Photogrammetrie • Fernerkundung • Geoinformation 3/2009, S. 235–244

The Aerial Imagery of World War One: A Unique Source for Conflict and Landscape Archaeology

Birger Stichelbaut & Jean Bourgeois, Ghent, Belgium

Keywords: Historical aerial photography, conflict archaeology, World War One

Summary: During World War One, for the first time, aerial photography rapidly developed as an intelligence tool that saw large-scale application by all fighting nations. Large numbers of these photographs have survived in archives all over Europe, the United States and even Australia. These are a remarkable primary record of the progress of World War One, as well as being a unique record of the landscape at the beginning of the 20th century, and a valuable source of data for any archaeologist, landscape historian or cultural resource manager. This paper briefly describes the results of a large-scale archival research project that has created a GIS-based index to the geographical coverage of this imagery, supported by a quantification and characterisation of these collections. In addition to the overview of the archives, a large case study is presented herein which illustrates the potential application of this material in archaeology.

Zusammenfassung: *Die Luftbilder des ersten Weltkrieges: Eine einzigartige Quelle für Konflikts- und Landschaftsarchäologie.* Während des Ersten Weltkrieges entwickelten sich erstmals Luftaufnahmen zu einem Mittel der militärischen Aufklärung, welches von allen beteiligten Nationen rasch in großem Umfang genutzt wurde. Eine große Anzahl dieser Bilder sind noch heute in Archiven in ganz Europa, den Vereinigten Staaten von Amerika und sogar Australien zu finden. Diese Fotografien sind zum einen bedeutende Zeugnisse, die den Verlauf des Ersten Weltkrieges dokumentieren, zum anderen halten sie auf einzigartige Weise die Gegebenheiten der Landschaft zu Beginn des 20. Jahrhunderts fest und stellen so eine wertvolle Quelle für jeden Archäologen, Landschaftshistoriker oder Kulturschützer dar. Dieser Artikel beschreibt kurz die Ergebnisse eines weitreichenden Forschungsprojektes in Archiven, in dessen Rahmen ein auf einem Geo-Informations-System (GIS) basierendes Verzeichnis über die geographische Verteilung der Bilder entstand. Hierbei wurde eine Quantifizierung und Charakterisierung dieser bildlichen Sammlungen durchgeführt. Neben einer Übersicht über die Archive wird außerdem eine umfassende Fallstudie präsentiert, in der eine potentielle Anwendung des bildlichen Materials sowohl in der traditionellen als auch in der Konflikt-Archäologie gezeigt wird.

1 Introduction

Following the First Battle of the Marne (5th to 11th September 1914), the character of World War One changed from a mobile war to a standstill in the trenches. Thus, both the strength and potential of the new weapon in the air were soon recognised. Before long, pilots and observers became the new eyes of the army, a role previously held only by the cavalry and espionage (Carlier 1921). Progress was made on both the technical aspects of aerial photography and the art of interpreting photographs taken from the air.

From the end of 1915 onwards, along the Western Front, photo-reconnaissance units were sent out on a regular basis for different purposes, but mainly to record the line of the

DOI: 10.1127/0935-1221/2009/0018 0935-1221/09/0018 $ 2.50

enemy's defences. Most aerial photography was aimed at the first lines or positions of defence, although a lot of strategic missions were carried out to gather information from far behind enemy lines.

Aerial reconnaissance work on the Western Front was conducted by various nationalities. The resulting, almost industrial, products, collected over four years, survived in large quantities and archival collections are spread throughout Europe, the United States and Australia.

In many archaeological papers, the importance of the Great War as regards the development of aerial photography is often acknowledged, but without going into too much detail (Bewley 2005). This is rather curious since the father of archaeological aerial photography, O.G.S Crawford, was engaged in photographic reconnaissance missions along the Western Front in France and Belgium (Crawford 1955). In the inter-war period, he subsequently used his experience to convert aerial photography into a standard archaeological prospection method, and even announced that "*the invention of aerial photography would be to archaeology what the invention of the telescope was to astronomy*" (Crawford quoted in Hauser 2008). Furthermore, aerial reconnaissance during World War One has always been overshadowed by – in the eyes of the public – the heroic battles involving fighter pilots such as Ball, Guynemer or von Richthofen. Until recently (see, e.g., Finnegan 2006), World War One aerial reconnaissance has rarely been studied in its entirety.

