

The aim of the project was to increase awareness and conservation of the shared cultural heritage within European archaeological landscapes, especially through non-destructive techniques of investigation such as aerial reconnaissance, air-photo mapping, field survey and the innovative use of satellite, airborne and ground-based remote sensing. The project did not have a single unified programme. Instead, the participants responded to their local situations, contributing to however many of the project's nine key Actions which seemed relevant to their individual capacities and needs. The nine Actions can be summarised as follows:

- Action 1 The promotion of training schools, workshops and seminars
- Action 2 Aerial and ground-based surveys of threatened sites and landscapes
- Action 3 Air-photo interpretation and mapping of cultural landscapes
- Action 4 Innovative surveys using air-photographs, laser scanning and satellite imagery
- Action 5 The search for under-exploited air photo sources from World War II
- Action 6 Networking and the exchange of skills across Europe
- Action 7 The Creation of a *European Centre* as a focus for future events and developments
- Action 8 Public outreach through websites, TV, radio, films and exhibitions
- Action 9 Centrally-funded activities, student exchanges, support for meetings etc

Achievements, October 2004 – October 2007

Overall, the planned activities, with inevitable modifications to meet changed situations since the project application in November 2003, were successfully completed, though the planned expansion into the Iberian Peninsula had to be postponed and the intended 'book of the project' was not in the event thought practical.

Highlights of the project included numerous productive training schools, conferences and workshops, focusing activity on individual countries or helping to spread expertise across Europe. There were successful programmes of exploratory air survey and mapping in several countries (including for the first time in Romania), along with exploratory work on the use of laser-scanning technology (lidar) in landscape and archaeological recording. The combination of aerial survey and ground-based remote sensing was explored in Italy, Germany and Hungary. A major international exhibition was mounted in Prague and there were several other exhibitions, along with press, radio and TV coverage in many countries across Europe. A central website, with links to many others, was maintained throughout the project and will continue to be so. It is clear that the impact of the project, both within individual institutions and more broadly in the participating countries, will continue well into the future.

Achievements within individual Actions

The results achieved in each of the countries and partner institutions are set out more fully in Appendix A. The following notes summarise the main results within each of the nine Actions.

Action 1 Promotion of Training Schools, Workshops and Seminars

Six training schools, with in-air and ground-based experience for students from across Europe, were held in Italy, Germany and the UK. Ground-based workshops, seminars or conferences were held in Estonia, Finland, Germany, Lithuania, Poland (twice) and Romania (twice). Assistance of one kind or another was given for other meetings in Belgium, Denmark, Italy and the UK. A total of about 130 students participated in the training schools and workshops, and a further 100 participants took part in other events, taking their acquired skills and understandings back to their native countries.

Action 2 Aerial and ground-based surveys of threatened sites and landscapes

Substantial programmes of aerial reconnaissance, mainly concentrating on sites and landscapes at risk from ploughing or other modern developments, were conducted in the Czech Republic, Italy and Poland.

Exploratory flights focusing on specific aspects of the landscape were undertaken in Belgium, Estonia, Germany, Hungary, Lithuania, Slovakia and the UK. The first 'home-based' air photographic flights were undertaken in Romania. In all of these countries important archaeological discoveries were made and photographs were taken of heritage landscapes, townscape and buildings for the benefit of present and future conservation work and public presentation.

Action 3 Air-photo interpretation and mapping of cultural landscapes

Photo-interpretation and mapping work was undertaken in all of the countries that carried out flying programmes, in particular for newly discovered sites or groups of sites within the landscape. Particularly important photo-interpretation and mapping work was undertaken in Italy and Belgium, in the latter case revealing, interpreting and publicising previously un-mapped traces of Great War military landscapes in Flanders, opening up possibilities and setting standards for similar projects in the future.

Action 4 Innovative surveys using air-photo, laser-scanning and satellite imagery

The use and testing of satellite imagery, airborne laser scanning (lidar), geophysical survey and other remote-sensing methods was undertaken in Germany and Italy. Co-partners in the Czech Republic, Hungary and Slovakia experimented successfully with the integration of one or more of these techniques alongside more established ground-based methods such as field survey, finds-collection and sample excavation.

Action 5 Under-exploited air photo sources from World War II and earlier

The search for German photo-maps from the 1930s and 1940s was less fruitful than hoped but several as yet un-exploited 'historical' archives of air photographs were located in Poland. Information about the already-known German photo-maps has been publicised on the web and the search for more of these precious documents will continue beyond the end of the Culture 2000 project. The project in Belgium clearly demonstrated the importance of 'historical' and modern air photographs in the understanding and conservation of Great War landscapes and military remains, a subject discussed at an international conference at Ypres in November 2006.

Action 6 Networking and the exchange of skills across Europe

The European network of specialists taking or using air photography and other forms of remote sensing has been substantially enhanced, both in numbers and geographical range. As a result of the project many students and young researchers have acquired international contacts which will serve them well in their future careers and in the development of aerial archaeology across Europe. A particularly useful range of new contacts was made in Scandinavia and the Baltic area, with initial contacts also in Iberia.

Action 7 Proposed 'European Centre'

The idea of a European Centre for Landscape Archaeology and Remote Sensing, to act as a 'nerve-centre' for future work and activities in this field of research and conservation, was refined throughout the project. In 2006 a first 'home' for the centre was offered at the University of Siena but this initiative stalled with the tragic death early in 2007 of the professor most closely involved in the discussions, Riccardo Francovich. In the following months, however, the idea has matured into a potentially more flexible and sustainable concept of a 'network' of 'centres of expertise' across Europe, each contributing according to its own capacities to a core of agreed values and objectives. The concept was warmly endorsed at the annual meeting of the international Aerial Archaeology Research Group at Copenhagen in September 2007. It is hoped that several such centres will declare their participation in 2008.

Action 8 Public outreach: websites, TV/radio, films and exhibitions

The project's central website (www.e-landscapes.com) went on-line in November 2005 and has been regularly enhanced and updated ever since. It will be maintained for at least three years beyond the end of the Culture 2000 project. Several partners have added 'Culture 2000' pages to their own websites. Work on a TV/video film assisted by Culture 2000 funding will be completed in late autumn 2007 and a major international exhibition was mounted in Prague as the final event of the project. Smaller exhibitions were presented in other countries, including one in a busy shopping mall in Hungary. Project members have also contributed to many radio and TV broadcasts.

Action 9 Centrally-funded activities, student exchanges, support for meetings etc

Funds were made available from a 'central' reserve to assist participation at training schools, workshops, seminars and meetings. Students and researchers were helped to undertake periods of research, study or practice in other countries. Funds were also used for other related purposes, including publication.

DEVELOPMENT, PROGRESS AND ACHIEVEMENT OF THE PROJECT

Pete Horne, Bob Bewley and Chris Musson, for English Heritage

Initiation and basic character of the project

Several co-partners in the present project also worked on a Culture 2000 project in 2001 (*Conservation through Aerial Archaeology – CAA*). This built on earlier training schools and exchanges organised by the Aerial Archaeology Research Group (AARG), a UK-founded body which has subsequently expanded into Europe and beyond. By 2003, when the present project was being planned, the Group provided an international network of contacts which was crucial to its conception, framing and successful execution.

The project was an ambitious one, involving 7 co-organisers (in the UK, Belgium, Hungary and two each in Germany and Italy), along with 11 co-partners in 7 other countries. The focus was on aerial archaeology, heritage conservation and public awareness, with particular emphasis on the broader landscape and on the spread of 'aerial' and other remote-sensing techniques to areas where the method has as yet been little used (such as the Baltic and Nordic region, the Mediterranean rim, some of the former communist states and the Iberian Peninsula).

Through consultation with the co-organisers and others, 9 key fields of activity, or 'Actions', were framed for the project. These are summarised in the previous section. There was no intention, however, to create a single unitary programme for the whole project, rather to outline a series of actions from which the participating institutions could choose those which they felt particularly suited to their needs of experience. The 18 participating organisations spanned from those who were pioneering the introduction of aerial archaeology and landscape studies in their own countries to those who were already well experienced but wished to carry out specialist studies or to develop particular aspects of their work. The wide range of experience, objectives and results amongst the project co-partners is illustrated in the individual reports.

Achievements and future prospects

The project has made a considerable impact in the field of aerial archaeology and landscape studies across Europe, with regular reports and discussions at meetings of the international Aerial Archaeology Research Group and elsewhere. At the final meeting of the participants in October 2007, it was unanimously agreed that the project had been a great success, with worthwhile results in each institution and across Europe as a whole. All of the participating institutions committed themselves to continuing and developing similar work in the future, given adequate funding from whatever source.

New cooperative partnerships have been formed, the level of debate about the use of new techniques has been raised, and plans are already being laid for future action, in particular to encourage and support the work just begun by the less experienced participants in the present project, and to extend its application to countries where (in recent years at least) aerial archaeology has hardly been used (in Scandinavia, Denmark, Holland, Ireland, Spain and Portugal, for instance). New funding will be needed for this and similar initiatives but the experience and contacts created during the present project will provide a firm basis for their planning, management and successful execution.

Progress and development of the project

The progress of the project, subject to inevitable adjustments of timing and emphasis in activities often conceived more than three years before their completion, was encouragingly smooth. There were early bureaucratic and financial problems in southern Puglia, Italy, but these were eventually overcome and excellent results were achieved. Less work, perhaps, than originally envisaged, was done with satellite imagery but this was offset by excellent experience

in the use of airborne laser scanning (lidar) and ground-based geophysical survey combined with aerial photography and 'traditional' methods such as field-survey and excavation.

The search for 1930s/1940s German photo-maps of Poland and other parts of Europe was less fruitful than hoped but their existence has been made known through the web and several important collections of war-time air photography were identified. The search will continue.

In the event, pressure of work in other parts of the project prevented an expansion into Spain and Portugal, though plans are being made, using contacts created over the past three years, to develop in this direction after the end of the present project. As a counterbalance to this disappointment, two ground-based workshops (only speculatively envisaged in the original application) were brought to successful outcomes in Poland in the final year of the project.

Particular satisfaction was given by the progress made in countries that were relatively new to aerial archaeology (Estonia, Lithuania and Romania) and by striking discoveries in Poland which may help to advance the long-delayed development of aerial archaeology and landscape studies in that country. In Italy and elsewhere progress was made in the processing of 'aerial' information to achieve long-term benefits in the conservation of sites and landscapes from the past in the face of modern agricultural and industrial development.

Administrative and financial support

Although time-consuming (especially for the project's supposedly 'retired' and un-paid project co-ordinator) the management and financial reporting of the project proved relatively straightforward. The 7 co-organisers met as a Management Group at Munich, Germany in 2004 (before the start of the project), at Leuven, Belgium in 2005, at Schwerin in Germany in 2006 and at Prague at the end of the project in October 2007. Many of the co-partners also contributed to discussions of project policy and management at these meetings.

Apart from this, mutually supportive email contact was maintained throughout the project. In a project in which 18 separate institutions, each managing its own financial expenditure and reporting (with specific approval from Brussels), the pro-forma Invoice Spreadsheet provided by the Culture 2000 office – at first frighteningly complex in appearance – proved invaluable in imposing a consistent pattern of reporting despite wide variations in internal practice in the different institutions. Computer programmes for merging the individual invoice spreadsheets from all 18 institutions were developed as part of the project's financial management.

Financial outcome

Some of the participants slightly overspent their original budgets (English Heritage more than slightly) while a few others fell fractionally short of their targets. The total expenditure amounted to €920,188 against an original target of €883,055, the participants contributing €502,233 against an agreed maximum from the EU of €417,955. None of the participants was able to reclaim VAT so the full cost of each expenditure was included in the financial accounting system.

The project also benefited from much time and experience contributed, without charge, by staff at the participating organisations, and from time given freely by experts and administrative staff from outside the project (in particular those acknowledged on the final page of the report).

The Aerial Archaeology Research Group also gave indirect financial support, to an approximate value of about €34,000, amongst other things by funding students – particularly those from central European countries – to take part in Culture 2000 activities.

'Spin-off' activities and interaction with other projects

There were many 'spin-off' benefits from the project. These are more fully recorded in the "What Else?" section further on in the report. They included publications, first links with Syria and the USA, the formation of new organisations in Denmark and Holland, promising developments in Romania, and contributions to recent and future international discussions.

AERIAL PHOTOGRAPHS AND FIRST WORLD WAR LANDSCAPES IN FLANDERS

Inventory, digitisation, survey and mapping

Jean Bourgeois and Birger Stichelbaut, Ghent University, Belgium

Background and objectives

The Department of Archaeology and Ancient History of Europe at Ghent University has more than 25 years of experience in archaeological aerial photography, mostly in the capture and use of oblique air photographs. Since 2003, however, there has also been a focus on historical photographs from WWI – an important archaeological resource, only rarely exploited in the past.

After the First Battle of the Marne in September 1914, the First World War became static. Both sides started to entrench their armies in the 800 km stretch of land between the North Sea and the French-Swiss border. Most soon realised the possible strengths of a new weapon – aviation and aerial reconnaissance. Air photographs were taken in all of the different theatres of war, documenting a cultural phenomenon that in places scars the landscape even today.

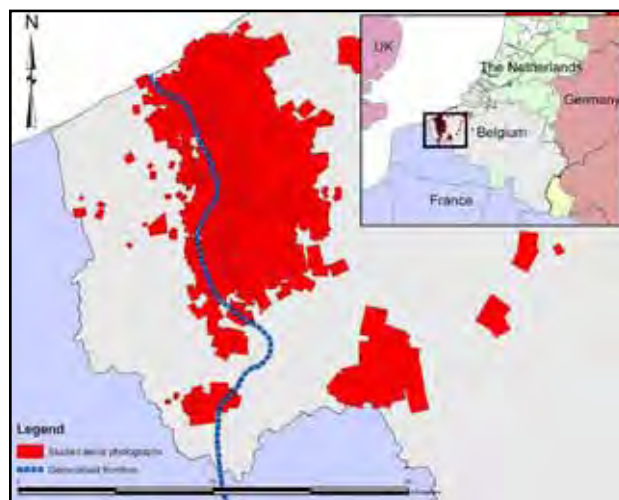
The specific aims of the Belgian contribution to the Culture 2000 project were:

- To look for previously unexploited archives of military aerial photographs, and to use them in the recording and mapping of archaeological features, both traditional and conflict-related.
- To undertake new exploratory flights so as to compare the traces recoverable through new photography with those visible on the historical images.
- To organise a conference on Military Aerial Photography and Archaeology.

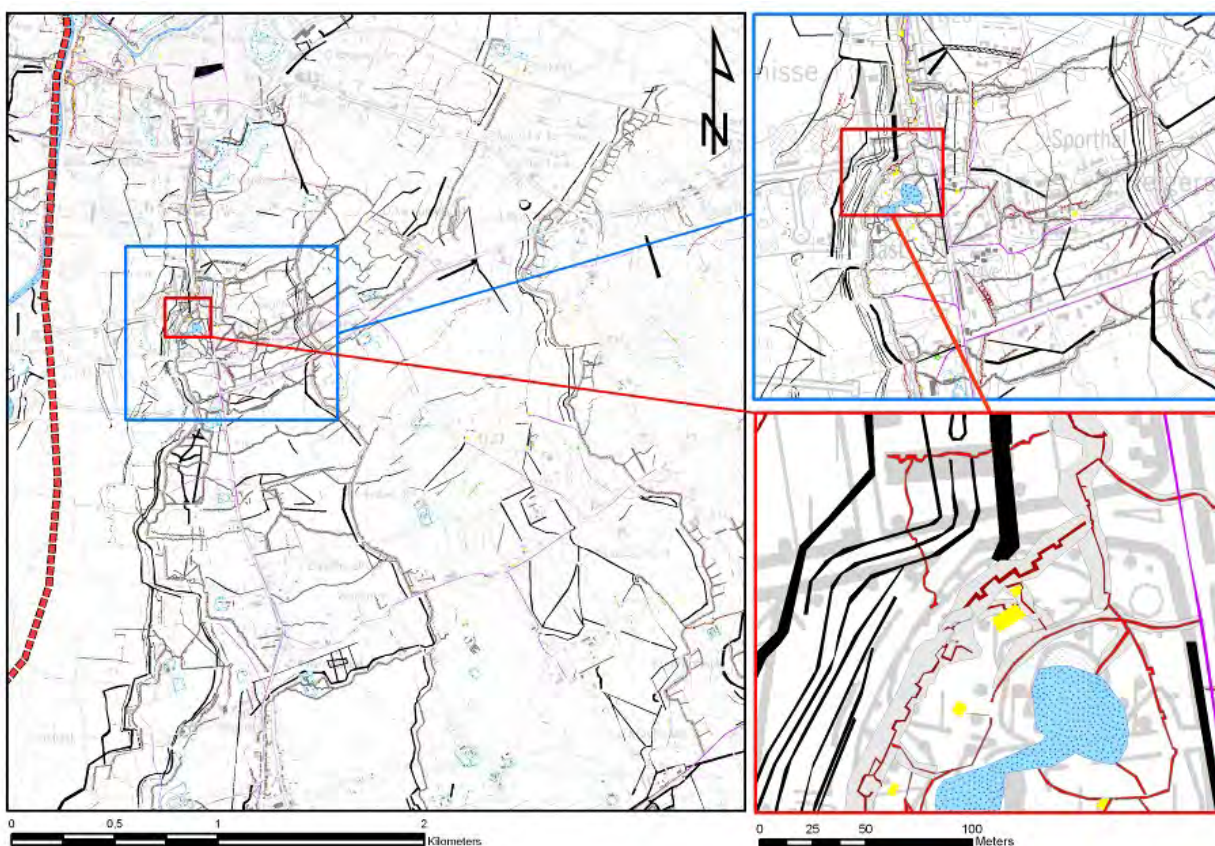
Archival research: WWI air photographs

The main photo-source in Belgium is the collection of the Royal Army Museum in Brussels (KLM/MRA) which holds 48,484 WWI air photo prints, stored in 365 boxes against 1928 place-names (of cabarets, crossroads, farms, toponyms, roads, trenches and miscellanea). Research was undertaken to make a geographical distribution in GIS of the collection. Altogether 1331 (69%) of the place-names were localised in GIS, corresponding to 42,356 aerial photographs.

Other smaller but valuable archives exist elsewhere in Belgium, in particular at the Historical Documentation Centre of the Belgian Army (657 prints) and at the In Flanders Fields Museum



Left: American aircrew handing over an aerial camera with focal length of 52 cm (Source: NARA Washington DC). Right: Localisation of the studied WWI air photographs.



Example of the detailed level of mapping undertaken within the project.

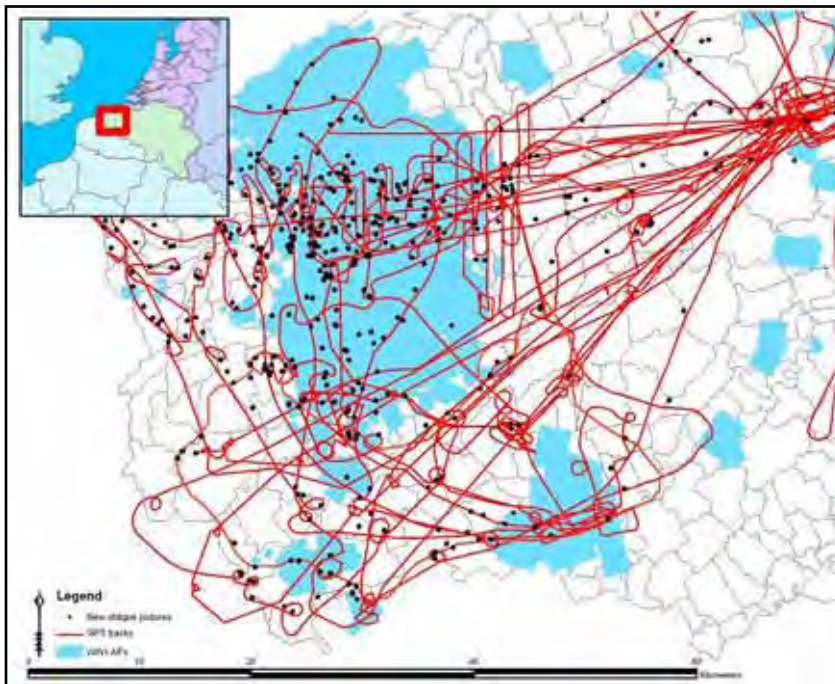
(about 800 prints). In addition, air photographs emerge at times in other records, such as the 'Moscow Archive' of the KLM/MRA, containing about 400 photographs not apparently represented in the main collection. There are also vast numbers of pictures taken by other forces over Belgian soil, now stored in archives across Europe and in the United States.

Mapping in GIS

A selection of almost 6500 air photographs were scanned at 400dpi and entered into a database. From these, 5200 were localised and (mostly) georeferenced in GIS, covering a strip 35x15 km between the northern part of the Ypres salient and Ostende (approx.750 km² in all).

The photographs record information about environmental history and traditional archaeological sites in addition to those of WWI. Among the historical and archaeological traces were numerous medieval moated sites and post-medieval fortifications. Most of the visible features, however, belonged to structures and military positions of the Great War. In general, they appear in the form of watermarks, snowmarks, cropmarks or soilmarks, and refer to events of similar date to the photographs themselves. Their study, for this reason, often has more interfaces with military photo-interpretation than with traditional techniques of archaeological air photo analysis.

