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**The complete Final Report or individual reports from partners can be downloaded from:**

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<http://www.muzarp.poznan.pl/EuLandscapes/EuLandscapes/index.htm>

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# 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.

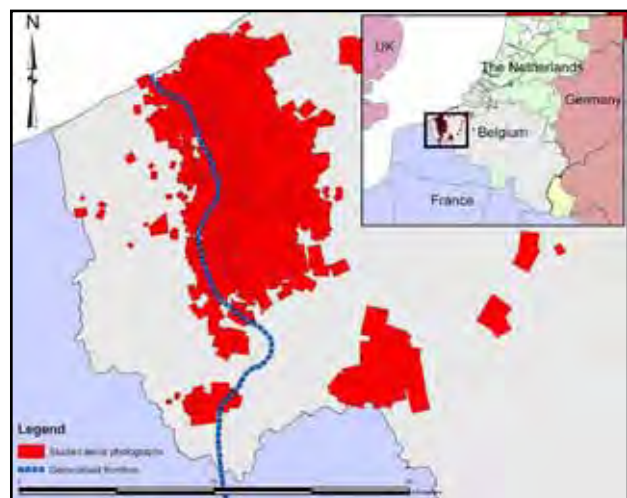
The specific aims of the Belgian contribution to the Culture 2000 project were:

- 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

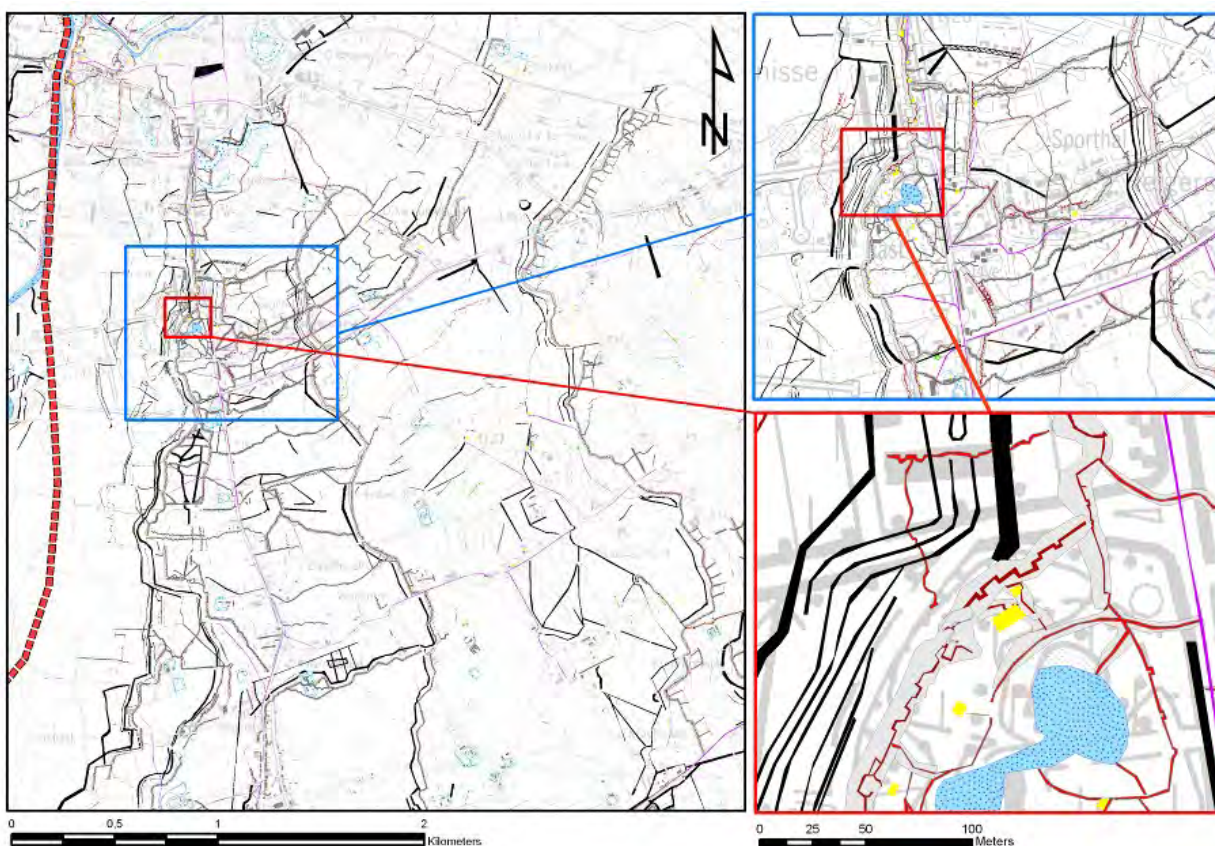
The main photo-source in Belgium is the collection of the Royal Army Museum in Brussels (KLM/MRA) which holds 48,484 WWI air photo prints, stored in 365 boxes against 1928 place-names (of cabarets, crossroads, farms, toponyms, roads, trenches and miscellanea). Research was undertaken to make a geographical 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.*

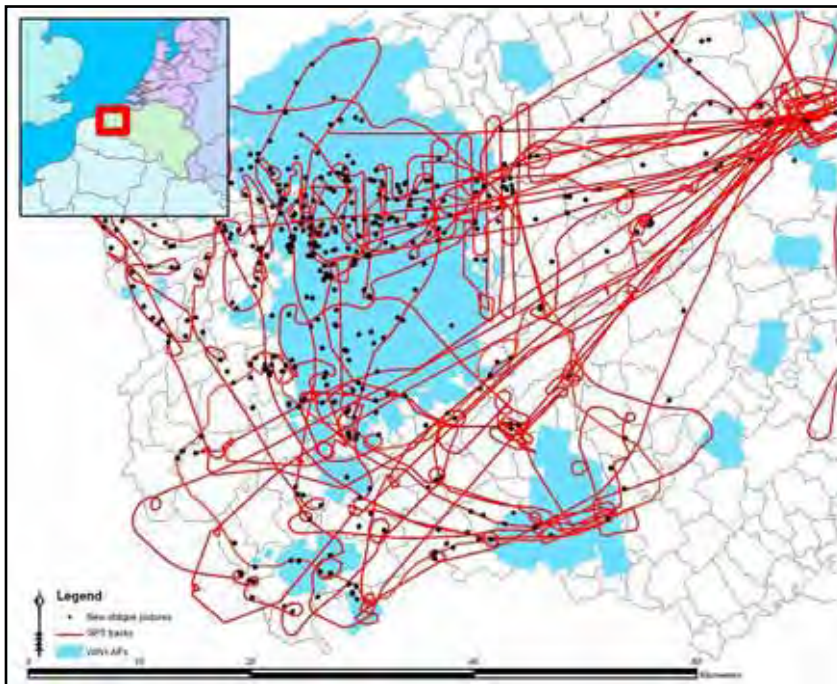
(about 800 prints). In addition, air photographs emerge at times in other records, such as the 'Moscow Archive' of the KLM/MRA, containing about 400 photographs not apparently represented in the main collection. There are also vast numbers of pictures taken by other forces over Belgian soil, now stored 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 km<sup>2</sup> 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.



### 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

Szamotuly, 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.