No one ever considered looking at the overall picture of what aerial photographs have preserved, mainly because, until recently, the images have only been used as illustrations rather than as a primary source. Consequently, the archives contain hidden potential, or, as Bewley and Raczkowski put it: "*Unlocking these* (hidden) *archives is perhaps the single most important development which would dramatically improve our understanding and knowledge of Europe's historical environment*" (Bewley & Raczkowski 2002).

The research goals of this paper are diverse. First of all, the archival aspect of these forgotten resources will be explored to illustrate which aerial photographic collections have been preserved, in what quantities, and covering which regions of the Western Front. Secondly, different possible applications for the images are further explored in brief. Finally, a large case study in West Flanders (Belgium) is presented to illustrate what information can be collected by using a huge number of georectified historical aerial photographs as a means of contributing to the rapidly evolving field of conflict archaeology.

By unlocking different collections and illustrating their wide distribution and possible applications all over Europe, we hope to highlight the huge potential of these aerial photographs for authors in diverse research topics.

2 Large-scale Archival Research

If we consider the use of the images as a primary source for various disciplines, the importance of the archival aspect should be emphasised. Scholars wishing to study a particular area need to be aware that these collections are scattered among archives and museums. Understanding the principal goal of aerial photography – to gather intelligence about the enemy – indicates the need for a multi-archival approach, especially if the aim is to comprehend larger regions rather than particular sites.

A survey of accessible collections of aerial photographs dating from World War One has revealed that many have been forgotten or hidden away in filing cabinets – literally hundreds of thousands of pictures have survived. For the most part unaffected by the ravages of time, they are currently kept in miscellaneous archives. The large numbers of preserved pictures are astonishing and allude to the real importance of aerial photography during World War One. This is perhaps best illustrated in popular magazines published shortly after the conflict, such as *Popular Mechanics,* in which aerial photographs (and their interpretation beneath a stereoscope) are even described as the "*deadliest weapon of the war*" (Finnegan 2006).

The collections which have been studied are briefly summarised with particular mention being made to the diverse methods used to reference and catalogue them.

Belgian Royal Army Museum
The 'Collection Photos Aériennes '14–'18' (Aerial Photo Collection '14–'18'), stored at the Belgian Royal Army Museum, is the largest in Belgium. The majority of the aerial photos were taken by the Aviation Militaire Belge (AvMB), or the Belgian Military Aviation during World War One. As a consequence, the distribution of the photographs is broadly limited to the area between Nieuwpoort (Belgium) and the northern part of the Ypres salient, the front held by the Belgian army.

Imperial War Museum
The aerial photo collection in the Imperial War Museum (IWM) is referred to as the 'Box Collection' and (before the detailed archival research) was said to hold more than 80,000 glass-plate negatives of 1914–1918 aerial photographs (IWM 2007, Watkis 1999). The collection is accessible though a card-index drawer which is keyed to the GSGS (Geographical Section of the War Office General Staff) sheet numbers of the 1 : 40,000 series of trench maps. Because of their tactical and strategic use, the maps were provided with a reference grid (24 squares by 6,000 yards wide) allowing the accurate positioning of structures. This exact grid is still in use at the IWM to classify the pictures by year and location. The entire collection was quantified by counting the aerial photographs on the index cards. This resulted in an estimated 133,288 unique glass-plate negatives of vertical aerial photos (1915: 2,472; 1916: 14,001; 1917: 52,7377; 1918: 64,078) covering France and Belgium. This number is significantly higher than the numbers put forward by the IWM (2007) and Watkis (1999) and underlines the need for detailed archival research.