To obtain a reliable listing of all relevant traces the air photos had to be inventoried, rectified and interpreted. Stereoscopic analysis was an absolute necessity and 150 digital stereoscopic views (anaglyphs) were created from stereo-pairs of overlapping pictures, using software that gave advanced possibilities for geographical information and image processing. The stereo views showed raised object such as bunkers, breastworks, artillery positions, embankments, ramparts, houses, sites and even trees in clear relief. The same applied for sunken features such moats, tank traps, mine craters and large bomb craters.



GPS track-logs from new air-photo flights (red lines) and newly discovered sites (black dots), overprinted on the area of studied WWI air photographs (solid blue).

A second multidisciplinary approach involved the interpretation and visualisation of historical stereo-pairs in a digital photogrammetric workstation. A digital elevation model (DEM) and a corresponding orthophoto were generated from the stereomodel. Finding matching control points in the field, however, proved difficult because of the wholesale destruction of the landscape by artillery fire, village expansion and post-war re-allotments.

The orthophoto provides a very accurate geo-positioning of the air photographs. More important were the contour map and the DEM, which allowed the reconstruction and visualisation of the past landscape in three dimensions, revealing features that would otherwise have remained hidden. The example studied (a 1917 second-line German trench system) clearly showed the difference between the raised breastwork of the trenches and more concave features nearby.

This multidisciplinary approach adds new possibilities for interpretation and visualisation. The only necessities are stereo-pairs of historical air photographs, GPS measurements and an appropriate workflow in the digital photogrammetric workstation. This methodology can be extended to other regions and periods, giving it potential importance for geographers concerned with reconstruction of the historical landscape and with the technical challenge of the restitution of archival air photographs.

This unusual approach has provided a detailed and accurate insight into the density, distribution and diversity of all possible material remains. Almost 20,000 individual features were inventoried and mapped in GIS, covering WWI trenches, barbed wire entanglements, barracks, cemeteries, gun emplacements, bunkers etc, but also including older sites such as medieval moats, bastioned town walls and forts. The work on the WWI features reveals the 'anatomy' of the whole German frontline between Ostend and the northern part of the Ypres salient, in far more detail than could have been gleaned from contemporary trench-maps and written sources.

Aerial photography in West-Flanders

A second goal was to conduct new flights in the province of West-Flanders, firstly so as to have two layers of aerial information – new oblique images and the vertical historical air photographs – and secondly because this part of Flanders has (for a variety of reasons) been less intensively surveyed from the air in the past. Because of unfavourably wet weather in 2005 and 2007 the number and duration of flights was lower than originally planned. However, 36 hours of flight time over the frontline area allowed the documenting of many new sites of all periods, from the



Poster for the Ypres conference and newly-discovered WWI trench system near the Belgian coast.

Bronze Age to WWII, including many moated sites of medieval and post-medieval date. But on only a couple of pictures was it possible to record WWI features as cropmarks or shadowmarks, perhaps because of landscape-destruction by massive artillery fire at the end of the war, but also because the study area's heavy soils need very dry weather for cropmarks to form.

Conference on *Military Aerial Photography and Archaeology*

The planned conference took place in collaboration with the In Flanders Fields Museum at Ypres on 19-21 October 2006. A first theme focused on the history of military air photography, with presentations on the history, importance and development of the discipline. A second session centred on the main collections of World War air photography, asking 'Where are the archives?', 'What do they contain?', 'What is their potentiality for historical and archaeological research?'. The third and final session concentrated on modern processing of the photographs and their applications, for both mainstream and conflict archaeology. A diverse international audience attended the 3-day event, the proceedings of which will be published by the University in a volume dedicated to the use of military aerial photographs for archaeological purposes.

International networking

The project provided many opportunities to enhance the University's network of aerial archaeology contacts across Europe, bringing about an invaluable exchange of information and expertise which will last in the longer term. Presentations on WWI air photography were given at a variety of workshops and conferences, both within the Culture 2000 project and as 'spin-offs' from it. Work on the WWI remains of Flanders will continue in the coming years.

General assessment of the project

The University's contribution to the Culture 2000 project demonstrated how modern cartographical techniques and the use of WWI air photographs can reveal new information about material remains from both recent and more traditional archaeological periods. The investigation was extended to encompass newly taken oblique images, so as to explore which source or sources might be most useful for specific purposes. In most instances, however, it was convincingly demonstrated that vertical and oblique, historical and modern, air photographs should be used together as complementary sources. Sources of this kind exist all over Europe, as well as in the United States. One of the goals of the Ypres conference was to bring them to the attention of historians, archaeologists, landscape specialists and the general public. The meeting, and its resulting publication, will carry this message well into the future.

LANDSCAPE SURVEY AND PRESENTATION IN THE CZECH REPUBLIC

Dr Martin Gojda, Mr L Šmejda, University of West Bohemia, Pilsen

Background and objectives

The objectives of the University of West Bohemia's contribution to the project were to encourage the use of aerial photography and other forms of remote sensing in landscape exploration and conservation. This was to be achieved through:

- Research, involving the combined use of new and innovative techniques, including new aerial survey and the study of existing air photographs of the Czech Republic.
- Education, involving the preparation of a video film and an on-line *Encyclopaedia of Aerial Archaeology and Remote Sensing*.
- Public presentation, through the preparation of a major exhibition on the role of aerial survey and related techniques in landscape exploration, analysis and conservation.

Research

Fieldwork

Fieldwork in a selected region was carried out with the use of various techniques such as air reconnaissance, surface artefact collection, geophysical survey and test excavation within an area around the legendary Hill of Říp, north of Prague. The intention was to explore the dynamics of past settlement processes in the vicinity of this 'sacred' mountain, which has legendary connections to the beginnings of Czech history in the early Middle Ages. Each year intensive aerial survey was conducted over the study area, revealing a number of previously unknown sites of prehistoric to post-medieval origin. Together with data gathered from repeated field-walking it was found that past settlement activity in this region was much more intensive than had previously been supposed. Test excavations on a double enclosure originally revealed through aerial survey produced important information about its date and function, showing it to belong to the earliest form of country feudal seat in Bohemia. The site is of particular importance because it is the first of its kind within Czech archaeology whose plan is fully preserved, in this case in the form of 'aerial' evidence. Pottery from the lower layers of the enclosure ditches and from two sunken houses in the interior dated the site to about 1150-1250 AD, the earliest stage of the High Medieval period in Bohemia.



Conjoined double enclosure discovered from the air (left) and under excavation in 2005 (right). The dating of the enclosure to the Medieval period, rather than to prehistory as expected, has had major implications for interpretation of heritage landscapes in the Czech Republic.



Left: Test excavations in the central, rectangular, part of the Ledčice enclosure, dated to the 12th-13th centuries AD. Centre: Part of the ground plan of one of the two sunken huts, with peripheral postholes, in the middle of the rectangular enclosure. Right: Geophysical survey of an oval enclosure near Vražkov.kj

Geophysical survey

Geophysical survey was mostly focused on sites identified from the air. A new type of caesium magnetometer, bought by the Department (with limited help from the Culture 2000 project), was used in a variety of situations to test its potential and to make comparisons with parallel measurement made with an earlier type of magnetometer. The experiments helped to clarify the relative potentialities, advantages and disadvantages of the two instruments in different types of terrain, geological regions and archaeological contexts. This in turn helped to refine the field methodology and to eliminate initial problems of data-collection and measurement-errors. The tests, many of them undertaken on sites originally discovered from the air, showed that the new instrument offered good possibilities for identifying sunken features; it was also capable of revealing the shape and dimensions of ditched enclosures and successfully distinguished between sunken features and production areas within a prehistoric settlement. The different but necessarily more limited capabilities of the instrument in wooded areas were also investigated.

Air photo analysis and survey

The evaluation of modern vertical air photographs was undertaken through the analysis of a collection of contemporary orthophotos of the Říp region owned by the Czech Ordnance Survey Office. This resulted in the identification of about 40 previously unknown cropmarked sites, some of which will become the subject of field-walking and geophysical survey in future years.

Digital stereo photogrammetry and the mapping of archaeological features identified by the stereo-examination of vertical air photographs became an important part of the research work, breaking new ground in a field that has not yet been systematically developed in Czech archaeology. Over the course of the project the research team, through the Department's own funds, progressively acquired the necessary equipment for this kind of work. One PC workstation dedicated to this aspect of cultural heritage research and management is now in use in the Department and this kind of work will continue after the lifetime of the Culture 2000 project. Preliminary work on the analysis of vertical aerial images was carried out within the project and the subject will soon be included as part of the aerial archaeology course provided by the Department for undergraduate students – a significant long-term gain from the project. Intensive air survey was undertaken in three areas: the Říp region (around 20 hours per year throughout the project), the Labe and Ohře river basins in central and north-western Bohemia (around 15 hours per year) and West Bohemia (around 10 hours per year). The flights produced



Cropmarks in the Říp region. Rectangular enclosure with a smaller enclosure in its interior (top left), small rectangular features (arrowed) and ring-ditch with possible grave-pit (in square). Also many other pits.

around 1500 colour and 3000 digital images, subsequently processed within the Department. In addition to newly-discovered sites, photos were also taken of known sites and monuments as well as non-archaeological features recorded for a variety of purposes (education, training in air photo interpretation etc). Spare seats in the survey aircraft were regularly taken up by advanced students of archaeology to gain practical experience in aerial survey and air photography.

Educational work and film production

Student training and E-learning

In addition to student participation in research-based flights (noted above), fifteen students each year participated in the Department's air survey training course in the central part of the Říp study area, helping to identify cropmarked sites and to photograph other features.

Distance-learning is used in the teaching of a course on aerial archaeology for students at the University in Hradec Králové in eastern Bohemia. Aimed at students unfamiliar with archaeology

and cultural heritage, this is in effect a contribution to general public education. The success of this effort gave rise to the concept of developing an *internet-based encyclopaedia of aerial archaeology and remote sensing*, freely accessible by the general public. This idea was included as a revision of the original Czech proposals for the Culture 2000 project. However, after initial experiments with database entry and design of the user interface it became clear that the work would far exceed the resources available within the Culture 2000 project. Work on the encyclopaedia has therefore been postponed to a later date.

Film production

However, the Department's main contribution in the educational field, partly funded by grants from the Culture 2000 project, was the production of a film on the history of aerial archaeology and its use in the study of European landscapes. Work on the 75-minute film included editing of footage taken from the air over the past ten years (including within the Culture 2000 project) in the Czech Republic, Germany, Italy, Poland, Slovakia and the UK. Interviews were recorded with leading figures in European aerial archaeology and a section was prepared on the work and equipment of the most important aerial archaeology institutions in northern and central Europe. Also featured in the film are the Culture 2000 training schools held in various countries. Editing work was undertaken by T. Petráň, Vice-Dean of the Prague Film and Television Academy. The film, in both Czech and English version, will be offered to the Czech TV2 educational channel (and to other outlets both inside and outside the Czech Republic). On completion the film will become a key part of the Prague exhibition noted below.

Exhibition and final meeting of project co-partners

One of the University's principal contributions to the project lay in the preparation of an international exhibition on aerial survey and related techniques in landscape exploration, analysis and conservation. This is illustrated below and in the penultimate section of the Report.

The final meeting of the Culture 2000 co-partners was held, with help from the Department, in the National Museum at Prague, on the day following the official opening of the exhibition. The meeting gave the project participants the opportunity to present their work, to discuss problems encountered during the project and to explore possibilities for future contacts and cooperation.

General assessment of the project

The Culture 2000 project allowed the Department to extend its work in aerial survey and related ground-based work, in the examination of existing air photo archives, in the use of geophysical instruments and in the preparation of a video film and major international exhibition. Attendance at a variety of meetings and the hosting of the final gathering in Prague, helped the Department to maintain and develop its contacts throughout Europe and to contribute to scientific debate.



Showcases at the exhibition in the National Museum, Prague, October 2007.

UNDERSTANDING ANCIENT LANDSCAPES IN EUROPE

Training and access

Dr Robert Bewley, English Heritage; Peter D Horne, English Heritage

Background and objectives

Aerial archaeology and landscape studies have a long history in the United Kingdom. English Heritage is a leading institution in the fields of archaeological air survey, landscape recording, air photo-interpretation and mapping, archive-management and public presentation. The organisation's main role was to serve as Project Sponsor, providing overall leadership and administrative and financial support for the project as a whole. It also provided skilled tutors for training events, workshops and conferences within or associated with the project, and administered the funds allocated to Action 9 (centrally-funded activities).

The specific responsibilities of English Heritage were as follows.

- To provide administrative and financial support in the receipt and expenditure of funds and in reporting to the Culture 2000 office in Brussels.
- To share expertise by arranging speakers and tutors for training events, workshops and conferences organised by Culture 2000 co-partners.
- To organise an aerial survey Training School in England, and to act as co-organiser for a Workshop in Italy in partnership with the University of Siena.
- To create and oversee a central website and 'virtual exhibition' for the project.
- To organise a final workshop and book of the project.
- To promote TV and video presentations so as to publicise aerial archaeology, landscape studies and the contribution made to them by the Culture 2000 project.
- To administer 'central' funds for activities under Action 9 in the project Agreement.

Management, administrative and finance

Management of the project was satisfactorily maintained throughout the course of the three years, with the necessary reporting at interim and final stages duly completed. Dr Robert Bewley left English Heritage for a new appointment late in the project and the responsibility within English Heritage was passed for the final few months to Peter Horne.

After negotiation with the Culture 2000 office in Brussels, the project start and finish dates were rescheduled to allow the inclusion of the final exhibition and meeting of co-partners at Prague in October 2007. The duration of the project was revised to run from 1 October 2004 to 31 October 2007. All administrative duties have now been concluded within the revised timescale and reporting period.

For other comments on administration, finance and timing of events see the introductory sections of this report.

Sharing expertise

English Heritage arranged for or provided speakers, tutors and pilot-instructors for eight events or actions in Belgium, Estonia, Finland, Germany, Italy, Lithuania, Poland and Romania over the three years of the project. The effort of time and skill was considerable: programming different types of activities, preparing lectures and exercises, assembling teaching material, devising new and more effective teaching methods and 'tidying up' after each event. In total this aspect of the work occupied 350 days of English Heritage staff time, considerably more than originally intended. The results, however, in the exchange of skills, improvement in training methods and creation of mutually supportive networks across Europe were felt to be entirely worthwhile.

UK Training School in Aerial Archaeology, Workshop in Italy

For a variety of reasons the sequence of **Training Schools** in Italy and the UK was re-arranged, the Italian schools taking place in 2005 and 2007 and the British event in July 2006, at Cirencester in south-west England. This meant that, with the smaller annual schools in North Germany, there were major and minor training schools at *some* location in Europe in each year of the project. The re-arrangement also allowed for input from the most experienced specialist trainers at all events whilst at the same time developing the skills of a number of new or assistant tutors.

The Cirencester Training School, like all others in the project, involved both airborne and ground-based instruction and practice. The School attracted 16 students from a variety of backgrounds in 9 countries (England, Scotland, Eire, Hungary, Italy, Latvia, Poland, Romania, USA) and additionally a Danish representative observing the organisation of the school to aid planning for a future event in Denmark.

The 10 tutors and pilot-instructors from the UK were joined throughout by an experienced colleague from Slovenia, Darja Grosman. A distinctive feature of the School was the attention paid to the initial cataloguing of the 5,464 digital photographs taken during the course; for the first time in any of the European training schools, this phase of the work was completed before the students left Cirencester after 9 days of intensive activity. In addition, the 34 flights undertaken by the students, for the most part in the company of both pilot and an airborne tutor, were genuinely 'exploratory' in that they surveyed a variety of different landscapes identifying new sites as well as visiting known sites for training purposes.

The organisation of the planned **Workshop** in Italy was undertaken by the project partners at the University of Siena, with English Heritage simply providing or arranging for tutors to take part in the instruction and discussions.



Students act as targets (left) whilst their co-students practice their photography skills (right).



Learning air photo interpretation skills and more detailed photo analysis using stereoscopes.



The importance of good pre-flight planning (lower left) and post-flight cataloguing (right) were all part of the learning process at the Cirencester Aerial Archaeology Training School in 2006.

Website, exhibition, TV film and ‘book of the project’

The project’s **website** (www.e-landscapes.com) was designed in Britain and managed throughout the project by the Poznan Museum in Poland. With financial help from the international Aerial Archaeology Research Group it is planned to maintain and upgrade the site for at least 3 years after completion of the Culture 2000 project. The planned **final exhibition**, along with the culminating **workshop** of project participants, was held in Prague rather than London, in October 2007 (see separate report). The **TV film** originally intended to be made in the UK was eventually produced in the Czech Republic, with help from project co-partners in Poland, Slovakia, Italy, Germany and the UK. After discussion with a number of publishers the idea of a **‘book of the project’** was not felt practical as a means of communicating with the general public throughout Europe, the project’s central website (with its various links), along with individual web sites and publications from individual partners, being felt more effective for this purpose.

Final workshop, Prague, October 2007

Following discussion with partners it was decided that the final exhibition and workshop should be held together as a way of cementing the network created and ensuring the continuation of the various actions that had so successfully been started. The venue in Prague’s National Museum proved a fitting location and it is clear that the exhibition, being situated in one of Europe’s most important tourist locations, will throughout its continuation into January 2008 attract a wide variety of visitors from all over Europe and beyond.

Central funds for 'Action 9'

A proportion of the project grant was administered by English Heritage for activities aimed at the broader project objectives. A total of just over 44,000 euro was spent on this kind of work. The funds were used to help project participants attend specialist meetings in Spain, Portugal and Croatia; to provide tutors for three training schools in North Germany; to help students to attend a training school and conference/workshop in Italy; to cover Aero Club membership for students at another training school in southern Italy; to provide tutors for two workshops in Poland and another two in Romania; to help in the publication of a book on aerial archaeology in Poland; to cover travel costs for discussions about the proposed *European Centre for Archaeology, Landscape and Remote Sensing*; to welcome Danish visitors to technical discussions in the UK, and to part-fund the cost of the final exhibition in Prague.

General assessment of the project

Overall, the objectives of the English Heritage contribution to the project – and of the project as a whole – were felt to have been satisfactorily met or even exceeded, though this required some revision of the exact methods employed. Additionally, the organisation's input in terms of staff time and costs was much higher than originally envisaged, mainly due to providing additional support for events organised by co-partner organisations. The results, however, were well worth the extra effort in building a stronger European network of skills and contacts that will have significant benefits for the future.



Students and tutors at the opening of the Cirencester Aerial Archaeology Training Course.

HERITAGE SURVEY IN ESTONIA

Aerial and ground-based evidence in partnership

Ants Kraut, Project Co-ordinator, National Heritage Board of Estonia

Background and objectives

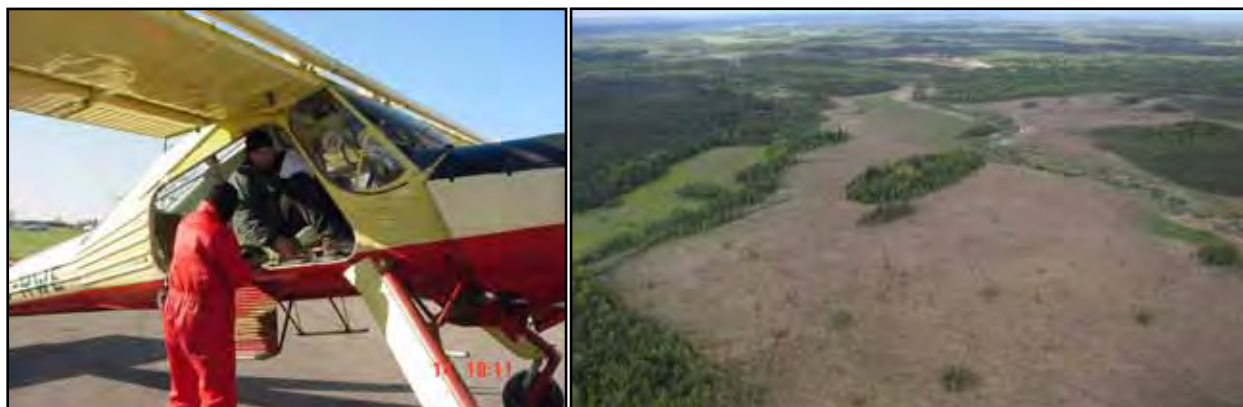
Traditional field survey techniques are well developed in Estonia but less use has been made in the past of geophysical prospection and virtually none of aerial survey, whether for exploration or for conservation. The Culture 2000 project has permitted the National Heritage Board to take the first steps in training Estonian archaeologists in the techniques and uses of exploratory air survey, air-photo interpretation and mapping, including initiating a limited programme of active aerial survey. Throughout the project the aerial work has been linked closely to ground-based observation and geophysical prospection in a complementary application of techniques not previously practiced in Estonia. Selective fieldwork and aerial observation have been carried out on carefully chosen sites, mostly in the north and north-eastern coastal areas, where forest cover is less dense and there was potential for recording wrecks and other submerged features.

Achievements in 2004-2007

The project team consisted of Ants Kraut, the Board's Chief Inspector of Archaeological Monuments, Armin Rudi, undertaking fieldwork and photo interpretation, and Endel Grensmann managing photographic and technical support. Professor Valter Lang of Tartu University and Professor Marika Mägi of Tallinn University were involved as consultants. Administration and financial issues were first handled by Riin Alatalu and later by Helle Solnask of Muinasprojekt OÜ, whose previous experience of EU-funded projects had been valuable at application stage.

The main activities included the testing of various methods of aerial archaeology in the specific environmental circumstances of Estonia, including the discovery of previously unrecorded sites from the air and the inspection of already-known sites (both archaeological and architectural) for a more precise definition of their boundaries and state of preservation. The aerial work was supplemented with extensive ground-inspection of the sites and study areas. A total of 27 hours of aerial reconnaissance were flown during the project, producing about 1000 photographs of 200 sites and locations, many of them not previously recorded from the air. Ground-based inspections were made at over 100 individual sites as well as of large tracts of landscape of potential heritage significance. Tests were also made with aerial reconnaissance along the route of large motorways, where there will in future be large-scale soil disturbance.

Aerial inspection in the chosen study-area was in the event impeded by extensive tracts of forest and mire, aerial observation normally working best in 'open' landscapes. Nevertheless,



Preparing for an air-photographic sortie, and a typical landscape, with bog, in northern Estonia.



A typical view from the eastern part of Estonia. In the open fields some of the stone-piles represent prehistoric graves, others are the result of stone-clearance during the extensive landscape re-ordering undertaken during the 1960s and 1970s



The site of the Viking harbour at Tornimäe in the island of Saaremaa. The Viking-age sea level occupies the right-hand half of the picture. Remains of the harbour were excavated to the right of the white-walled Russian church, just left of centre.

large bogs are not without interest and aerial inspection helped to reveal the courses of ancient or medieval sledge routes. The study of historical maps can also contribute to the identification of historical communication routes. The comparison of data obtained from historical maps with that gathered from the air was one of the main objectives of the programme.

Aerial exploration revealed several complex aggregations of archaeological features, including sites that were settled during the Middle Ages and therefore bore traces of historic fortifications, such as the ruins of a medieval feudal stronghold overlying a Viking Age settlement site at Angerja, Rapla County. In the majority of cases the reconnaissance flights were supported by on-ground inspection. All seemingly positive results need to be cross-checked through follow-up visits on the ground, a phase of work partly completed during the course of the project.

The project team's particular interest focused on manorial estates. At such estates the air photographs have provided good overviews of the often extensive complexes and of the exact relationship of individual buildings to one another, especially regarding possible connections of the manorial buildings with former (archaeological) settlement areas.



The site of the harbour at the medieval castle of Maasi. The castle and its adjacent bay lie to the left of centre. There are documentary sources to shipwrecks not far from the castle but aerial photography has not as yet been able to locate them.



The medieval stronghold on the island of Saaremaa. This was the scene of the last 'War of Independence' against the Germans and Danes in March 1227. Aerial photographs of this kind are valuable for documenting the character and state of preservation of such monuments. They are also used in both popular and scientific publications.



Professor Marika Mägi with participants in the Tallin Workshop of October 2006, at the site of the ancient harbour at Tornimäe on the island of Saaremaa.

Aerial Archaeology Workshop

One of the key events in the Estonian part of the project was an international seminar and workshop on *Aerial Archaeology and Maritime Landscapes* held in October 2006 in Tallinn and on the island Saaremaa. This provided opportunities for promoting cooperation between coastal archaeologists from various parts of the Baltic and Scandinavian area and offered the possibility to integrate the methods of aerial archaeology into this kind of work. An important part of the seminar involved meetings and networking with experts from project co-partners, discussing the possibilities of applying aerial photography in the recording of the Estonian landscape.

Network contacts and meetings

Project members participated in meetings in partner-countries (Finland, Belgium, the UK and the Czech Republic) to broaden their experience through discussion with air photographers and landscape archaeologists from other parts of Europe. Attendance at courses in Finland and Poland proved of great value, providing extensive experience in the practice of aerial archaeology, both in the air and in the office, and offering supportive contacts for the future.

General Assessment of the project

The National Heritage Board feels that the project objectives were realized to the full.

- Networking on a European level was enhanced and the exchange of information strengthened.
- New experience was gained at two specialist workshops and the acquired knowledge was tested in Estonia, an important gain from the European project.
- Two major universities specializing in archaeology in Estonia were engaged in the project and a joint seminar took place.
- Exploratory flights were carried out and valuable experience gained in active aerial work.
- On the basis of the flights a database of aerial photographs was compiled.
- The results of the air photographic recording were tested on the ground.
- In areas searched by aerial reconnaissance historical maps were digitized for further research work in the future.
- A methodology was developed for the comparative analysis of historical maps and freshly-taken aerial photographs, a technique until now little used in Estonia.
- Technical equipment was updated and the know-how to use it was developed.

Changes in the planned activities

- It was decided not to attempt taking photographs from a tethered balloon. Instead, the project team concentrated on light-aircraft flights, drawing on experience gained from European colleagues in the decade since the first aerial archaeology workshop in Hungary in 1996.

Problems

- There were significant differences in the air-survey results as compared with those achieved in Lithuania and Poland. It will be necessary to make comparisons also with the results achieved in Latvia (outside the Culture 2000 project) to establish whether the differences might be caused by the specifics of landscape development in the various countries.
- The search for sunken wrecks and other possible features in coastal waters did not produce the expected results. It will be necessary to carry out a larger number of flights, in varying weather and lighting conditions, to explore the possible reasons.
- Further experience is needed to achieve success in some aspects of the project, especially in areas where the natural conditions are unfavourable. For example, attempts to use aerial survey to establish the precise location of buildings on archaeological sites have so far had limited success, though patches of darker soil indicating intensive human activity have been detected on numerous occasions.

Added value

- Excellent aerial photographs have been taken of the built heritage and historic parks and some have already been used in publications, mainly in overviews of the local cultural heritage published by rural municipalities.
- Based on experience gained in the Culture 2000 project, aerial photography may be used for future environmental monitoring and for determining the state of protected areas.
- The project offered valuable experience in co-operation, in the creation of a unique data-bank based on aerial photography, and in establishing the basis for future research and collaboration.

HELSINKI SYMPOSIUM ON AERIAL ARCHAEOLOGY

4-9 October 2004, Helsinki, Finland

Nina Heiska and Professor Henrik Haggren, Helsinki University of Technology

Background and objectives

Aerial survey and air photography have as yet hardly been used for archaeological or landscape studies in Finland, and their application in the other Scandinavian and Nordic states has been sporadic. The aim of the Helsinki Symposium was to promote the use of aerial archaeology in the Nordic and Baltic countries. The meeting was organised by the Helsinki University of Technology, the University of Helsinki and the Finnish National Board of Antiquities as the first pan-European event in the Culture 2000 project. Assistance was also given by the Finnish Ministry for Education, Sites and the Aerial Archaeology Research Group.

The Helsinki Symposium on aerial archaeology

The Symposium was a well-attended and lively event, introducing a relatively new archaeological technique to the region. A sub-group was formed to encourage further cooperation between the Baltic and Nordic states in the fields of culture and aerial archaeology. Contacts have been maintained over the following years despite relatively slow progress in the practical implementation of aerial archaeology in many parts of the region.

The Seminar

During the first two days of the meeting a public Seminar was held in the auditorium of the National Museum of Finland. Eighty-three professionals and students from various fields, ranging from land surveying to archaeology and architecture, took part in the discussions, which were led by experts from Culture 2000 co-partners in Germany, Lithuania, Poland and the UK as well as by speakers from Austria, Denmark, Finland, Iceland, Latvia and Slovenia.

The presentations and discussions covered a wide range of subjects: the principles, practice and potential of aerial survey in landscape and archaeological studies; varying kinds of remote sensing, from aerial reconnaissance to satellite imaging; the uses of aerial archaeology in various parts of Europe; and aerial work in the Baltic and Nordic states. A final discussion looked to the future and resolved to form a regional grouping of interested specialists to promote aerial archaeology and landscape studies in the Baltic and Scandinavian states.

The Workshop

The Seminar was followed by a four-day Workshop in a well-equipped computer laboratory at the Aleksandria Learning Centre in the University of Helsinki. Altogether, 28 professionals and graduate students who had attended the introductory Seminar stayed on for more intensive study and practical exercises at the Workshop. The participants came from Iceland, Norway, Denmark, Poland, Russia, Estonia, Latvia, Lithuania and Finland. They were instructed and encouraged by six tutors from Slovenia, Austria and the UK.

During the Workshop the participants studied aerial photographs and maps from their own countries. Through descriptions of basic principles and practical exercises they were taught to read information from the photographs, to relate it to the maps, to interpret the data in archaeological terms and to transcribe the information onto the map-base. The meeting was felt by all to have been a success, in particular in the way that a wide variety of archaeological and landscape information had been treated by the participants according to the needs and circumstances of their own countries.



Students and visiting tutors at the Helsinki Workshop in October 2004.

Developments since the Helsinki meeting

The organisers of the Helsinki meetings were satisfied with the events during the Symposium. In particular, they felt that the formal and informal contacts made during the week would serve as a sound basis for cooperation and networking in the future.

Following the Symposium there has been a growing awareness of the value of aerial archaeology and its methods in Finland and in the neighbouring countries. For instance, a Finnish-Russian team took aerial photographs of an archaeological site at Lake Valg, Estonia, in the summer of 2005. In 2006, too, a Finnish engineering student who took part in the Symposium completed his thesis on the Lake Valg project at the EVTEK University of Applied Sciences. At the time of writing, in early autumn 2007, however, there appears to be no active aerial survey work in progress in **Finland** through the use of light aircraft. However, adjunct professor Kari Uotila, of the University of Turku, has started documenting excavations and historical buildings with the aid of photography from a tethered balloon.

Nor does there appear to have been any progress with the renewal of aerial survey in **Sweden** since the death some years ago of Jan Norrman, who pioneered the technique in that country.

However, excellent cropmark photographs of previously un-discovered archaeological sites in **Norway** were taken in the summer of 2007 by Lars Forseth, after reading published accounts of the Helsinki Symposium.

At least one practicing archaeologist from **Iceland** has maintained his interest in the subject, though he was unable at the last minute to attend one of the final events in the Culture 2000 project, a specialist workshop at Poznań in Poland.

In **Denmark**, on the other hand, interest has been gathering pace. Archaeologists who attended the Helsinki Symposium and later Culture 2000 events have now formed an active Danish aerial archaeology research group with members undertaking both aerial and ground-based work (LAND – Luftfoto Arkæologisk Netværk Danmark). Danish archaeologists have visited English Heritage to look at work patterns and the organisation of the Cirencester Training School; there are now plans for a training school in aerial archaeology in Denmark in 2008 or 2009. In response to all these developments the international Aerial Archaeology Research Group held its annual meeting in Copenhagen in September 2007.

In the coming years it is hoped that future European projects may help to build on these early beginnings in these countries.

BRINGING AIR AND WATER TOGETHER

Innovative landscape survey in the coastal zone of NE Germany

*Dr Susanne Gerhard, State Authority for Culture and the Preservation of Monuments,
Mecklenburg-West Pomerania, Schwerin, North Germany*

Background and objectives

Through the Culture 2000 project the State Authority has enhanced knowledge of dated and undated sites and finds in the offshore region of the Baltic Sea, as well as the nature of drowned landscapes along the coastline. These results will assist future interpretation and conservation of threatened underwater and coastal sites and will improve public appreciation and concern for the cultural heritage.

The project's aims were pursued through four main fields of activity:

- Exploratory air photography, for combination with ground-based and underwater survey.
- Annual 5-day Training Schools in aerial archaeology and a 3-day International Workshop.
- The use of GIS in the mapping, analysis and visualisation of information from various data sources.
- The creation of teaching aids for local schoolchildren and young adults and of exhibition material for a variety of presentations.

By enabling the employment of a Culture 2000 project officer the European funding greatly expanded the Authority's capacity to enhance its archaeological records, to promote the use of aerial information in its educational and conservation work, and to introduce a new generation of young archaeologists to aerial archaeology. The project will have a long-term effect on the Authority's use of aerial information in its research, education and conservation work.

Aerial survey of the coastal zone and offshore waters

Throughout the project the Authority – as was the case from 1992 onwards – used its own funds to finance a long-term and continuing programme of aerial survey by Dr Otto Braasch along the Baltic coastline, recording under-water features (wrecks, drowned forests and submerged structures of various kinds) as well as land-based sites (ancient settlements, forts and WWII relics etc). In each year of the project part of the annual flying programme was dedicated to flights with students at the Training Schools described below.



Left: Dr Otto Braasch, pilot and tutor at the three training schools in Barth, preparing for another sortie over the coastal waters of the Baltic Sea. Right: The Baltic coastline, with Rügen Island at top right. Every red triangle denotes a wreck-site identified from the air by Dr Braasch



Clockwise from top left: The town of Barth, where the annual training schools were held, a typical wreck site, the eroding cliff-top fortress at Kap Arkona; and a view of the ever-changing Baltic coastline.

Training Schools in aerial archaeology

In the three years of the project thirty-four young archaeologists from Finland, Sweden, Lithuania, Latvia, Poland, England, Ireland, Italy, Croatia, the Czech Republic and Germany benefited from the Training Schools held at Barth in May or June each year (see below). Additional funds to cover student travel and subsistence costs were attracted for the 2006 and 2007 Schools from the Aerial Archaeology Research Group and from Geisteswissenschaftliches Zentrum Geschichte und Kultur Ostmitteleuropas (GWZO) at Leipzig University. These grants were a response to the overwhelming number of applications from Eastern Europe (more than twice the number of places actually available). Without this help many of the students and young professionals from Eastern Europe would simply not have been able to attend the Schools. The students profited from lessons and demonstrations by specialists from Germany, the UK, Poland and Italy, with guest speakers from German universities and the Authority itself.



Besides bringing home solid basic knowledge about aerial archaeology, both over water and over the countryside, the Schools gave the students the opportunity to take part in about 4.5 hours each of active aerial survey and in-air training. As a direct result one of the students, from Croatia, was given permission to undertake aerial survey along the Croatian coast. Several other students chose aerial archaeology as the subject of graduate work. Personal and professional contacts made during the Schools will no doubt lead to further scientific cooperation when this next generation of young archaeologists enter professional life, further promoting the aerial archaeology network across Europe.

International conference at Schwerin

In January 2007 thirty archaeologists met in Schwerin for a successful 3-day conference under the title *From Heavens Above*. Participants came from co-partner organisations as well as from universities and public authorities inside and outside Germany. Sharing expertise and discussing methods and results during the intensive conference programme (along with agreeable evening hours together) encouraged a widening range of professional contact as the basis for further collaboration in the future.



Teaching aids and exhibition material

A 28-page booklet was prepared within the project for readers from the age of about 11 to 15. Entitled *Von toten Schiffen und versunkenen Kirchen* ('From dead ships and sunken churches'), the booklet is lavishly and colourfully illustrated with drawings showing the principles of aerial archaeology, along with aerial views from the coastland of Mecklenburg-West Pomerania. The factual information is woven into a background story of two local children. A grammar school teacher with wide experience in leading pupils' archaeological associations, and the renowned aerial archaeologist Dr Otto Braasch, added their own experience, assessing the booklet as useful, informative and accessible. In the future it will be incorporated in the Authority's growing internet presentation to make it readily available to interested readers of all ages. Throughout the project contributions have been made to the Culture 2000 website. Text and photographs were provided for the project's final exhibition in Prague.



Two pages from the 28-page booklet prepared as part of the Culture 2000 project, introducing school-children to the concepts of heritage and aerial photography through the story of two local children.

GIS and the mapping, analysis and visualisation of information

A substantial amount of new information was gathered during the project, through continuing aerial survey for the Authority by Dr Otto Braasch. This was supplemented by the records created during the three Training Schools and by evaluation of the Authority's existing air photo archive. New data were added to the internal GIS system, through which the information becomes available to all of the Authority's staff for use in conservation and educational work. Text records were updated and colour slides and black-and-white images were scanned for faster reference in the future. A digital image database was started and by the end of the project more than 5000 images had been entered and indexed. This work will continue for the benefit of the day-to-day work of the Authority's heritage inspectors.

In the event, only limited work proved possible on other image sources, partly because the air photo archive already provided abundant material for analysis, partly because other potential sources proved unsuitable or limited in number. Satellite imagery such as, for instance, the images provided by Google Earth proved to be of too poor resolution for effective use. Geomagnetic, seismic, sonar or radar surveys are available from national, regional or military (maritime) authorities concerned with collecting information about obstacles or possible dangers along the coast and in shipping channels. But only one such survey has been made at an archaeological site. Moreover most of the information was not gathered with archaeological questions in mind and thus proved to be of little value for archaeological use.

Culture 2000 funding helped in the purchase of specialist but inexpensive software (AirPhoto) for the treatment and rectification of aerial photographs. The Authority's project officer attended the training school at Foggia, Italy, to gain experience in its use and in other aspects of aerial work, providing a sound basis for future work on the air photo archive, given adequate funding.

Other Culture 2000 activities

The Authority's Culture 2000 project officer took part in three annual conferences of the Aerial Archaeology Research Group and the Schwerin conference cited above, presenting talks on three occasions (on the Culture 2000 project and on education work with young people). She also attended the Culture 2000 conference on Military Aerial Photography and Archaeology at Ypres, Belgium, and the Aerial Archaeology Training School at Foggia in Italy.

A number of public presentations were given during the project and others are planned after its completion. Short reports on coastal air photography, education and the Culture 2000 project were published in both German and UK journals. Of particular note was a 50-slide PowerPoint presentation on aerial archaeology in a coastal environment, prepared for eventual use in the Museum of Underwater Archaeology at Sassnitz on Ruegen island (currently undergoing refurbishment). The presentation was translated into English for use at the Prague exhibition.

General observations and future prospects

Experience both before and during the Culture 2000 project has shown that aerial photography is an indispensable means of archaeological survey in the coastal regions of Mecklenburg-Vorpommern. It can be carried out on a continuing basis, on a large scale and at comparatively low cost. Geophysical or under-water survey, by contrast, undertaken for a variety of research projects, cannot be applied on the large scale which the coastal area demands.

During the project it became clear that traditional exhibitions and publications are becoming progressively less popular for communicating ideas and information, with digital media becoming more and more important. It therefore seemed best to add information wherever possible to the project's central website and (once its re-structuring has been completed) to that under preparation for the Authority itself. As an outcome of the Training Schools a glossary of aerial archaeology (in German, English, Polish, Italian and perhaps later Dutch and another Slavic language) is being collated for publication on the project's central website. Work will continue after the end of the Culture 2000 project.

LATE HALLSTATT PRINCELY FORTS AND THEIR LANDSCAPES

Aerial survey, lidar imagery, geophysical prospection and ground observation

Dr. Jörg Bofinger, Dr. Dirk L Krausse, Dr. Jörg Biel. Regierungspräsidium Stuttgart, Landesamt für Denkmalpflege (LAD), Baden-Württemberg, South Germany

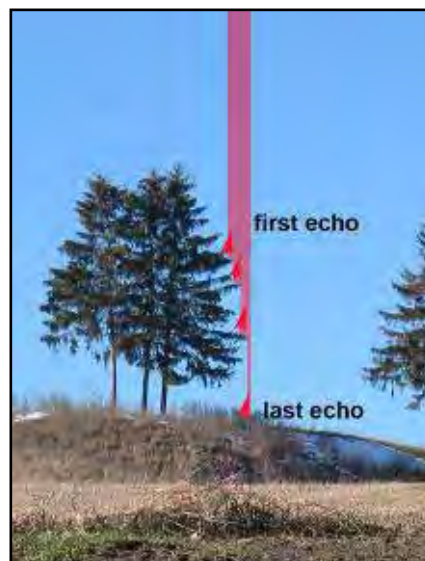
Background and objectives

The contribution of the LAD Baden-Württemberg was focused on the archaeological micro-landscapes around Late Hallstatt princely hillforts in south-west Germany, in close cooperation with French colleagues doing similar work outside the Culture 2000 project.

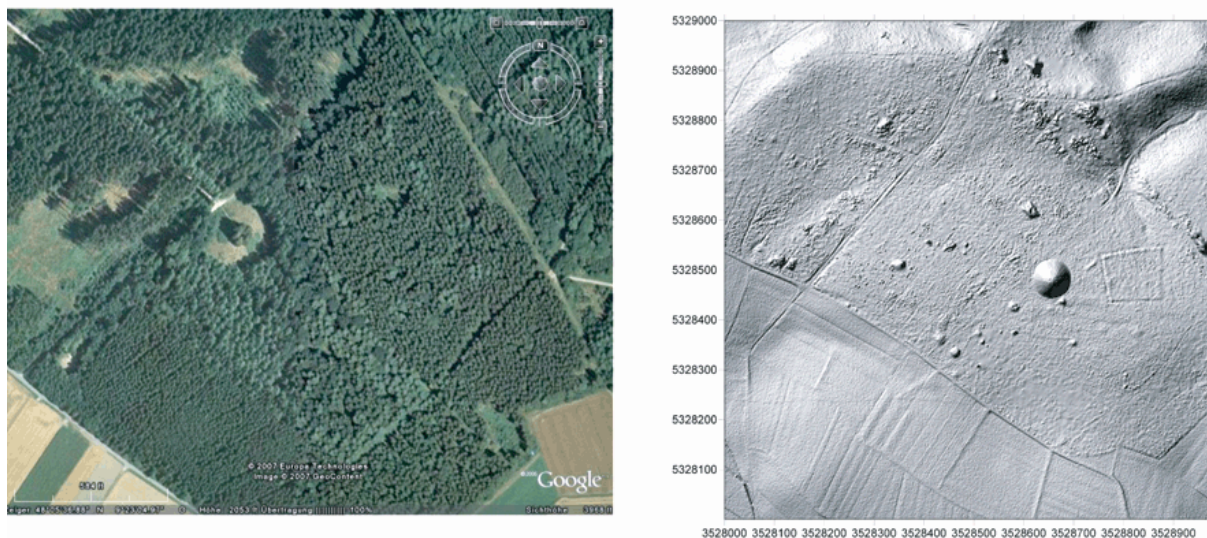
The micro-landscapes round the hillforts are being mapped systematically by air photography and lidar imagery, a new technique using an airborne laser scanner which can create digital surface models even in dense woodland, revealing parts of the landscape which would otherwise remain hidden or invisible. The air-photo and lidar work have been complemented by ground-based survey and geophysical prospection carried out by the LAD's own experts and by a specialized company. The recent development of the landscape and its impact on site preservation has formed the main objective in this part of the agenda. Knowledge gained about the state of preservation of the hillforts and their surrounding landscapes, where archaeological traces have often been virtually levelled by the plough, will make it possible to provide more adequate protection in the future.