Australian War Memorial
Few researchers are aware of the existence of the major collection of historical aerial photographs at the Australian War Memorial (AWM) in Australia. This collection had already been compiled during the war and in the 1920s by the Australian War Records Section to document the Australian battlefields. The collection, which contains 16,030 aerial photographs, is accessible in the same way as the Imperial War Museum's 'Box Collection' – that is, by means of the contemporary GSGS trench map sheet references.

Bayerisches Hauptstaatsarchiv
The only still existing sizeable German aerial photographic collection was found at the Bayerisches-Hauptstaasarchiv (Abteilung 4: Kriegsarchiv): the 'BS-Aufklärung' (Photo-reconnaissance Collection). A. Fuchs, the former director of the archives, states that: *"one can hardly estimate the number of aerial reconnaissance pictures"* and also *"the number of photos is in the six figures"*(Fuchs 2000). The collection contains approximately 300,000 printed aerial photographs, catalogued by unit (mainly Bavarian *Fliegerabteilungen*) which took the aerial photographs. The 'BS-Aufklärung' is only described to a certain degree in the collection's finding aid. This document describes the most prominently photographed place names and indicates the core of the geographic distribution of what remains of German aerial photographs. It consists of 127 large box files, each containing huge numbers of aerial photos. The aerial coverage relates mainly to Belgium and France. For a detailed overview of other German collections, we refer to the research of P. Haupt (Haupt 2009).

US National Archives
A collection of World War One aerial photographs can also be found at the US National Archives and Records Administration. The guide to the archives (Matchette 1995) refers to the records of the American Expeditionary Forces (AEF) as Record Group 120. Within the records of the 2nd Section of the General Staff (GHQ AEF), Intelligence Section, an aerial photographic collection is briefly described as *"American, French, and some German aerial photographs and index maps relating to the Western Front, 1917–19 (16,291 items)*"(NARA 2008). These aerial photographs date from 1918 (the battle of St Mihiels and the Meuse-Argonne offensive) and 1919 (US occupation of the Rhineland and some of the former 1918 battlefields).

Archival patchwork
In order to gain a full understanding of this archival patchwork of aerial coverage, one major goal was to shed light on the combined

Tab. 1: Summary of aerial photographic collections.

	Number of archived aerial photographs
Belgian Royal Army Museum	48,511
Imperial War Museum	133,288
Australian War Memorial	16,030
Bayerisches Hauptstaatsarchiv	approx. 300,000
US National Archives	16,291