In addition to consultation and co-operation with colleagues in France and elsewhere the programme of work within the Culture 2000 project included the following:

- New aerial survey to increase understanding of the micro-landscapes surrounding the hillforts, plus the purchase and analysis of lidar imagery for the same areas.
- Verification and where possible dating of the sites through ground-observation, geophysical prospection and sample excavation.
- Documentation of excavated structures by 3D laser scanning and integration with the data obtained from lidar survey.
- Enhancement of international networks, education and training of scientific staff, participation in conferences and workshops, publication work for specialists and the general public, and contributions to the Culture 2000 website and final exhibition in Prague.



Left: The Heuneburg, photographed by Dr Otto Braasch. Right: First and last echoes in lidar survey.



Comparison of Google Earth air photograph (left) and last-echo lidar imagery of a wooded area NW of the Heuneburg. The processed lidar data reveals previously hidden mounds and a rectangular enclosure.

Aerial and ground-based work on and around the princely hillforts

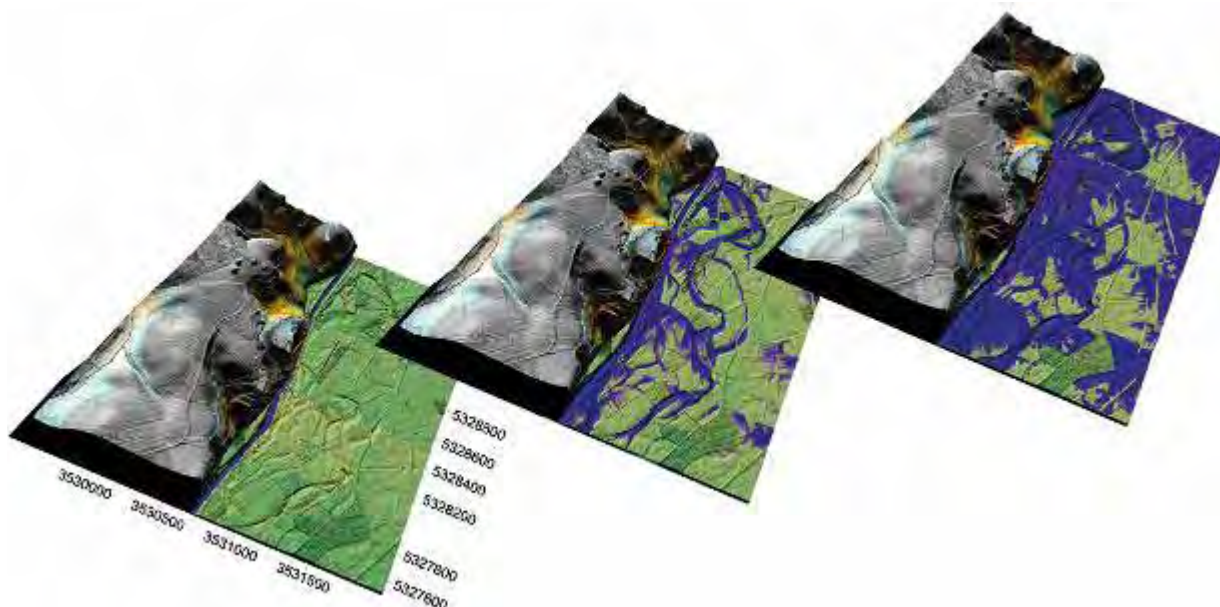
Aerial survey was continued and enhanced around the princely hillforts throughout the course of the project. New and existing aerial photography was compared with lidar data in the Heuneburg and the Hohenasperg survey areas to detect and verify archaeological settlement structures. Additional non-destructive geophysical survey was undertaken in the Ipf, Heuneburg and Hohenasperg study areas. Exemplar excavations at the Heuneburg and Ipf forts showed that features detected by aerial photography and lidar survey could be identified as important archaeological settlement features (town gate, moat, main road of the Heuneburg, farmsteads near the Ipf etc). The large archives of existing air photography in Baden-Württemberg (principally the heritage archive which contains about 400,000 photographs) were revisited to collect data for comparison with the ground survey and lidar material.

An important contribution of the Culture 2000 project was the opportunity to compare lidar data processed by the Landesvermessungsamt Baden-Württemberg with more expensive imagery generated by Toposys Ltd of Biberach. As a result it became clear that the much cheaper data distributed by the Landesvermessungsamt offers a sufficient resolution to reveal a variety of archaeological structures – a major benefit for the economy of future lidar work.

Research on and around the Heuneburg

Lidar imagery for a 20 sq km area round the Heuneburg was studied in detail. The imagery shows the surface topography in great detail, including ancient fluvial features in the Danube Valley, documented in every detail and hence mappable in three dimensions to an accuracy of 2cm. The digital terrain model constructed from the lidar data, when combined with a flood-water simulation for the Danube Valley has given new insights into the possible cultivation of the landscape in Early Medieval times and in prehistory. Significantly larger areas free of flood water, especially towards the centre of the valley, can now be regarded as potential locations for settlement or burial, as impressively illustrated by the Hallstatt settlement alongside the Bettelbühl necropolis, on a gravel ridge largely free of high water in the middle of the Valley.

The work so far has shown that the high-resolution lidar data provide an additional means of documenting both topography and archaeological features, though the effects of ploughing and other human activity can result in a heavily biased information source. Future work, after the end of the Culture 2000 project, will aim to show how much these sources of bias can mislead interpretation and whether the impact of modern interventions can be offset in the search for archaeological understanding. That said, the landscape changes visible through the lidar data in



Computer simulation, using topographical data from lidar imagery, of increasing flood-water levels in the Danube Valley adjacent to the Heuneburg. The right-hand image shows areas of higher land, free of even the most extreme flood-water, that were long favoured for settlement, burial and communication routes.

the meandering riverbed of the Upper Danube constitute valuable information in their own right. Using these new data a research group will try to reconstruct the fluvial history of the Danube so as to identify potential settlement areas or wharves in the valley.

In addition to lidar survey the plateau of the Heuneburg was explored by geophysical prospection, revealing many new structures on the unexcavated parts of the plateau. During archaeological fieldwork in the area of the Heuneburg precinct a spectacular discovery was made: a stone gate forming part of the early Iron Age fortification system. This impressive gate (12 x 8 m), constructed from large limestone blocks, was scanned by 3D laser-survey (Arctron Ltd.), providing the opportunity to integrate the resulting data with the digital terrain model obtained through airborne laser scanning.

Air photography and geophysical prospection at the Hohenasperg

Geophysical survey around the Hohenasperg started in the final months of 2005. Here, the study of the air photo and ground-based data helped in assessing the potential contribution of lidar survey in the understanding and conservation of landscape and archaeological features in a densely populated region heavily affected by recent and earlier construction work.

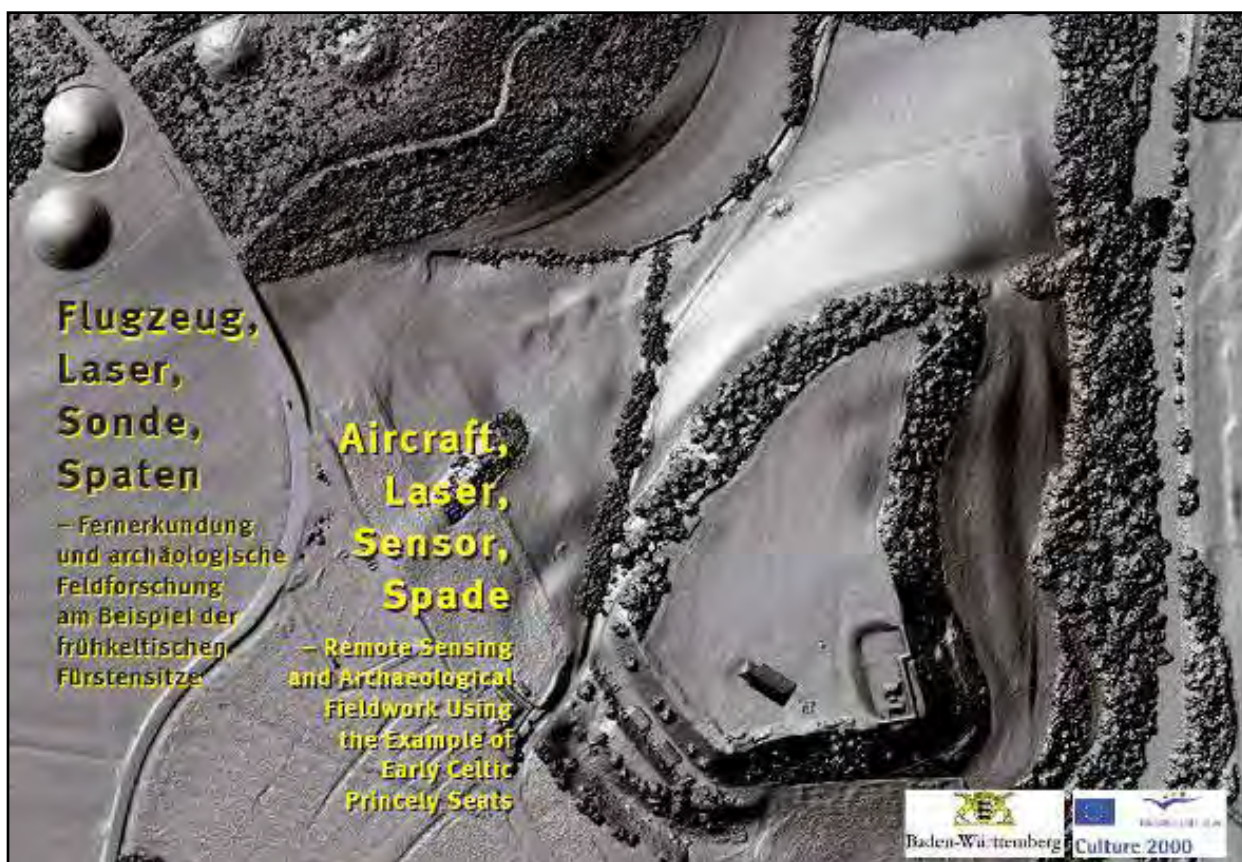
Professional networks, education and publication

Professional collaboration across Europe was maintained and developed throughout the project. Association with the DFG priority-programme 1171 led to good contacts with international workgroups, for example the Mont Lassois research team. At a Workshop in November 2004 in Esslingen workgroups from Germany, France, Switzerland and Austria presented and discussed the first results of their archaeological field survey, traditional geodesy, lidar imagery and geophysics. The varying research perspectives of different national traditions, along with the exchange of knowledge and methods and the study of differing heritage recording systems, has given a new impetus to the current work and will serve to promote continuing trans-national co-operation after completion of the Culture 2000 project.

Participation in the Aerial Archaeology Training School at Foggia, Italy, in May 2007 gave a member of the LAD's staff the opportunity for training in methodological and practical aspects of aerial archaeology, both on the grounds and in the air.

The first results of the ongoing work were presented at the conference on *Computer Applications in Archaeology*, at Tomar, Portugal, in March 2005. An article in the conference proceedings is in print. At the *2nd International Conference on Remote Sensing in Archaeology* (Rome, December 2006) the results of the lidar work in Baden-Württemberg were presented, and were published in the conference proceedings. An article in the 'Nachrichtenblatt der Landesdenkmalpflege Baden-Württemberg' (August 2007) summarised the results of the lidar work and field activities. A further opportunity was provided by the Culture 2000 workshop *Bringing Air and Water Together* at Schwerin, North Germany, in January 2007.

A notable achievement, assisted by Culture 2000 funding, was the publication in hard copy and on the Internet of a 48-page German-and-English booklet on the princely forts and their surrounding landscapes. This will be particularly useful in informing the general public about the character and value of archaeological work carried out through both new and traditional investigative methods. Copies of the booklet were made available for the opening of the project's final exhibition in Prague and images and related text were used in the exhibition itself.



First-echo lidar image of the Heuneburg and nearby burial mounds, as seen on the cover of the 48-page bilingual booklet prepared as part of the Culture 2000 project

General assessment of the project

The Culture 2000 project gave the LAD the opportunity to supplement its on-going work on the princely fortresses and their surrounding in highly productive ways, especially in the testing and use of lidar data and air-photographic evidence, along with the publication (on-line and in hard copy) of a booklet aimed primarily at the general public. Culture 2000 funding also enabled the LAD to expand its international contacts and to take part in a number of important meetings, along with the final exhibition in Prague.

LIDAR SURVEY FOR ARCHAEOLOGICAL AND LANDSCAPE STUDIES

Seeing through the trees

Dr. Benoît Sittler, Institute for Landscape Management, University of Freiburg, Germany

Background and objectives

The motivation for joining the Culture 2000 project as an associate partner was to share the University of Freiburg's experience of working with airborne laser scanning (lidar) in documenting and assessing cultural landscapes, with particular reference to the exploration and analysis of 'ridge and furrow' cultivation hidden under woodland cover in southwest Germany.

The principal objectives of involvement with the Culture 2000 project were:

- To present the University experience with lidar applications at international conferences and discussion groups.
- To develop and maintain regular exchanges with the archaeological community involved with the use of this technique in France.
- To participate in meeting of the Culture 2000 co-partners to promote the mutual exchange of expertise and experience in the use of lidar for archaeological and landscape research.

Presentations to the scientific community

Lidar (**L**ight **D**etection and **R**anging, see opposite page) is a form of airborne laser scanning which can create a detailed 3d representation of the surface of the earth, and of archaeological features preserved upon it, even where these are hidden beneath tree-cover too dense to be penetrated by traditional air photography or ground-based survey. In addition to its applications in topographical mapping and archaeology, the technique has also been used in a wide range of other disciplines, including geographical studies, forestry and landscape research.

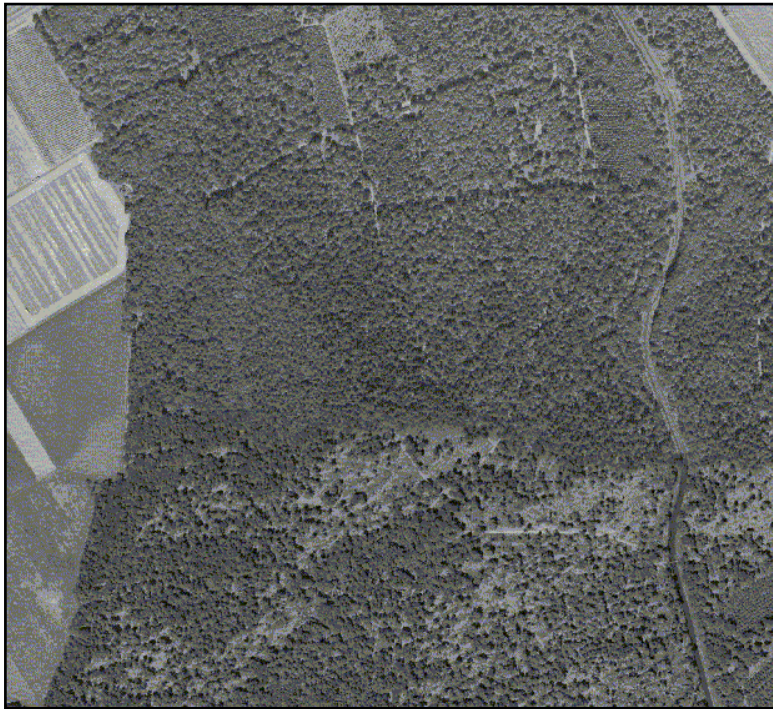
Pulses from an airborne laser scanner are reflected first from the surface of trees, buildings or open fields to produce an image like that shown at the top of the facing page. Other reflections (or 'echoes') may be returned by the lower branches of the trees, and finally even by the ground surface itself. With suitable filtering the last-pulse/last echo signals can produce a highly accurate 3D representation of the actual ground surface (a 'digital terrain model'), even where this lies obscured by dense tree cover. This is illustrated in the lower image on the facing page.

During the course of the Culture 2000 project the author took part in and/or gave presentations at a wide range of meetings, reporting regularly to the project's central secretariat and making presentations to co-partners at Munich in 2004, Schwerin in January 2007 and Prague in October 2007 (when the University's work also formed part of the Culture 2000 exhibition mounted at the Czech National Museum). A presentation was also given at the annual meeting of the international Aerial Archaeology Research Group at Copenhagen in September 2007.

Specialist conferences involving presentations and discussion, often focused on the University's own work with forested ridge-and-furrow field systems near Rastatt, in Germany, included those on Computer Applications in Archaeology at Tomar, Portugal, in March 2005, and the Unesco Conference on the use of space technologies for the conservation of natural and cultural heritage, in Mexico later the same year. Presentations were also given at specialist meetings in Austria, France, Germany, Italy and Poland.

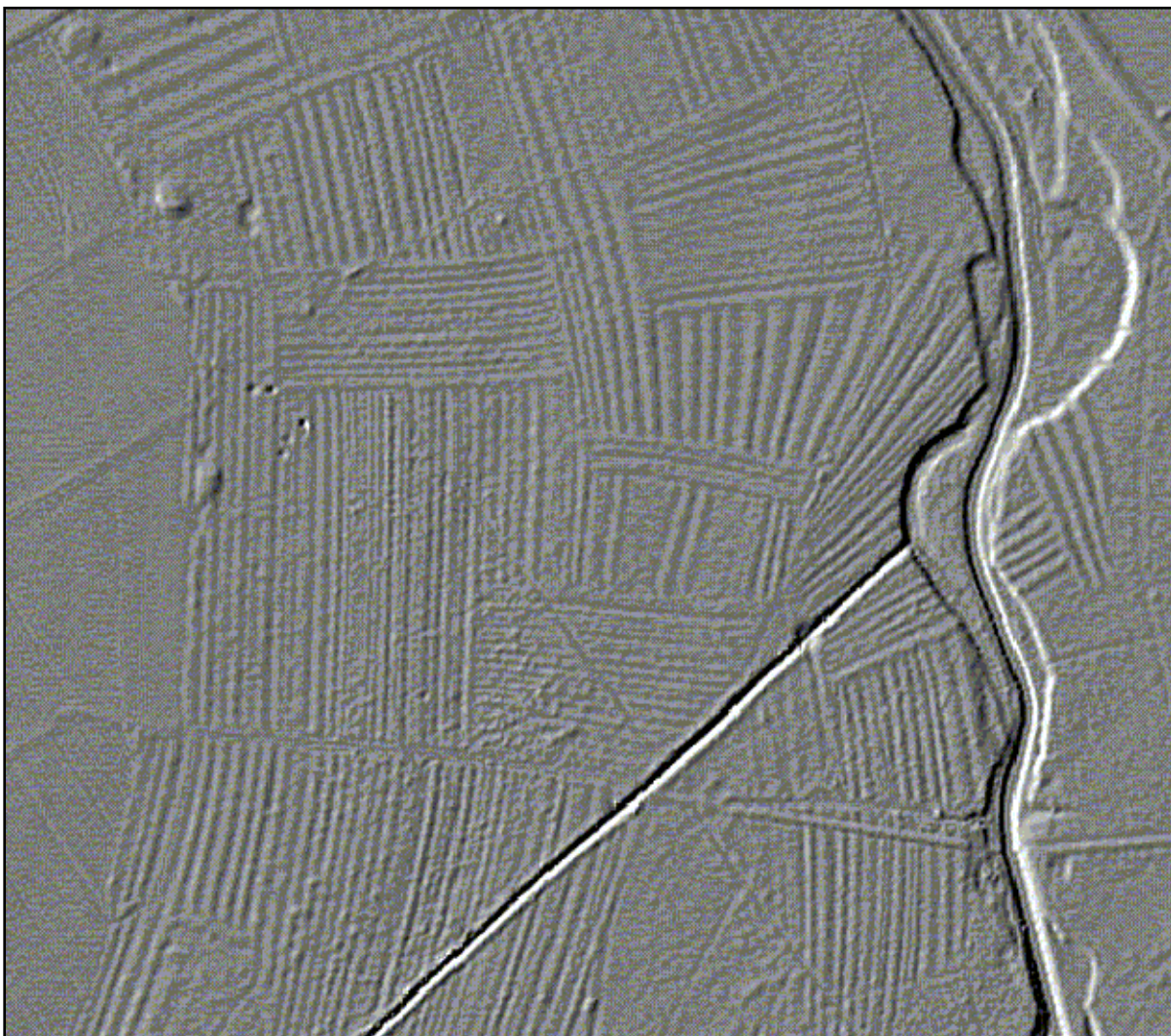
Summary and future prospects

As a result of the work undertaken at the University, and through the contacts made at the meetings noted above, the University of Freiburg became one of the partners in a joint funding proposal to the European Union's Seventh Framework Programme, aimed at promoting the use of lidar for the non-destructive monitoring and damage assessment of endangered cultural heritage sites. At the time of writing the result of the application is still awaited.



Left: Excerpt from a lidar survey near Rastatt in SW Germany. This image, derived from the first-pulse measurements ('first echo' in the diagram in the previous section of the report), shows the surface of the tree-cover, which obscures the greater part of the area, and a few open fields on the left.

Below: The same area, as derived from the last pulse ('last echo') data. The complex and well-preserved pattern of ridge-and-furrow cultivation, which has been protected from recent plough-erosion by the tree-cover, is now revealed in clear detail. Note the far more eroded condition of the earthworks in the regularly-ploughed modern fields on the left.



LANDSCAPE SURVEY, PRESENTATION AND PROTECTION IN BARANYA COUNTY, HUNGARY

Gabor Bertok, for the Directorate of the Museums of Baranya County, Pécs, Hungary

Background and objectives

Despite recognition of their importance by Hungarian archaeologists, aerial photography and other modern methods such as GIS and computer-based research databases have until recently been little used in archaeological research and museum work in Hungary. As a result, aerial images and their interpretation have appeared only infrequently in museum displays and other presentations for the general public.

Through the Culture 2000 project the Directorate of the Museums of Baranya County, based at Pécs in south-western Hungary, has been able to demonstrate the use and importance of aerial photography and non-destructive archaeological methods such as geophysical survey in the presentation and protection of the national heritage. By doing so the Directorate has aimed to improve the quality of its own work, both in research and in presentation of the landscape and archaeological heritage to schoolchildren and the general public.

Finally, the Directorate hopes that the better availability of its research results, together with the demonstrated usefulness of aerial survey in archaeological and landscape recording and presentation, will enhance the longer-term use of aerial archaeology in Hungarian heritage research, presentation and conservation.

The Directorate has pursued these objectives in four main ways:

- By setting up a three-year landscape survey project in Central Baranya County to undertake aerial and field survey and archaeological landscape mapping, using heritage information from the County and National Museums as well as the archive of the Hungarian Military Mapping Agency and satellite imagery freely available on the Internet.
- By setting up a GIS-based database for publication on the Internet, making the results of the project immediately available to young people, the general public and researchers.
- By creating a travelling exhibition on the importance of aerial survey and other non-destructive methods in the interpretation and understanding of the landscape heritage.
- By taking part in meetings and exchanges with Culture 2000 co-partners and others, and by organising a workshop centred on the Directorate's work within the project (in the event this was deferred because of pressure from other meetings in the final year of the project).

Regional research: aerial survey and field observation

Forty hours of aerial reconnaissance during the project succeeded in identifying 172 potentially 'new' archaeological sites, as well as photographing (in most cases for the first time) numerous already-known sites, typical landscapes and townscape views. Site maps were made using orthorectified aerial images. Sixty-nine of the newly-identified sites were examined in the field in a programme of visits that will continue after the end of the Culture 2000 project.

As a result of this campaign of integrated aerial and field survey it has been possible to build up an archaeological database of the study area, pairing detailed site plans with information gained on the ground – a method rarely applied in Hungary in the past. Apart from a few cemeteries and burials, most of the 'new' sites are either settlements of various types or linear features such as roads, field-divisions and settlement boundaries. Further research into the linear features *between* the settlements may be included in future research projects, to enhance understanding of the interrelationship between the sites in various archaeological periods.

An unexpectedly large number (18) of the newly-discovered sites, apparently of various ages and functions, were surrounded by defensive or enclosure ditches. Ten of the 18 appeared, on



Left: The Szemely-Hegybes henges, with the smaller one in the background of the picture. Above: One of the other circular enclosures revealed during the exploratory flights, as marks in the ripening grain-crop. Below: The larger of the Szemely-Hegybes henges, with the trial excavations undertaken as part of the Culture 2000 project.

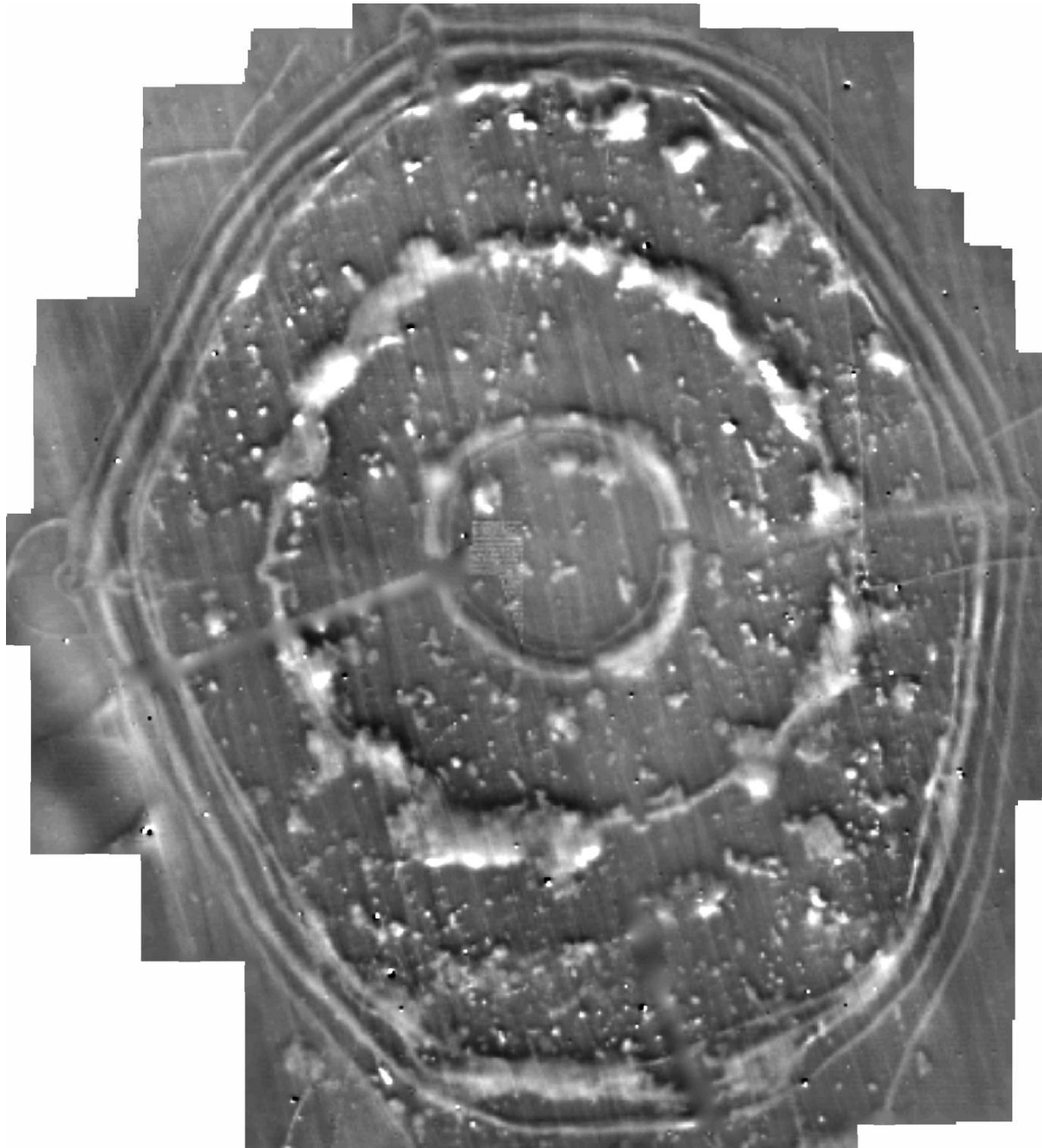


the basis of archaeological material brought to the surface by ploughing, to belong to the Central European Lengyel Culture of the Late Neolithic/Early Copper Age, dating from around 6500 to 6000 years ago. From these discoveries there is beginning to emerge an entirely new picture of the Late Neolithic landscape in this part of Hungary. Moreover, these sites will serve as a framework for further research into the region's landscape archaeology.

Targeted research at Szemely-Hegybes

In keeping with the original research design it was decided to concentrate on one of the so-called 'henge' monuments or fortified settlements for a more detailed investigation, using a variety of non-invasive techniques as well as sample excavation. The henge at Szemely-Hegybes was the most significant of the newly discovered sites, being the largest known feature of this type in Europe. (Unknown to the Museum it had in fact been seen a few years earlier by Dr. Otto Braash during one of his aerial excursions into Hungary.)

Preliminary non-destructive investigation included aerial survey and mapping, creation of a digital terrain model to determine whether the traces detected from the air still survived as surface relief, boring to establish a basic stratigraphy of the site, and magnetometer survey to create a detailed plan of the site. Later, two trial excavations, 2 m wide and 360 m long, were set out at right angles to cross the interior of the site and its perimeter of three massive and roughly concentric sets of ditches. Post-excavation work included radio-carbon dating of two charcoal samples to refine the site's chronology. Also undertaken were comparative pottery analyses and the study of bone remains to gain information on animal husbandry and hunting.



Detailed site map of the Szemely-Hegyes henge based on the geophysical survey results.

As result of these investigations it is now possible to set out a complete plan and basic stratigraphical and chronological scheme for the site. Although it has not been possible so far to shed light on the *function* of the henge, a number of clues have been uncovered that may contribute to understanding of the site. The innermost area is largely empty but – unlike most similar sites – contains a limited number of carefully placed features, perhaps implying that the core of the site had a special role, be it sacred, social or otherwise. The longer axis of the henge also points exactly at the summit of Szársomlyó, a hill of triangular silhouette that is visible from all directions within the local landscape. The hill may therefore have had a significant role for the people who constructed the henge. Future research work at Szársomlyó may clarify the

possible connection with the Szemely henge. Aerial survey, field survey and excavations have revealed several other settlements of the Lengyel Culture in the vicinity of the Szemely henge. The vast dimensions and complexity of the ditch system at Szemely may indicate that it had a special importance, a central role, among the earthworks of similar age in this vicinity.

Exhibition, publicity and publications

In February 2007 an exhibition entitled *Aerial Archaeology Survey of Baranya County* was mounted in the largest shopping mall in Pécs, visited by 30,000 people every day. Posters of the exhibition have since been displayed at various other locations. The posters, and possibly the exhibition itself, will continue to circulate throughout Baranya County and beyond after the end of the Culture 2000 project. Images and text were also provided for the international exhibition in Prague which formed one of the final events of the Culture 2000 project.

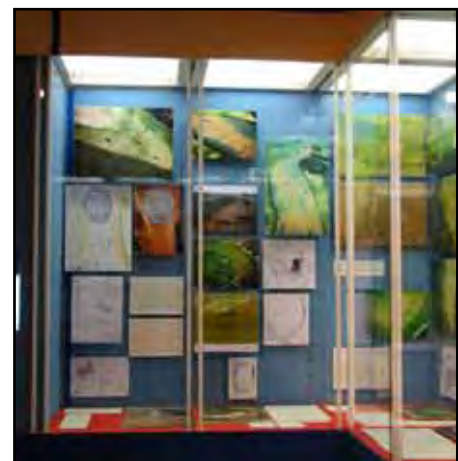
The results of the project were also presented on Hungarian State Television, at the annual conference of the Aerial Archaeology Research Group in the UK in 2006 and at the final meeting of the Culture 2000 co-partners in Prague in October 2007. Publications on the work at Szemely-Hegybes have appeared, or will shortly do so, in prestigious academic journals in Hungary. A bilingual web page (in Hungarian and English) explaining the project's results has been set up at <http://neolithic-henges.baranya.hu> and <http://korarok.baranya.hu>. Material from Hungary has also appeared on the Culture 2000 project's central website.

'Spin-off' benefits of the Culture 2000 project

As a result of experience in the application of GIS and geophysical methods during the Culture 2000 project the Directorate was invited to participate in the on-going work of the Syrian-Hungarian Archaeological Mission. Work done in Syria through this link included survey of a Crusader settlement in 2005-2006 and prospection in 2007 using ground-penetrating radar at Margat Castle, near Baniyas in the coastal region. In September 2006 a presentation was given at Sabboura, near Damascus, during a conference on Remote Sensing and Assisting Systems promoted by the General Organization of Remote Sensing, the civil mapping and surveying agency of the Syrian Arab Republic (see <http://www.gors-sy.org/conference.htm>).

General assessment and future prospects

The Culture 2000 project has enabled the Museum Directorate to make significant discoveries in Hungary, to refine its research and presentation work, and to enhance its scientific contacts in Europe and beyond, including in Syria. Although the project has now come to an end the Directorate hopes to continue many aspects of the work begun as a result of the grant.



The results of the project on display in the Pécs shopping mall (left) and the Prague exhibition (right).

HIDDEN LANDSCAPES IN THE TAVOLIERE DELLE PUGLIE

Foggia, Apulia, Southern Italy

*Prof Giuliano Volpe, Dr R Goffredo, Dr A V Romano, Department of Human Sciences,
University of Foggia, Italy*

Background and aims

Although still relatively young, the archaeological section of the Department of Human Sciences at the University of Foggia has set in train a comprehensive archaeological study of the ancient landscapes that falls within the cultural region of Daunia, in northern Puglia, at the top of the heel of Italy. The Department's approach is that of 'total archaeology', involving the integrated use of multiple sources (archaeological, epigraphic, literary and documentary etc) as well as new technologies and innovative techniques derived both from the humanities and from the world of science. This approach gives the opportunity to examine the landscape from a distance, as it were, and potentially to fill a 'gap' in Italian archaeology between the examination of individual settlements and the study of the landscape as a whole.

The University is in process of establishing a laboratory of landscape archaeology to specialise in aerial survey, air photography and remote sensing, and to promote intensive aerial survey over the Tavoliere plain around Foggia. The Culture 2000 project has allowed the University to enhance its capacity in this and related fields in four important and potentially long-lasting ways.

- By putting in place a structured and long-term programme of archaeological air survey.
- By developing the use of satellite and laser imagery for archaeological purposes.
- By achieving a closer integration between systematic ground survey, aerial exploration, remote sensing and other investigative techniques in the study of the ancient landscape.
- By organising a training school, attending meetings and arranging student exchanges to promote the use of aerial survey, remote sensing and landscape studies in Italy.

Aerial survey, air photo interpretation and mapping

Through the Foggia Aero Club, and with international assistance by pilots and experienced aerial surveyors from Germany and the UK, more than 200 hours of exploratory air survey have been undertaken during the three years of the Culture 2000 project, recording archaeological sites across Northern Apulia but also covering excavations in progress, townscapes, historic buildings and typical landscape features. This work has led to the discovery and recording of hundreds of previously unknown 'sites', within ancient landscapes from prehistory to recent times that are virtually continuous across the Tavoliere plain.

It has been possible during the project to develop the first stages of a systematic and continuing programme of exploration and monitoring of the archaeological heritage of Northern Apulia. The importance of *monitoring* lies in the fact that the Tavoliere and the surrounding hills are now under serious threat from ill-planned urban and rural development, from environmentally damaging public projects (in particular wind-farms) and from the renewed scourge of illegal excavation by the tomb robbers who have destroyed so much of Italy's Etruscan heritage.

After three years of work within the project the University's air photo archive now contains around 46,000 traditional and digital images. The project has also allowed the University to purchase the complete archive of vertical air photographs taken in 1954-55 for national mapping purposes. This is a hugely valuable historical source for future research and conservation work, in that the photographs show the landscape as it appeared before the dramatic changes brought about by intensive arable cultivation and urban development from the 1960s onwards.

Following photo-reading, interpretation and geo-referencing, the most informative oblique (and occasionally vertical) photographs have been rectified and then imported into a GIS system, in



The remarkable cropmark ditches of a Neolithic village, with internal 'compounds', near Foggia. Also visible is the overlying rectangular pattern of Roman roads, farms, fields and agricultural planting.



Left: The cropmarked walls of a previously unknown Roman villa west of Foggia. Right: The devastation caused by wind-farm construction on the site of a multi-period Neolithic and later settlement complex.

'themed' layers according to the type of archaeology recorded, producing a cumulative record of the whole of the evidence available on the air photographs. The process has produced a series of archaeological maps which can be used in on-going study of the stages of historical land-use of the area and (equally importantly) in the planning of conservation strategies for the archaeological sites and historical landscapes so defined. As a result of work done and contacts made during the course of the Culture 2000 project, the aerial survey flights which produce much of the information for these maps are now being part-funded by the potential developers of wind-farms and other construction projects.

Laser imagery and related aerial photography

In May 2005 the Universities of Foggia and Lecce learned through Culture 2000 contacts that lidar (laser scanning) and other airborne imagery of the ancient city of Arpi, near Foggia, was being taken for the University of Durham, CNR Potenza and the UK Natural Environment Research Council. In response, intensive oblique air-photography of the city was undertaken within the Culture 2000 project to enable comparison with the lidar data. The lidar imagery is undergoing processing at the University of Durham and a member of the project team from Foggia will take part in this work during three-month study-visit to Durham in 2008.

Integration of aerial and ground-based research

The landscape of the Tavoliere presents a complex palimpsest of past landscapes laid one upon the other, from the Neolithic through the later prehistoric, Roman and medieval periods, virtually to the present day. Only through the integration of the results from aerial reconnaissance, other remote-sensing methods and traditional techniques such as field-walking survey and limited test excavation, can the more complete understanding of these long-preserved traces of the past be understood and (to an extent, at least) protected.

The University's response has involved an interaction and integration between broad-scale survey of large areas (in effect the whole of the Tavoliere plain) with the intensive study of more restricted zones, in particular through the field-checking of archaeological evidence (much of it initially obtained through aerial survey) in the University's special study areas of the Celone, Ofanto Valley and Carapelle Valleys. This kind of work will continue in future years.

Improvements were made during the project in the University's GIS system to assist integration between aerial evidence and field survey data. Methodologies were created for the interpretation of poorly-defined air-photo features, both by checking 'air-photo' sites on the ground and by taking air photos of features initially identified through ground-based survey.

In addition, a systematic programme of high-resolution magnetometer survey was initiated through a collaboration with Professor Marcello Ciminale of the University of Bari and Dr Helmut Becker from Munich. Work has focused in the first instance on a number of the most interesting and dramatic sites revealed during field-walking and aerial survey, so as to further define the plan-forms of the sites and to test the aerial and ground-based evidence.

Training School, meetings and student exchanges

The Aerial Archaeology Training School, which followed the same basic pattern as an earlier one mounted by the University in 2003, was held a year later than originally planned, in May 2006. Twenty-three students from across Europe (18 in a 'beginners' group and 5 in an 'advanced' group) took part in integrated aerial and ground-based instruction and exercises with the help of tutors and pilot-instructors from Austria, Germany, Slovenia and the UK. The students have now taken their newly-acquired skills and perceptions back to their native countries and to other parts of Italy for use in their future careers.



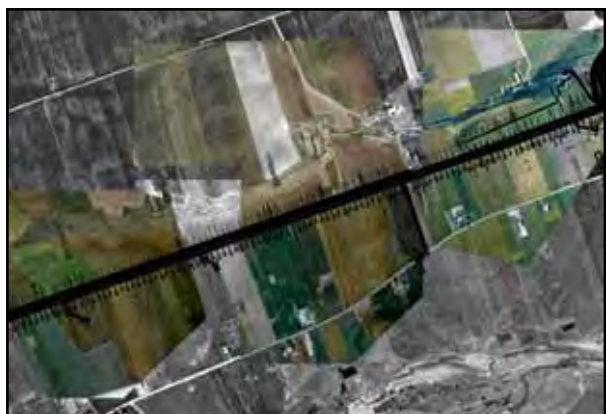
Students and tutors at the Aerial Archaeology Training School at Foggia in May 2007.

Members of the Culture 2000 ‘team’ took part in the project’s co-ordination meetings at Munich and Leuven in 2004 and 2005, in the annual meeting of the Aerial Archaeology Research Group in 2005, in the Rome Seminar in 2004, in the aerial archaeology Training School at Grosseto in 2005, and in the final meeting of Culture 2000 co-partners in Prague in October 2007, when material from Foggia was also included in the international exhibition opened on that occasion.

General assessment of the project

After three years of intensive activity supported or supplemented by the Culture 2000 project the University feels confident that the Italian scientific community now understands more fully the potentialities of aerial archaeology in heritage research, interpretation and conservation. Skills and attitudes from across Europe have been passed on to a new generation of students through the Training School, and the University’s international contacts have been further enhanced.

In some ways the most important result lies in the University’s success in using aerial and ground-based survey to reveal often unsuspected traces from the past while at the same time framing strategies for the future protection and conservation of the region’s archaeological sites and landscapes. The University will continue its pioneering use of aerial survey to identify ‘areas of archaeological sensitivity’ worthy of protection, the aerial work now being at least partly funded by the potential developers themselves. The effectiveness of the University’s contribution to archaeological and landscape conservation will be further enhanced by its recently assumed leadership and coordination of a major project by the Regional Authority (along with other universities and the Soprintendenza) to create a General Map of the Cultural Heritage of Puglia, recording all of the archaeological sites known throughout the Region.



Left: Rectified air photographs (in colour) along the intended route of a new railway line. Right: Part of the resulting map of ‘archaeologically sensitive’ areas, made to assist conservation before and during the building work. Air photographs and maps of this kind will contribute to conservation efforts in other areas.