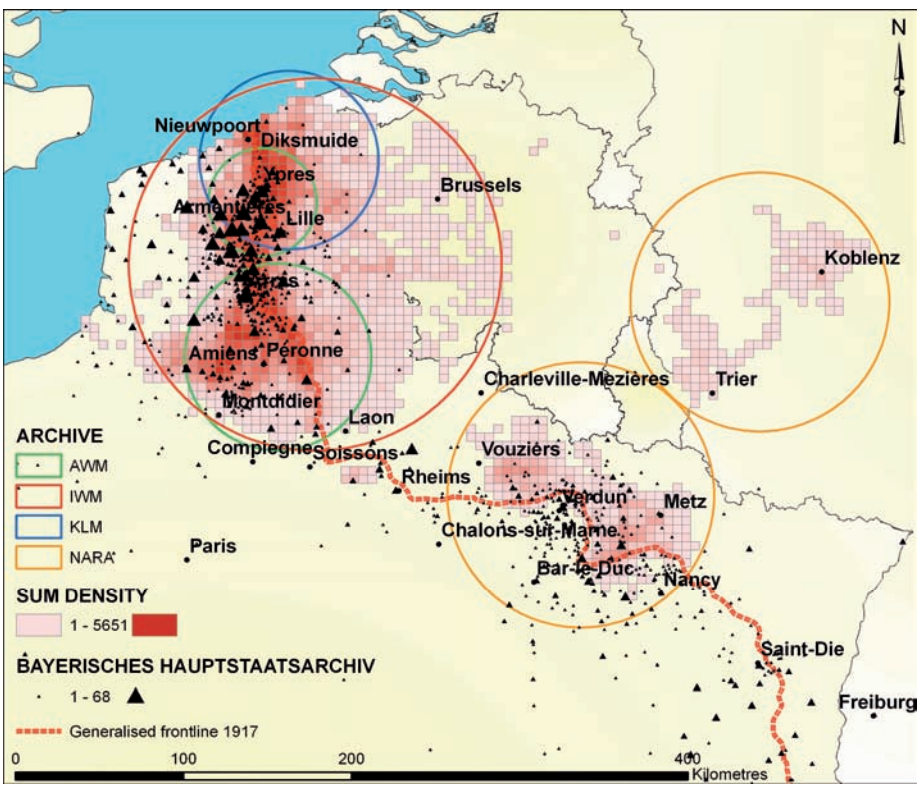

Fig. 1: Archival study of World War One collections of aerial photographs.

geographic coverage of all major aerial photography collections. This very useful tool enables users to determine which archives are of interest for particular areas in Europe. The aerial coverage of the collections has been indicated on a basic map of Europe, not only to give an idea of how these sources were dispersed throughout Europe but, where possible, to identify blind spots and hot zones to enable a realistic assessment of future research zones for a variety of disciplines.

The outcome was astonishing because the quantities of aerial photos preserved are enormous and much more consolidated than was expected. Several hundreds of thousands pictures could be tracked (cf. Tab. 1) in collections which form an archival patchwork of aerial coverage. Some archives have unique aerial photos for certain areas, while others overlap to a large extent. Although the overall picture has yet to be studied, in our opinion such an approach is essential for any further

research because it allows users to locate and identify specific aerial photographic coverage. All data has been transferred into the classification system used at the Australian War Memorial and Imperial War Museum because this forms a regular grid based on the GSGS trench map-referencing method.

The combination of this huge amount of information extracted by means of archival research all over the world, gives an unparalleled view of the availability of aerial photos. Immediately, three clusters can be observed (cf. Fig. 1). The first and largest group stretches from the North Sea in Belgium to Montdidier (France). This cluster comprises photographs of both warring parties, although the gravity point of the German pictures lies in the centre between Armentières and Arras (France). The shifting of the front lines during the war can be seen clearly on the grid. An additional remark concerns the situation of the German point locations on the western side of the front lines, while the Allied picture seems to focus on a larger area on both sides of the front line. Briefly, this cluster covers the western part of Belgium and the French regions of Nord-Pas-de-Calais and Picardy. The second cluster is mainly located in the Lorraine with some very limited coverage in the neighbouring regions (Champagne-Ardenne, Franche-Compte and Alsace). These areas are only covered by German and American aerial photos. The eastern limit of the cluster is only covered in German boxes of aerial photos. The third group of aerial photographs is American and is located in the Rhineland.

Equally important are the areas where aerial coverage is lacking. It is noticeable that there is somewhat of a gap between the largest clusters between Compiegne and Vouziérs (France). Both the Allied and German collections focus on other areas. This gap is linked to the absence of Bavarian army operations in the region; the collections of other German armies which were active in these areas were destroyed during Allied bombardments in World War Two. From the Allied point of view, the French front line ran from the Somme to the east. Since the French aerial photo collections are very dispersed and thus inaccessible (Beylot 2009), these areas can be considered as empty zones.

3 Application of the Sources: 'The First 30 Kilometres – Nieuwpoort to Houthulst Forest (Belgium)'

3.1 *Introduction*

The aerial photographs are a storehouse of information for the study of past landscapes and, as such, can be used for a variety of applications. A first and important application of these aerial photos is that they enable the detection of previously unknown archaeological sites. Artillery fire destroyed the parcelling and drainage in the field systems at the front. This, combined with the deliberate flooding of some rivers for strategic purposes, provided the ideal (humid) conditions for the detection of watermarks and earthworks. Literally hundreds of unknown medieval moated sites can be detected. For instance, in the centre of an aerial image (cf. Fig. 2), an excellent example of a previously undetected archaeological site can be observed as a large circular earthwork (watermark). In addition, many war features, such as trenches and barbed-wire obstacles, are visible on the photograph.