LANDSCAPE EXPLORATION, INTERPRETATION AND CONSERVATION IN TUSCANY, CENTRAL ITALY

Dr S Campana, Prof R Francovich[†], Dept of Medieval Archaeology, University of Siena, Italy

Background and objectives

As one of the pioneers of aerial archaeology in Italy, the Department of Medieval Archaeology at the University of Siena, through its recently-founded Laboratory for Landscape Archaeology and Remote Sensing (LAP&T) at Grosseto, has contributed to the project in four main ways:

- A structured and long-term programme of archaeological air survey in Tuscany.
- The purchase, evaluation and use of satellite and laser imagery for heritage purposes.
- The integration of aerial, satellite, geophysical and field-walking survey in landscape studies.
- The organisation of a Training School, workshops and the exchange of skills to promote aerial survey, remote sensing and landscape studies in Italy and beyond.

Aerial survey, air-photo interpretation and mapping

With support from Culture 2000 for additional flights, 150 hours of aerial survey were flown during the project, recording landscapes, townscape and archaeological sites in southern Tuscany. About 45 previously unknown sites were recorded, many at risk of damage or destruction by ploughing or other modern developments. The University's air-photo archive now contains over 33,000 traditional and digital images. To assist their analysis and public presentation a number of students were trained in air-photo mapping and interpretation. Development work during the project also helped to make air photographs from the University's growing archive available on an interactive website at <http://shaq.archeo.unisi.it/oblique/>.



Cropmarks of a previously unknown Roman villa and a medieval castle mound discovered from the air.

Integration of aerial, geophysical and field-walking survey

The project saw the testing and evaluation of geophysical equipment for large-scale data acquisition – particularly important in Tuscany because of the nature and use of the region's soils. Without the integrated use of multi-sensor approaches it would rarely be possible to achieve a real impact on Cultural Resource Management or on the search for a better understanding of the region's developing settlement patterns through time. Hence the tests within the project on the GSSI TerraVision system (with 14 radar antenna and 12 cm resolution) and the Foerster MultiCAT system (4 fluxgate gradiometer). Both systems gave extremely interesting results and the University is now contemplating adding to its existing geophysical equipment so as to increase its future capacity to contribute to research and conservation.



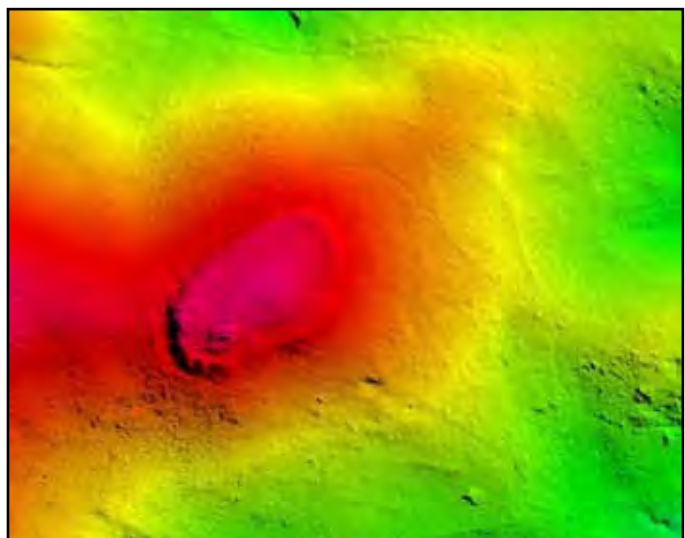
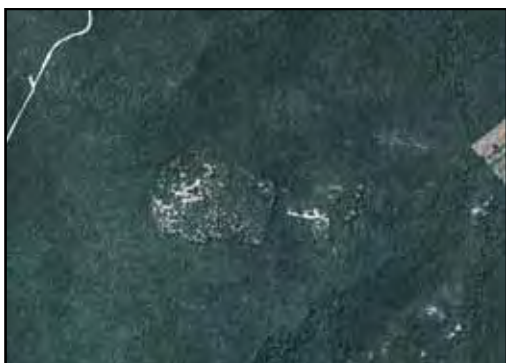
A major component of the Siena project has been the combined use of air photography, field-walking survey (top right) and (in the rest of this image) various forms of geophysical survey, including ground-penetrating radar, the results of which for one of the Aiali buildings are seen at bottom left.

Laser-scanned landscape data

During 2005, in partnership with the UK Natural Environment Research Council, lidar data was acquired for four sample areas, representing different kinds of cultural sites and woodland cover in Tuscany. Lidar survey will be particularly important in the heavily wooded landscape of Tuscany (and of Italy as a whole), since it can 'see through the trees' to create a digital terrain model of the underlying surface, including otherwise-hidden landscapes and archaeological features. The principal aim within the project was to identify the potential of airborne laser scanning for mapping archaeological features hidden from traditional air photography by the obscuring blanket of trees (almost half of Italy's land-mass is covered in woodland or forest).

Preliminary analysis of the lidar data was carried out within the project and will continue in the longer term through cooperation (and a student exchange) with the University of Durham in the UK. The results are beginning to show the extent to which laser signals can penetrate different kinds of Mediterranean tree cover at locations with known archaeological sites typical of those found in Tuscany. The potential to advance knowledge is enormous because many as yet unexplored sites and landscapes lie 'protected' by woodland cover, in contrast to those in agricultural areas where most archaeological sites have been destroyed or flattened by centuries of ploughing. The capacity to record these previously hidden sites will help in the formulation of strategies for their longer-term investigation and conservation.

Lidar imagery of a wooded medieval castle. Whilst the photograph below shows the surface of the tree-canopy, the image on the right, of the processed last-return lidar signals reveals the underlying earthworks.



Training School, workshops and student exchange

One of the project's main events, in May-June 2005, was a 10-day international Summer School at Grosseto on *Aerial Survey, digital photography and GIS-based interpretation*. Twenty-one undergraduate and post-graduate students and researchers, from over 100 applicants from various fields of research and heritage conservation, received instruction and practical experience both on the ground and in the air. Each student flew for about 8 hours during the School's programme of aerial exploration, during which over 15,000 photographs were taken. Among innovations were several new teaching methods, the presence of participants from Spain and the training of pilots from the Aero Club of Florence to assist in future survey work.

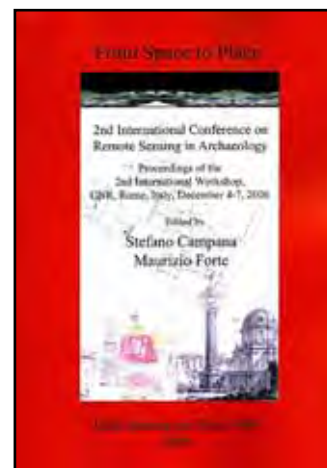
A successful specialist Workshop, initiated through the Culture 2000 project but funded mainly by Leica Geosystems, was held at Grosseto in June 2005, on *GPS and Laser Scanning in Archaeological Research*. More than 150 students and research workers took part and a publication is planned. In 2006 logistical and specialist support was provided for a workshop on *Archaeological Landscapes and Digital Technologies*, again largely funded by outside bodies.

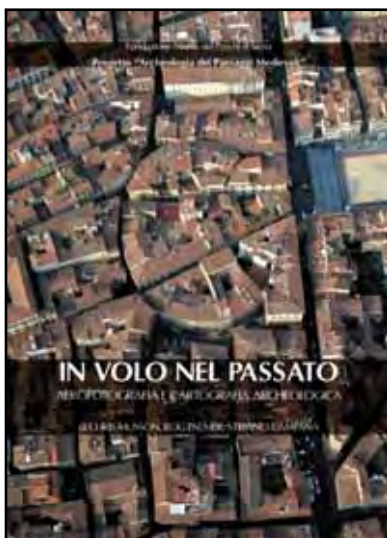
In July 2006 the project helped to organise the first Italian summer school on *Geophysical Survey for Archaeology*. The 35 students, from 60 applicants, spent time on theoretical lessons, field-data collection and data processing under the direction of 15 tutors from Europe and beyond. Much new data was collected and interpreted for a site first discovered through aerial survey and progress was made on the evaluation of various methods of data integration.

In November 2006, with financial help from a range of outside bodies, the project mounted a week-long Summer School entitled *Exploring Archaeological Landscapes*, which brought together international experts and 31 students from across Europe (from 75 applicants). The school was based mainly on presentations and extended discussion, but also involved the demonstration of survey instruments in the field. New ideas were developed on 'visibility', 'serendipity' and 'emptiness' as important concepts in archaeological work.

This event immediately preceded the 2nd International Conference on Remote Sensing and Archaeology, *From Space to Place* (below), held at Rome in December 2006 as a result of organisational work by representatives of CNR-ITABC and the Laboratory of Landscape Archaeology and Remote Sensing at Grosseto. During the four days of the conference almost 100 papers were presented by over 200 authors, with discussion by an estimated 150 active participants. The speakers came from 25 countries on four different continents.

During 2006 a postgraduate student from Siena spent two weeks in the Department Prehistory at the University of Vienna, attending lessons and working in the laboratory of Dr. Michael Doneus. Other students from the University attended meetings and workshops in Italy and other parts of Europe, including the annual meetings of the Aerial Archaeology Research Group and the final conference of Culture 2000 co-partners at Prague in October 2007.





The manual of air photography (left) and two posters from Culture 2000 events (centre and right).

Traditional and Internet publications

A major event, in May 2005, was the publication of a profusely illustrated manual on the theory, practice and uses of aerial archaeology, the first to deal in Italian with exploratory air survey of the kind promoted through the Culture 2000 project. The book, *In volo nel Passato: aerofotografia e cartografia archeologica* (Musson, Palmer and Campana 2005), arose as a by-product of an earlier Culture 2000 project which helped to fund the first Italian aerial archaeology school at Siena in 2001. The book is now available as a pdf download from the Internet (<http://www.bibar.unisi.it/libri/bda12.html>).

Throughout the project the University regularly posted information about Culture 2000 events on its own websites (notably www.lapetlab.it) with the aim of raising public and official awareness of heritage landscapes in Italy and of the need for their presentation and conservation as part of the common cultural heritage of Europe. This website has been progressively enhanced, in both Italian and English, throughout the course of the project. News and other items were also contributed to the Culture 2000 project's central website.

Networking and exchange of skills

Staff and students from the University continued to play an active part in enhancing the pan-European network of contacts in aerial archaeology, remote sensing and landscape studies. Conferences and workshops were attended and presentations made. A particularly fruitful exchange of skills in the processing and interpretation of lidar imagery was developed with the University of Durham in the UK. This will continue beyond the end of the Culture 2000 project.

Conclusions

The Culture 2000 project has allowed the University to develop its work in a variety of ways in aerial and geophysical survey, data integration and the interpretation of lidar data, as well as extending its contacts with experts and research students across Europe. A number of important events were facilitated through cooperation with other bodies and outside funding sources, and important agreements for the supply of equipment or software were reached with Geostudi Astier, Zenit, Leica Geosystems and ESRI Software. Future events springing from the Culture 2000 project will include an exchange visit by a research student to Durham University in the UK, an exhibition in Siena on *Medieval Landscapes from the Air* and a Summer School on *3D Modelling in Archaeology*, to be held at Ascona, Switzerland, in May 2008.

AERIAL SURVEY AND MEDIEVAL LANDSCAPES IN SOUTHERN APULIA

Combining modern and traditional technology

Prof G Ceraudo, Prof P Arthur, University of Salento, Lecce, Italy; Agenzia per il Patrimonio Culturale Euromediterraneo, Lecce, Italy

Background and objectives

Within the scope of the European Landscapes project the Laboratories of Ancient Topography and Photogrammetry and of Medieval Archaeology at the University of Salento aimed to apply a combination of new and traditional techniques to aid the understanding of the towns, settlements and landscapes of Southern Apulia from antiquity to the present day.

The main focus of the project in the Salento Peninsula comprised:

- The creation of specific procedures for archaeological and landscape exploration
- The combination of traditional methods of ground-based survey with aerial photo analysis
- The enlargement of the aerial photo archive with the addition of newly acquired vertical and oblique coverage of Apulia, along with studies in the use of satellite imagery
- The creation of a database and GIS environment for data management
- The training of students as research workers and conservation archaeologists in the combined use of aerial survey, field survey and satellite data
- The creation of a specific website, in both English and Italian

The project explored the archaeology of the relationship between Lecce, a pre-Roman settlement which then became a Roman colony and later the modern provincial capital, and its port at San Cataldo on the Adriatic Sea 12 km away, which managed its overseas commerce in the past. The landscape between the two is rapidly changing because of aggressive agricultural development, the urban expansion of Lecce and tourist development along the coast. Thus, the knowledge acquired within the project can be used to improve the way in which the land is to be used, making sure that the local cultural and archaeological heritage is safeguarded.

Aerial photography and exploration between Lecce and San Cataldo

The project allowed the University to combine the existing aerial photo archives from the Laboratories of Ancient Topography and Photogrammetry with numerous vertical and oblique air photos produced by military bodies and private companies both in the past (1943, 1947 and 1954-55) and recently, making a collection of more than 300 photographs for the study area. During the course of the project 60 hours of flight time covered the area under investigation and other large sections of the Salentine peninsula and Adriatic coast. Aerial survey flights over the study area and its surroundings were carried out with ideal soil and sea conditions and visibility.

More than 40 days of fieldwork made it possible to cover the entire study area using systematic territorial survey. To this may be added the processing and analysis of finds and the compilation



Field-walking survey in a typically stony area of the Salento landscape.



Left: An area between Lecce and the port at San Cataldo. The wheel-ruts of ancient roads can be clearly seen in the centre of the photograph, where they are cut into the exposed bedrock. Right: Rectangular cropmarks, perhaps of small square-ditched enclosures. The long cropmark towards the top of the photograph may belong to an ancient road. Air photographs in this section are by Dr Alessandro Rizzo.

of the database. Finally, a total of 3 months of work on the Roman pier in San Cataldo made it possible to clean the structure and record it in detail.

During the field surveys traditional field-walking and survey methods were combined, when possible, with digital topographic methods. Every single topographical unit was surveyed and mapped using a GPS. In this way most of the information regarding the sites – geolocation, the descriptions of evidence and details of the surveys – were taken in digital form directly on site, drastically reducing the time spent on data entry once back in the laboratories.

Field survey brought to light 25 new sites dating mainly to Late Antiquity and the early Middle Ages, lying in the territory between Lecce and San Cataldo. Late Roman occupation and agricultural activity was largely witnessed by the discovery of potsherds of amphorae (mainly Tunisian), and African Red Slip ware, including a lamp fragment dating to the 5th-6th century AD. The survey and quantification of pottery found has, so far, indicated a quite unprecedented increase in activity some time between the 8th and the 10th/11th centuries AD, with the establishment of what may have been small farmsteads. An early medieval cemetery was also examined. Very little later medieval pottery was found, suggesting a diminution of rural settlement. Instead, the establishment of various *masserie* or farming complexes dating between the 16th and 18th centuries represents post-medieval occupation and farming.

In the area between the ancient city and the sea, near Masseria Ramanno (already known thanks to the discovery of a Roman Republican kiln site in 1997) humidity and cropmarks in the oblique and vertical aerial images allowed better definition of the settlement producing amphorae for overseas transportation. The University of Siena research group further surveyed the area, using magnetometer prospection over an area of approximately one hectare. The

evidence found made it possible to identify, with a high degree of precision, at least two kilns and a number of walled structures. The data acquired made possible the more economical planning of excavations.

Unfortunately, it proved impractical to carry out extended experiments with the satellite imagery. The geophysical work by Culture 2000 co-partners from Siena was felt to offer a more effective integration of remote sensing survey techniques into the project as a whole.

Work at San Cataldo and along the Adriatic coast

The ancient port at San Cataldo is well known for the ruins of a Roman pier, yet this important monument has had little work done on it from a technical-structural point of view until now. Here, oblique-photo analysis and interpretation revealed a large L-shaped structure below water, built in 1901 out of blocks of reused stone taken from the Roman pier. The huge quantity of historical and cartographic documentation found in the archive, together with data from aerial surveys and from the work carried out directly regarding the structure, have made it possible to reconstruct the history of the port from ancient times onwards. Indeed, it was fundamental to Lecce's growth in medieval times, both for commerce and pilgrimage. Prior to 1496, it was still able to receive the future king Ferdinand of Aragon, who arrived there with three galleys.

Aerial surveys were also carried out along vast sections of the Adriatic coast, documenting some settlements that have already been mentioned in the literature, some that have had archaeological excavations carried out, and others which hitherto have had nothing published.



Left: The remains of the Roman pier at San Cataldo, showing how the ancient structure was re-used when the modern pier was built on top of it in 1901

Below: The pier undergoing cleaning and recording during the study of relationships between the port and the Roman and medieval town at Lecce





Left: The partly-excavated settlement of Rocavecchia on the Adriatic coast. The visible structures belong mainly to the medieval period, with a massive Bronze Age defence across the neck on the right-hand side. Right: The cropmarks of rectangular structures within the urban area of a native settlement.

These included the minor promontory of Torre Chianca, site of a small coastal settlement in Roman times; the bay at Torre dell'Orso, used for its natural caves, some of which were cult centres; and the area of Rocavecchia, an important Bronze Age, Roman and medieval settlement, where aerial survey has shown the existence of several sites visible as cropmarks.

Database work and GIS in present-day research

All of the resulting information has been organised into a database with the aim of exploiting the spatial analysis capabilities of GIS. The GIS was utilised not just as an instrument for containing and organising data or producing high quality maps, but also as a system for allowing material acquired on site to interact with information on the landscape, geology, soils, elevation data and land use, all of which would have had to be sought through more laborious methods in the past.

Training, meetings and website

In addition to the principal research, another result was the training of students in practical archaeological landscape studies. Throughout the project students were trained in the use of GPS in field survey, pottery studies, aerial photo analysis, archaeological excavations and basic GIS operations. Furthermore, training excavations were carried out at San Cataldo, involving cleaning the structure of sandy top soil and planning it. Six students took part in the Culture 2000 Training School at Foggia in May 2007 and two others presented talks at the final meeting of project co-partners at Prague in October 2007, when posters and other material from Salento were included in the exhibition mounted at the National Museum. Finally, a bilingual website (www.unile.it/aerialsurvey) was developed with the purpose of publishing the project's first results and of creating a space for up-to-date information on the development in aerial archaeology studies. The work on the project was carried out by Veronica Ferrari, Giuseppe Gravili, Alice Medda, Alfio Merico, Maurizio Pastore and Mariangela Sammarco.

Final assessment

The University feels that the project achieved extremely worthwhile results in terms of research, methodological development and student training, despite being hampered initially by local bureaucratic problems over funding and financial management. A useful contribution has been made to understanding the relationship between Lecce and its port at San Cataldo and hence to future efforts to achieve archaeological and landscape conservation in this part of southern Italy.

LITHUANIAN HERITAGE FROM THE AIR

Through recording and collection to education

Dr Romas Jarockis, for the Department of Lithuanian Heritage Protection

Background and objectives

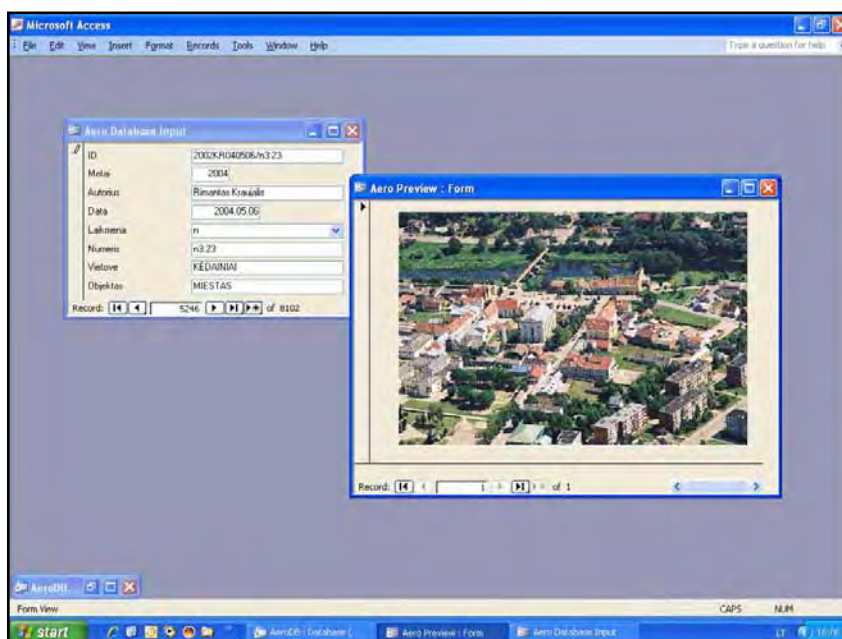
Over the past 50 years the territory of Lithuania has been photographed from the air five times. The resulting vertical photographs and digital ortho-photos, cared for in the archives of the Aero-geodesy Institute in Kaunas and the GIS centre in Vilnius, are open to the public and copies of the photographs can be acquired at reasonable prices. In 1996 the Department of Lithuanian Heritage Protection began a limited programme of aerial photography for purposes of heritage protection. At the beginning of the project the Department's air photo archive contained rather more than 2000 oblique air-photo images, representing more than 300 sites and structures of the Lithuanian cultural heritage.

The Culture 2000 project has enabled the Department to enhance its work in four main ways:

- By developing a digital database of air photographs of the Lithuanian heritage.
- By supplementing the small but valuable programme of regular aerial photography undertaken by the Department in recent years.
- By exploiting new and existing air photographs as a tool in teaching local history.
- By organising an International Workshop in Lithuania and by joining the Europe-wide network of contacts in aerial archaeology, remote sensing and landscape studies.

Digital database of air photographs and related data

The basic model for the digital database has been created. Vertical photographs covering 150 sites were selected from the historical archives and were digitised. The digital database is structured on the basis of data packages, ie: collections of aerial photographs, often taken in several different years, with attached texts containing information on individual heritage sites (a castle, a town, a hillfort, a prehistoric enclosure etc). The packages contain black-and-white vertical photographs, ortho-photos and oblique colour views taken over a period of years. They will be constantly added to as new photographs are acquired. In implementing the project, interpretation and scientific investigation were (and will continue to be) undertaken for sites and monuments detected in both the recent and the archival air photographs.



One of the computer screens from the newly-implemented database system for the Department's air photo archive, here showing an 'oblique' townscape view from a recent flight. The archive also contains a range of earlier black-and-white 'vertical' photographs.



Above: An Iron Age fort at Šaukštelis in its landscape context. Newly-taken images of this kind are enormously effective in showing the character and state of preservation of nationally-protected monuments, not least in communication with school-children and the general public.



Left: An archival black-and-white vertical photograph from 1957, showing a complex of Iron Age to Medieval hillforts and a Dominican monastery of the early 18th century at Liškiava, Varėna district. Images of this kind are invaluable in showing the landscape as it was half a century ago.

Aerial photography

On completion of the Culture 2000 project the Department's digital archive now contains some 5000 colour images. Within the three-year period of the project 45 hours of aerial survey were undertaken, producing about 2500 images of approximately 400 cultural heritage sites, of which some fifteen (mostly Stone Age and Iron Age settlements or hillfort complexes of Iron Age to Early Medieval date) were new to the record. Five days of field survey were organised to examine the previously unrecorded sites and to compile information for the national archive.



The title page from one of the education packs created as part of the Culture 2000 project. On the right are three of the images from later parts of the pack, which also includes further air photographs as well as documentary references, maps and descriptive texts

Education packs

Progress with educational information packs was less extensive than originally hoped. Initially it was planned to produce educational packs of some twenty towns and townships with origins going back to prehistoric times, but time-constraints and the need to build up experience meant that only seven were completed within the time-frame of the project. The packs contain historical and recent aerial photographs, supported by other archaeological data, historical information, cartographic material, ancient paintings and ground-based photographs. The information is specially adapted for schoolchildren so as to show features of the local cultural heritage and to emphasise their importance for society, both historically and in the present day. It was originally planned to produce the packs in hard-copy for distribution to local schools but it now seems more likely that this kind of material will find its way into the education system more effectively through the internet (as is possible with the packs completed within the project). As a result, part of the money intended for publication of the education packs was used to cover publication of the proceedings of the International Workshop described in the next paragraph.

International Workshop and Culture 2000 contacts

The planned international workshop on aerial archaeology and landscape studies took place at the University of Klaipeda, on the western coast of Lithuania, in November 2005. A total of 30 participants from Lithuania, Denmark, Finland, Latvia, Norway, Poland, Russia and the UK considered a range of topics of particular significance to the Baltic region. They also discussed the possibility of future cooperation in the promotion of aerial archaeology, culture and landscape studies around the Baltic Sea. The meeting attracted coverage on radio, television and in the local press. A publication of the proceedings, along with a number of additional papers, will appear shortly after completion of the Culture 2000 project in late autumn 2007.

Academic staff, professional archaeologists and students from Lithuania took part in a number of meetings organised or assisted by Culture 2000 funding, including those of the Aerial



Left: 14th-17th century town of Kaunas, in central Lithuania. Above: 16th-century church at Seredžius, Jurbarkas district. Below: Field visit during the international workshop at Klaipeda in November 2005.

Archaeology Research Group in Germany (2004), Belgium (2005) and the UK (2006). Valuable contacts were created at these meetings and at various Culture 2000 events, including the Helsinki symposium of October 2004, the aerial archaeology training schools at Barth (North Germany) in 2005 and 2007, and the geophysical prospection workshop at Grosseto (Italy) in July 2006. A report on the Lithuanian part of the project was presented at the final meeting of Culture 2000 co-partners at Prague in October 2007. Lithuanian material was also included in the exhibition opened at the Czech National Museum in October 2007.

Overall assessment of the project

In addition to the creation and maintenance of international contacts, two aspects of the project deserve particular mention. Firstly, the use of aerial photography and digital systems for heritage documentation and monitoring was further developed within the Department. Secondly, experience was gained in preparing educational material for use in local schools and in a first Lithuanian publication focused on aerial survey (following the Klaipeda Workshop of 2006).

'Spin-off' benefits in the field of research and university education include the planned inception (in 2008) of a course on aerial archaeology for students of archaeology and history at the new University of Klaipeda. Work on the education packs prompted the submission of a funding application to the Lithuanian Ministry of Education, entitled '*Use of aerial photographs for teaching history and geography at secondary school*'. The project has been positively evaluated and it is hoped that funding will be forthcoming in the years following the Culture 2000 project. Culture 2000 material is also being used in autumn 2007 in a series of lectures to school-teachers at 19 local education centres. All these developments will help to give the Culture 2000 project a long-lasting affect on archaeology, heritage protection and education in Lithuania.

PHOTO-MAPS AND AIR PHOTOGRAPHS IN POLAND

Old and new resources for Poland's landscape heritage

*Włodek Rączkowski, Institute of Prehistory, Adam Mickiewicz University, Poznań;
Andrzej Prinke, Poznań Archaeological Museum; Dariusz Krasnodębski, Institute of
Archaeology and Ethnology, Polish Academy of Sciences, Warsaw.*

Background and objectives

Poland and much of Europe possesses a largely un-recognised landscape resource in a widespread coverage of German military photo-maps from the 1930s and 1940s, showing the landscape as it was before the radical changes of the post-war years. The full historical potential of these photo-maps has yet to be assessed.

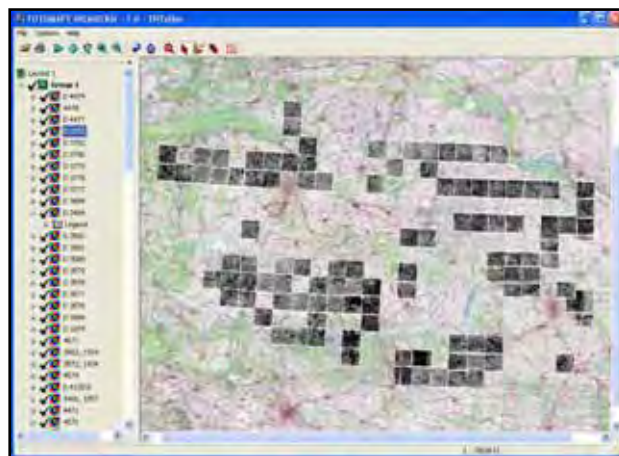
Until recently little money has been allocated in Poland to exploratory air photography, which has been seen as a relatively 'new' technique despite its widespread use elsewhere in Europe. It has to compete for funds with Poland's long-standing programme of ground-based survey, the Polish Archaeological Record or AZP. This now covers the greater part of Poland and holds over 700,000 entries. The existence of the AZP provides an unrivalled opportunity for Polish aerial survey to be even more effective, adding 'shape' to sites known only from surface scatters of archaeological material and revealing archaeological and landscape features where no evidence is visible at ground level.

The Polish contribution to the Culture 2000 project has pursued four main aims:

- To identify the location, number and quality of the German photo-maps across Europe and to test methods of making them more widely available.
- To create a database system linking ground-based and aerial evidence.
- To carry out aerial survey in a number of study areas, along with mapping of the results
- To take part in the Europe-wide network of contacts, meetings and discussions and to publicise the project and its achievements through the Internet.

German photo-maps

Unfortunately, the search for photo-maps (by Włodek Rączkowski) failed to locate any in the National Archive in Poznań. The National Museum in Szczecin was found to hold an as yet un-catalogued collection of aerial photographs taken before and during WWII, but unfortunately no



Left: One of the 1:25000-scale German photo-maps from the 1930s and 1940s, that provide a valuable record of the landscape before the radical changes of the post-war years. Above: Part of the Internet presentation of known photo-maps in Poland.

German photo-maps. A search of the Central Military Archive in Warsaw showed that its air-photographic material is still un-catalogued and therefore very difficult to access, whether for air photographs or for photo-maps. A database of over 1300 photo-maps and mosaics so far located at Poznań, Słupsk and Warsaw in Poland and at Keele in the United Kingdom has been completed and posted on the project's central website. The search for further photo-maps and WWII photographs will continue beyond the end of the Culture 2000 project.

Database development to link aerial and field-walking evidence

A major feature of the project has been the design and implementation (mainly by Andrzej Prinke and Włodek Rączkowski) of a database application (*Aph_Max*) for the storage and analysis of air photo archives in several institutions. This has been used initially for mass data entry of the 3000 air photographs taken during the aerial archaeology school at Leszno in 1998, now held by the Adam Mickiewicz University. The Culture 2000 project has thus allowed the creation of a third and essential module in a heritage management system which has been under development for several years at the Poznań Archaeological Museum. It will enhance the management of air photo collections through the creation of unique files for each photograph. These can then be compared with other datasets such as text descriptions for individual sites. The *Aph_Max* database will shortly be linked to the complementary datasets of the AZP so that each can complement and supplement the others in the recording, protection and management of sites and monuments, whether known from ground-based survey or from aerial evidence.



Two screens from the *Aph_Max* database system

Aerial survey, mapping and interpretation

Important discoveries were made by Dariusz Krasnodębski during 15 hours of survey over the Vistula, Bug and Narew Valleys and the Bielsk Plain in north-eastern Poland, areas previously little explored from the air. The 3500 photographs taken during these flights recorded a significant number of previously unknown sites, including early medieval strongholds and Roman-period burials. Of equal importance, two supposed strongholds were shown by aerial survey and ground observation *not* to be genuine archaeological features. The partial destruction by ploughing of several deserted villages was documented, allowing a degree of protection to be provided in the future. Photographs were also taken of medieval hillforts, multi-phase Roman-to-medieval settlements, a prehistoric graveyard, and a host of traditional towns and villages along with characteristic landscapes.

A total of just under 74 hours of flying by Włodek Rączkowski in Wielkopolska, Kujawy, Lubusz Land, Lower Silesia and western Pomerania produced almost 5000 aerial photographs, recording hundreds of archaeological sites, many of them previously unknown and here revealed as variations in colour or height in the ripening crops. So-called 'pit-alignments', well known in other parts of Europe, were recorded for the first time in Poland in two of the survey areas. There were also spectacular traces of previously unsuspected long barrows and trapezoidal buildings from the Neolithic period, often at locations that had produced no archaeological evidence on the ground. Other settlements were represented by groups of pits.



Typical results of the recent aerial survey flights in Poland: two medieval fortresses (left), a typical village layout (top right) and the cropmarks of sunken houses and pits in a previously unknown settlement.

Aerial records were also made of numerous villages, medieval towns, granges, manor houses, monasteries and churches, as well as more recent industrial and military features, typical landscapes and archaeological excavations in progress.

The most sensational discovery, however, was that of a 'lost' medieval town, Szamotuły, in Wielkopolska region, known to have burned down in the 14th century and now shown to have been rebuilt to virtually the same layout some distance away from its original site. The discovery appeared prominently in many newspapers and TV news items, and raised great interest throughout Poland. Both academic archaeologists and the general public were shown by this remarkable discovery that aerial survey has a huge potential for revealing previously unrecognised parts of the cultural heritage. The discovery has resulted in many invitations for public and academic lectures, for popular and specialist publications and for discussions about the possible use of aerial reconnaissance in other parts of Poland.

The time taken to deal with these discoveries (and the large number of images acquired) restricted the amount of mapping and overall analysis that could be completed within the Culture 2000 project but this work will continue and be intensified after its completion.

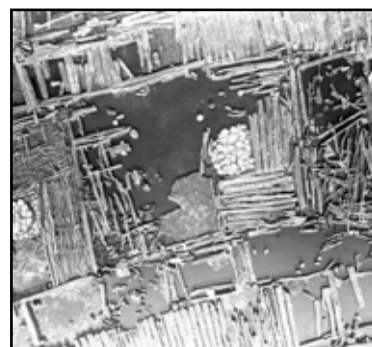
Dr Otto Braasch, from Germany, visited Poland in his own aircraft for two days in July 2007 and gave advanced in-air training to two students who have shown a long-term commitment to the use of aerial archaeology in their future careers.

Culture 2000 network, meetings and website

Students and members of the Polish project team took part in meetings of the Aerial Archaeology Research Group in Germany, Estonia, the UK and Denmark during the project.



Above: Students and contemplative tutors from one of the two workshops held at Poznań during the final year of the project. Left: Cover of the book on aerial photographs in Polish archaeology, Biskupin ... and what next?, published with help from the Culture 2000 project. Below: recent and historical photographs of Biskupin.



They also participated in the Culture 2000 symposium at Helsinki in 2004 and in training schools or workshops in Italy, Lithuania and the UK later in the project, as well as in the final meeting of Culture 2000 co-partners at Prague in October 2007. Material from Poland figured prominently in the major exhibition opened in October 2007 at the Czech National Museum.

Two successful workshops on aerial archaeology and landscape studies were organised by the Adam Mickiewicz University at Poznań in the final year of the project – the first restricted to Polish students, the second for students drawn from countries dispersed widely across Europe and beyond (Armenia, Montenegro, the Netherlands, Estonia, Finland, Romania and Poland).

Throughout the project the Archaeological Museum at Poznań has acted as host to the project's central website, www.e-landscapes.com, to which all of the co-partners have made contributions. It is hoped that the website will be maintained and developed with further news and information for at least three years beyond the life of the Culture 2000 project.

Overall assessment of the project

The project has amply demonstrated the value of aerial survey in Poland and will hopefully assist in securing at least modest funding for the technique in the longer term. Linking the results to the AZP databases will help in the conservation of the sites and landscapes revealed from the air. For the general public the photographs have provided striking evidence of the nature and value of these half-hidden traces of the cultural heritage which Poland shares with Europe as a whole. The photographic materials are already in use for teaching landscape history and have been, and will be, used as illustrations in a variety of publications, both academic and popular. Thanks to this the general knowledge about the potential of aerial photography for landscape studies is growing among professional archaeologists and students, as well as the general public. The general attitude towards aerial survey in Poland is changing.

ROMANIA: A FUTURE FOR THE PAST

Aerial information in landscape recording and conservation

Irina Oberländer-Târnoveanu, Institute for Cultural Memory (CIMEC), Bucharest

Background and objectives

Apart from some work by Glasgow University in recent years, aerial survey has remained virtually unused in Romania for archaeological purposes or landscape study. The Culture 2000 project has given the Institute for Cultural Memory the opportunity to promote its introduction through the study of 'historical' air photo sources, through a programme of fieldwork and through the initiation of a small programme of exploratory aerial survey in the final year of the project. By participating in the Culture 2000 project staff from the Institute have been able to learn from experienced colleagues how to use air-photography in identifying and mapping sites and in monitoring their state of preservation over time.

The Institute's contribution to the Culture 2000 project has had three main aims:

- Training of CIMEC staff and of other Romanian archaeologists in remote sensing methods in archaeology and landscape studies.
- Developing a pilot project for the recording of archaeological sites and landscapes in a chosen study area, using air photo interpretation, mapping, field survey and new aerial survey.
- Improving information about known and previously undetected sites, and drawing this to the attention of officials and cultural resource managers so as to aid future conservation and enjoyment by schoolchildren, young adults and the general public.

Training and participation in meetings

In May 2005 Culture 2000 and other funding enabled the Institute to organise a week-long international training course for 34 participants, including 6 from CIMEC, in aerial archaeology and GIS in heritage work. Experience of active aerial survey and air photo interpretation was gained at Culture 2000 training schools in the UK in 2006 and in Italy and Poland in 2007. Meetings of international experts were attended, and contacts made, in Belgium (2005), the UK (2006) and Denmark and the Czech Republic (2007). A close collaboration was established with one of Britain's foremost air photo interpreters, Rog Palmer, who conducted week-long workshops in Bucharest in 2005 and 2007, along with extended training at Cambridge in 2006.



Participants and tutors in the first Romanian training course, held at Buşteni in May 2005.

Pilot project on the Mostiștea River Valley

A study area was selected in the Mostiștea River Valley, SE of Bucharest, within the Lower Danube Basin. This is one of the most archaeologically rich areas in Romania, from early prehistory to modern times. Many archaeological sites there have been destroyed or are at risk of damage or destruction by modern development and intensive arable cultivation. Many more await discovery through the aerial techniques which have proved so fruitful in other parts of Europe. Within the study area the project had the following goals:

- To enrich the National Archaeological Record by determining the exact location of known sites and by discovering and recording previously unknown ones through the examination of aerial photographs, archive sources, digital photography and digital cartography.
- To use the collected material to compile maps of archaeological sites, monuments and landscapes and to create a related digital archive.
- To identify landscape changes in recent decades by comparing older and more recent aerial photographs.
- To make archaeological information available to the public, to cultural resource managers and to researchers through the Institute's website at <http://map.cimec.ro>.

The first stage of work comprised the acquisition, study and processing of a range of cartographic and related material – maps and cadastral plans at various scales from 1897 to 2005, orthophoto plans from 2003-2005, vertical air photographs from 1972 to 1986 (all requiring geo-referencing) and digitised satellite imagery (CORONA) from 1968-1972.

The second stage involved field survey, site recording and the collation of documentary sources (bibliographic, cartographic and photographic). Over 40 days of field survey were undertaken in the summers of 2006 and 2007. Some of the sites had not been visited since their first mention in the archaeological literature in 1923. The field surveyors identified the precise locations of the sites, recorded their present state of preservation, took GPS coordinates, made digital



Air photograph of the Malu Roșu site (centre foreground), from the first exploratory flight in July 2007.



Field visit to the Malu Roşu site, on a promontory overlooking the waters of Mostiștea Lake.



photographs of each location and marked the sites on paper maps. They also filled in site cards for subsequent transfer to the database so as to create digital archives for each site.

The third stage, in July 2007, involved hiring an aircraft and taking 200 oblique air photographs of the study area. Although July is not usually ideal for archaeological air photography this gave the opportunity to gain a better understanding of the landscape and to apply, for the first time in independent flight, the methods and skills acquired during the Culture 2000 training courses.

Within the chosen study area it proved possible to identify over 190 archaeological sites in approximately 34 localities, to record them in the database and to mark them on digital topographical maps and aerial photographs. Before the project only 13 sites were known at 11 localities in the same area. The gain from the project has therefore been enormous.

A specific example is provided by a detailed study of landscape evolution around an important (and previously excavated) Copper Age settlement at Malu Roşu on a promontory above Mostiștea Lake. Using air photographs from 1977, 1986 and 1992 it was possible to demonstrate the promontory's progressive erosion and to illustrate the impact of wetland drainage and the creation of dams and irrigation systems on the surrounding area's landscape and archaeological sites, some of which now lie hidden beneath the present-day water level.

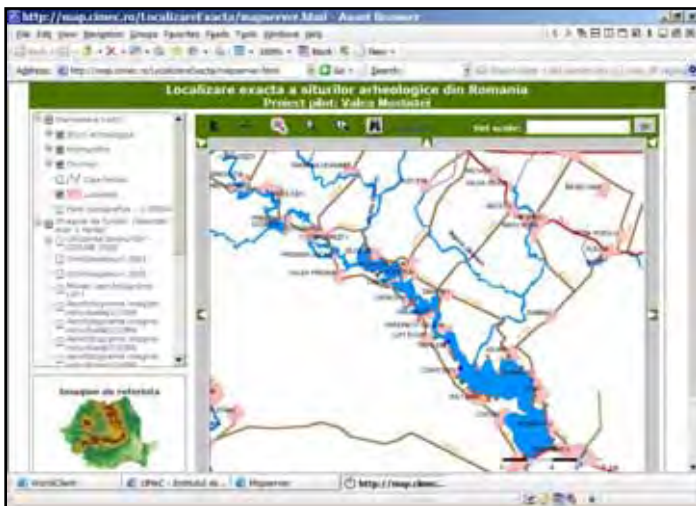
WEBGIS development

An important piece of work within the project was the development of WEBGIS methods for the collation, processing and public presentation of the resulting images and information. The system developed for the Mostiștea Valley uses Mapserver, a free internet software developed by the University of Minnesota, originally with support from NASA (which needed a way to make its satellite imagery available to the public). Mapserver software has the advantage of being open-source and highly customizable. The Institute chose to develop and customize Mapserver using ASP.NET technology from Microsoft, Microsoft SQL Server as DBMS and JavaScript.

The resulting system for the Mostiștea Valley provides tools to search, query, display and print maps and air photographs of archaeological sites from the internet through an easy-to-use interface, as well as to overlap foreground layers over a variety of background information (air photos, orthophotos, elevation models) and to measure distances and areas.

The spatial database contains:

- General data about the geography of the Mostiștea Valley (rivers, lakes, roads, elevation, land-use and land-cover) at a scale of 1:100,000 with a temporal resolution 1997-2000. The data was provided by the Ministry of Environment and Sustainable Development.
- Detailed topographical maps at scale of 1:25,000 with a temporal resolution 1978-1980, from the National Military Topography Service.



WEBGIS screen from the system developed as a principal component of the Culture 2000 project, with a typical historical map and air photos from 1977 and 2007 of the Latène settlement at Piscul Caldărean.

- Air photographs in grayscale at a scale of 1:15,000 with temporal resolution 1972, 1977 and 1986, from NCGCPRS.
- Orthophotos at a scale of 1:5000 with temporal resolution 2003 and 2005, from NCGCPRS.
- Landsat satellite imagery with spatial resolution of 30 m and temporal resolution 2000-2002, from Global Landcover Facility.
- Archaeological sites classified by period, category and archaeological culture.

The preliminary results of this development, along with further information about the system and its creation, are available on the Institute's website at <http://map.cimec.ro>.

Overall assessment of the project

The project has produced a substantial improvement in archaeological knowledge and has clearly demonstrated the potential of aerial photography, in combination with other methods, to record known sites, to discover new ones and to contribute to their future conservation and enjoyment by providing information about them to officials, cultural resource managers and the general public. The project has also enabled the Institute's staff (principally Irina Oberländer-Târnoveanu, Carmen Bem, Ionuț Șandric and Bogdan Șandric) to establish a network of aerial archaeology contacts and co-operation across Europe. Despite the modest funding there has been steady progress in learning how to use aerial photography in the investigation, recording monitoring and conservation of Romania's archaeological and landscape heritage.

SLOVAKIA: PUBLIC PRESENTATION OF A STONE AGE PHENOMENON

Dr Ivan Kuzma, for the Archeological Institute of the Slovak Academy of Sciences

Background and objectives

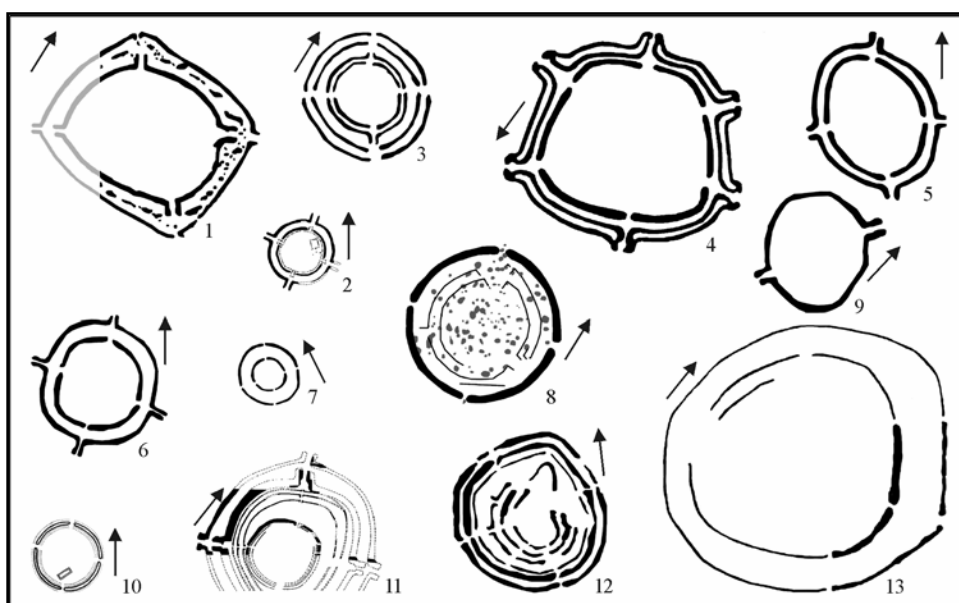
The great stone circle at Stonehenge, in southern England, dating from around the third millennium BC, is one of the world's most famous prehistoric monuments. But significantly earlier, around 6800 years ago, prehistoric societies in Central Europe started to create timber circles enclosed by monumental circular ditch systems. These oldest known monumental structures in Europe have been revealed through aerial survey in Austria, the Czech Republic, Germany, Hungary, Poland and Slovakia. Many of them are sited on fertile loess or on sandy soils and today they are under massive threat of destruction, dramatically accelerated by the intensive agricultural use and industrial transformation of the modern landscape.

The Slovak part of the Culture 2000 project, promoted by the Archeological Institute of the Slovak Academy of Sciences, took as its focus these circular enclosure systems in the south-western part of Slovakia, mostly around Nitra, an area particularly rich in archaeological sites.

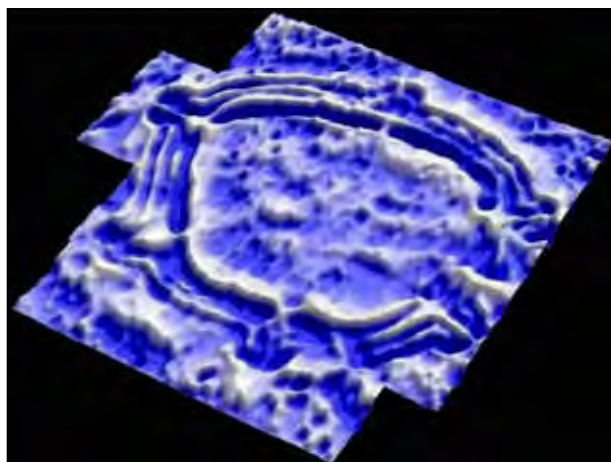
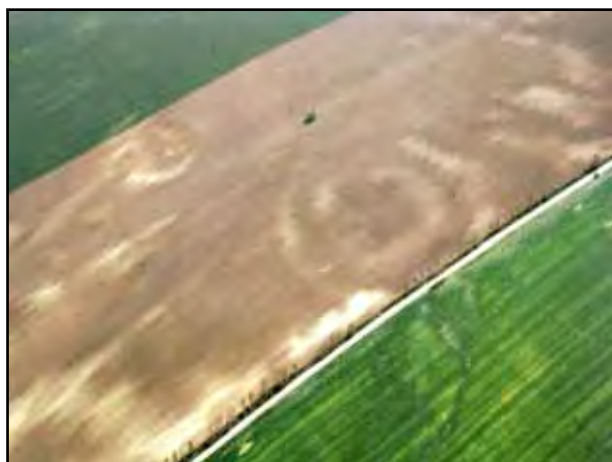
The main objectives of the work were:

- To use aerial survey and related methods of remote sensing, along with ground-based survey, to illustrate the known sites and to discover previously unrecognised examples.
- To present the monuments and their interpretation to the general public, using new technologies made possible by the Culture 2000 funding.
- To engage in discussion with Culture 2000 co-partners about the interpretation of the Slovakian evidence and the wider European phenomenon.
- To train young archaeologists in aerial survey and thereby contribute to the preservation of these remarkable features of the shared European cultural heritage.

Aerial exploration throughout the project revealed many new archaeological sites and the resulting data were prepared for analysis and public presentation. Discussions were held with specialists throughout Europe and Slovakian students and young research workers took part in various aspects of the project, including active aerial photography.



Plans of Neolithic circular timber structures in Slovakia, the principal subject of aerial exploration and presentation work within the Culture 2000 project.



Air photographs, geophysical data and excavations across the massive ditches of the Golianovo site.

Aerial photography, field survey and geophysical prospection

Aerial survey is one of the most effective methods of archaeological investigation. When combined with innovative technologies such as digital aerial photogrammetry and high-resolution magnetic prospection, as within the Culture 2000 project, the technique becomes even more effective.

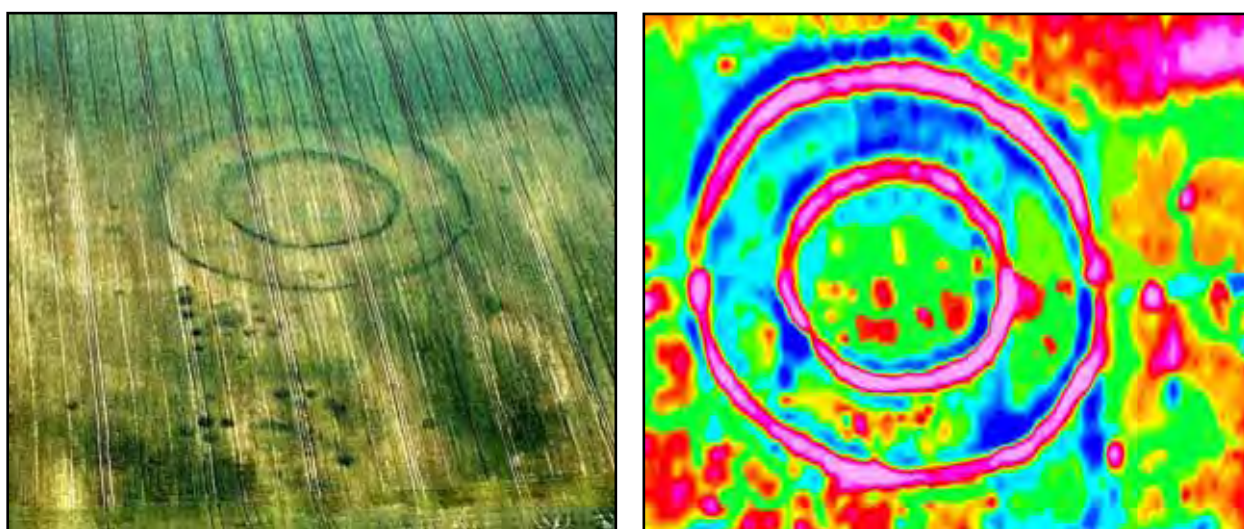
Before aerial survey only a small number of circular enclosures were known in Slovakia, as a result of traditional field survey. By the end of the Culture 2000 project, with its programme of aerial survey, more than 60 are known, 20 of them in the chosen study area close to Nitra.

During the project systematic aerial survey was undertaken in flights over western Slovakia. Many known archaeological sites were photographed, along with approximately 120 entirely new features, including 15 new circular enclosures. Field-walking and geophysical prospection on selected sites, using a caesium magnetometer, produced excellent results in most cases. Cataloguing, indexing and archiving of the air photographs (taken in digital format throughout) has been completed and preparation of the air-photo database is well advanced, along with the archaeological interpretation and mapping of selected sites.

The enclosures range from 30 to 300 m in diameter. Some of the more simple ones, especially those that are oval in shape, may date to the Bronze Age, along with circles from 5 to 20 m in diameter, which probably served funerary functions in the Bronze Age or later periods. It seems fairly certain, however, that the double and multiple circular features with diameters of more than 60 m belong predominantly to the Neolithic period, and in particular to the Central European Lengyel Culture. Not all of them, however, have produced datable finds from



Air photograph, geophysical plot and plan of the quadruple-ditched site at Cífer, in Trnava district. Its layout suggests that it may have been built in two phases, each consisting of two ditches.



Air photograph and caesium magnetometer survey of the relatively simple double-ditched site at Kľačany in Hlohovec district, its two ditches measuring respectively 35m and 62m across.

excavation or surface collection. Verification by excavation is problematic in structures of this size. The assumption that small-scale excavation might not give clear-cut results was confirmed, though there were enough finds in most cases to support the general dating.

Data processing and interpretation

The data from aerial reconnaissance, terrestrial survey and geophysical prospection, along with topographical and land registry information, were entered into the Institute's GIS to facilitate the standardised mapping and interpretation of the various sources of information. The local environment of the circular monuments was then examined through the thematic layers of the GIS, focusing on the inter-site analysis of water supply, site characteristics, mutual visibility, settlement patterns, sustainability and agricultural potential.

These spatial analyses, already well advanced for some of the sites, may contribute significantly to a better understanding of their function (or functions) and significance to the societies of their time. It will be interesting, for instance, to investigate the mutual visibility of sites in relation to the orientation of their gates and internal features. Such analyses and interpretations, however, have limitations, both because of the methods used and because of the quality and quantity of the input data. The basic and necessary assumption – not always capable of verification – is the simultaneous existence of structures which lie technically within sight of one another.



Public presentation

Work within the Culture 2000 project has been used to develop functional interpretation models. Based on prospection and excavation data, standardised datasets have been used to create virtual reality models, of which one is illustrated above. These have been produced at differing degrees of detail for use in virtual simulations and presentations to research workers, schoolchildren, young adults and the general public. Some of the results will shortly be placed on the Internet, in a site under preparation for the Institute, with a home page for scientific and public access and a virtual exhibition.

Broadcasting companies have been invited to document and popularise the project and to explain the place of these fascinating Stone Age monuments, both in Slovakia and in the broader European context. The film made within the Czech part of the project, in close cooperation with the Slovak team, will also be offered for transmission in Slovakia.

Meetings and specialist discussion

The function of the circular enclosures has been widely debated for more than two decades, as has their relationship with the later phenomenon of timber circles, henges and palisaded enclosures in Britain. The project leader, Dr Ivan Kuzma, has contributed discussions of the circular enclosures and their interpretation, both regionally and as part of a pan-European phenomenon, to local and specialist journals in Slovakia, Poland and Germany. He also wrote on the subject (with Dr Jan Tirpák) in a special issue of *Contributions to Geophysics and Geodesy*, published in Bratislava in 2005 and made a later contribution in the published *Proceedings of 7th International Conference on Archaeological Prospection*, held at Nitra in September 2007. This conference, organised by the Dr Kuzma and his Culture 2000 team, attracted 99 participants from 23 countries, from as far apart as Australia and Russia, the United Kingdom and Japan.

Discussions have been held with specialists at various meetings associated with the Culture 2000 project. Contributions and contacts have also been made at meetings of the Aerial Archaeology Research Group, at the Archaeological Prospection conference at Rome in 2005 and at the final meeting of the Culture 2000 co-partners in Prague. Slovakian material was also presented in the major exhibition opened at the Czech National Museum in October 2007.

General assessment of the project

The main objective of the Slovakian part of the project was the popularization of these oldest European monuments in their context as an early pan-European socio-ritual phenomenon. The Culture 2000 funding helped the Institute to fulfil these aims, especially through the use of new technologies in processing and interpreting the data and in presentation of the results to the general public. Also important were the consultations at the European scale with other project partners. Last but not least the project allowed the training of young Slovak archaeologists in aerial survey – a contribution to the future of our shared European cultural heritage.

FLIGHTS INTO THE PAST

Landscape history and discoveries from the air

Exhibition at the National Museum, Prague, Czech Republic, October 2007-January 2008

International exhibition on aerial survey and landscape exploration

It was always intended that the Culture 2000 project would end with a final exhibition on aerial archaeology and the work undertaken by the Culture 2000 co-partners. This was initially programmed for London but when an offer was received, through the good offices of Dr Martin Gojda, the venue was changed to the prestigious National Museum of the Czech Republic, in the heart of Prague. The Museum's 'special exhibition' hall was only available for the three months from late October 2007, necessitating a revision of the project start and finish dates so as to run from October 2004 to 31 October 2007 (instead of 1 September 2004 to 31 August 2007). The exhibition itself was programmed for 23 October 2007 to 13 January 2008.

Preparation of the exhibition

The content and preparation of the exhibition was overseen by Dr Martin Gojda, of the University of West Bohemia, the bulk of the cost being met from the project's 'Action 9' funds. All of the co-partners contributed material to the exhibition, which was professionally designed by Jan Polasek and mounted with great skill by the Museum's exhibition staff under the leadership of V Slunečko. Introductory text and captions were presented in both Czech and English, as was a well-illustrated 32-page guide. The exhibition was opened on 23 October 2007 in the presence of the Culture 2000 co-partners, many dignitaries and a host of guests. The final meeting of the Culture 2000 co-partners took place at the Museum the following day.

The exhibition will remain in Prague until 13 January 2008. Discussions are in hand about its possible re-mounting at other venues, both inside and outside the Czech Republic.

Format and content of the exhibition

The aim of the exhibition is to acquaint the general public with the benefits of aerial survey and air photography in exploring our ancestors' past. The basic principles and methods of 'aerial archaeology' are explained, and emphasis is placed on aerial prospection as one of the most important 'non-destructive' methods of archaeological investigation. The items on display include the work of the Czech Academy of Sciences, the University of West Bohemia, key contributors to the growth of aerial archaeology throughout Europe, and of course the Culture 2000 co-partners. The exhibition also aims to draw attention to the importance of the shared archaeological heritage and the need to protect and preserve it within the historic and present-day landscapes of Europe.

Topics main topics in the exhibition are as follows:

- Discoveries from above – 'aerial' discoveries throughout Europe and the methods through which they were made
- The historic landscape – its visible as well as its hidden or half-hidden aspects
- Discovering the invisible – traditional and modern techniques of exploration from the air:
- The history of aerial survey – from balloon photography to airborne laser scanning
- What to do with the image data? – processing, archiving and understanding the aerial data
- How and where to learn about aerial archaeology – teaching and research throughout Europe
- A mosaic of European projects – the work of the Culture 2000 co-partners

Facing page: Invitation card, opening ceremony and pictures from the exhibition.



WHAT ELSE?

Spin-Off Activities and Associated Events

Associated events

In several cases members of The Culture 2000 'team' instigated or facilitated events funded largely from outside the Culture 2000 project. In addition to advice and experience, the project was able to offer small grants to students for attendance at such meetings, for example an aerial archaeology workshop at the British School al Rome in November 2004, mainly funded by grants from the Aerial Archaeology Research group (though contributions from the Association for Cultural Exchange and the British Academy).

Aerial archaeology in Denmark, Holland, Ireland, the USA and Syria

In recent decades air photography has been little used in Denmark despite excellent results in the past. As a result of participation in Culture 2000 events, archaeologists in Denmark are now planning a self-financed training school in 2008 or 2009. Similar ideas are under discussion in Holland, and 'national' aerial archaeology groups have been formed in both countries as a direct result of involvement in Culture 2000 events. Two of the training schools attracted participants from Ireland, where there is a growing interest (but as yet little active work) in air photography and aerial archaeology. An archaeologist from the USA, already working on aerial observation in America, attended the UK training school in July 2006. A Hungarian team-member has also been fostering the idea of archaeological air photography in Syria while working there as a direct result of experience gained during the Culture 2000 project.

Expanding the European network

Culture 2000 events have helped to boost membership of the Aerial Archaeology Research Group. After a cull of lapsed members in 2004 the Group's membership stood at just over 100. By the end of the Culture 2000 project this figure had risen to nearer 200, with a progressively increasing proportion of members now drawn from various parts of continental Europe. The Group's meetings and twice-yearly newsletter keep members of the European network in touch with one another and with latest developments in heritage-based aerial studies.

Other indirect results from the Culture 2000 project

As a result of cooperation between three of the project's most active members (also involved in an earlier Culture 2000 project in 2001), the first Italian-language book on exploratory air photography was published in Florence in 2005. A book of essays and articles on aerial archaeology was also published in Poland with the help of small but significant financial assistance from the Culture 2000 project and the Aerial Archaeology Research Group.

In partnership with a member of the research team in another Culture 2000 project (on the Roman Frontier in Europe), a successful session on landscape archaeology was organised at the 2007 meeting of the European Association of Archaeologists at Zadar, Croatia, prompting an invitation to organise a similar session at the World Archaeological Congress in 2008.

A Romanian archaeologist who attended several of the Culture 2000 training schools and workshops has subsequently made contacts and started aerial survey work in other parts of Romania. He has also been invited to take part in exploratory flights in Hungary.

Students from several European countries who first made contact through Culture 2000 events have spent time in the UK receiving advanced training by Rog Palmer, one of the most stalwart (but unpaid) supporters of the Culture 2000 project.



Culture 2000

EUROPEAN LANDSCAPES

past, present and future



HIGHLIGHTS 2004-2007

Belgium Air photographs uncover the battlefields of Ypres

Czech Republic Air survey, excavation and a grand exhibition

English Heritage Air photo training schools at home and abroad

Estonia Estonian archaeologists take to the air

Germany (Mecklenburg-Vorpommern) Seeing beneath the waves

Germany (Baden-Württemberg) Iron Age fortresses in their landscape setting

Germany (Freiburg) Airborne laser scanning to 'see through the trees'

Hungary Combining techniques to explore the Neolithic

Italy (Puglia) Uncovering and mapping the past through aerial survey

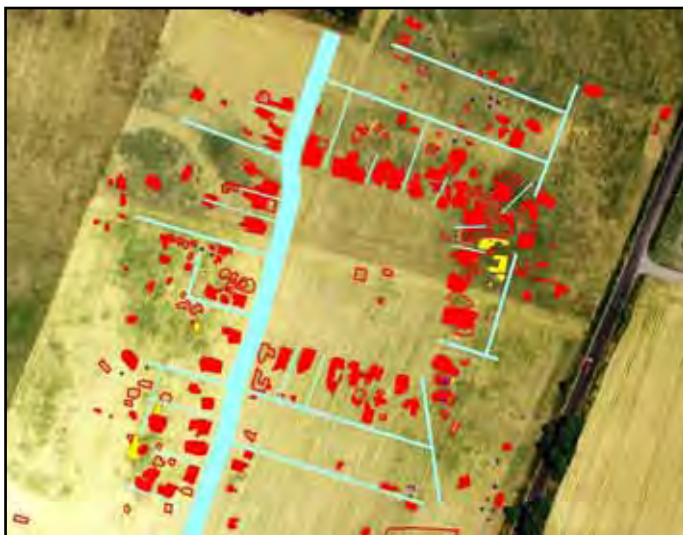
Italy (Salento) Modern techniques and a Roman harbour

Italy (Tuscany) Air survey, laser scanning and geophysics

Lithuania Raising awareness through aerial archaeology

Poland New discoveries and new systems for heritage conservation

Slovakia Stone Age monuments from the air and on the ground



A LOST TOWN RE-FOUND

Szamotły, in Poland is a medieval town, its originally open market square now filled with later buildings (top). Until recently historians believed that the town always occupied its present site. This view changed dramatically in July 2006 when spectacular air photographs, taken as part of the Culture 2000 project, revealed its original location at Mutowo, 2.5km away, where it had stood before a disastrous fire in the 14th century. One of the photographs is shown here (centre), rectified to fit the present-day map. In the bottom image the town's large open square, outlined by the dark marks of cellars beneath its surrounding buildings, has been plotted on the rectified photograph, along with the presumed lines of the linking streets.