By examining aerial photos, it becomes quite apparent that most of the visible features are of a more recent nature and are connected to the Great War. They depict an industrialised war landscape from the North Sea in Flanders to the French-Swiss border. Two lines of field defences can be seen, divided only by a narrow stretch of land: no-man's-land. When we focus on the zones further away from the front line, we can see trenches providing places for artillery zones, embedded with gun pits and camouflaged positions. In addition, barracks, railways, ammunition dumps, wireless signalling sites, hospitals, railway stations and aerodromes make up the largest part of the visible features.

This brings us to the third and largest application of these aerial images for modern scholars: researching the war landscape by combining early aerial imagery and GIS. Because of the abundance of these resources, it is possible to study multiple front sectors at the same time, rather than being restricted to a site-oriented approach. By using GIS, all the relevant war features can be re-mapped on to

Fig. 2: Belgian aerial photograph of the front near Diksmuide (West Flanders, Belgium), also recording a previously unknown archaeological feature as a circular earthwork or watermark in the centre (source: Royal Army Museum Brussels).

modern maps. It is also possible to reconstruct and interpret this historic military landscape by interpreting the visible traces, locating and georectifying the aerial photos, and making an inventory of all visible features. Using spatial analysis techniques, we can learn more details about the distribution, density and diversity of all sorts of war features.

To examine the value of World War One aerial photography for the new and still developing field of conflict archaeology (Saunders 2002), an extensive area (443 km²) of the Western Front was chosen between the North Sea coast at Nieuwpoort and Houthulst in the south. This specific area was selected for several reasons. First of all, historic aerial photographs taken by different nationalities are both available and accessible in the Belgian archives. Secondly, the area chosen is interesting because the front line remained mainly static, with few large offensive actions taking place, which has facilitated the interpretation of the aerial photographs. The area studied is primarily the German front line, since there is no similar aerial photographic coverage of the Allied part of this front. Furthermore, the intention was to focus on the organisation of a front sector in depth, rather than only the first lines.

3.2 *Data Acquisition and Methodology*

In the study area, 4,270 aerial photographs (paper prints) were scanned and the information was transferred into a database. The pictures date from the period between April 1915 and October 1918. All aerial photographs were georectified using the ImageWarp 2.0 extension of ArcView 3.1 (second order polynomial transformation, 9–15 ground control points. This method was chosen because it is easy to use (for archaeologists) and does not require camera or lens parameters (which are simply not available). True orthorectification of the images is possible and has been explored (Stichelbaut et al. 2005). However, this requires a huge amount of work to locate GCPs on a landscape which was completely destroyed and transformed during and after the conflict. Therefore, this method is not cost efficient. It is simply not possible to use it for the

thousands of images which are needed to research an entire sector.

The choice of GCPs is crucial to the success of the georectification of aerial photos. This cannot be stressed enough when using historical aerial photos because there is a problem which might arise sometimes. At the heart of this matter is the large time lag between the shooting of the pictures and the reference maps used (scanned cadastral maps from 1997, with an accuracy of 1–5 metres to the 1 : 10,000 topographical map). This is made even more difficult because the images are located in a landscape where an industrialised war was fought. Artillery bombardments destroyed large parts of the landscape and field boundaries.

A high density of aerial coverage is particularly important for a comparative study of the aerial photographs. Although a lot of information can be retrieved from a single aerial photograph, much more can be retrieved by comparing multiple images. It is only when different pictures are compared that minor changes can be detected that give us detailed information on the nature, organisation and meaning of certain traces.

In addition to the comparative method, many aerial photographs have been studied using stereoscopy. In the large collections of historical images which were analysed, it is possible to find stereo pairs which were deliberately taken for stereo purposes. The intensity of the photo-reconnaissance missions from 1915 onwards, on both the Allied and German sides, forced the ground troops to conceal their field positions and intentions from aerial observation. To counter this ongoing war between aerial interpreters and the ground troops, a new technique was developed called stereoscopy. The invention of this was not new in World War One – the innovative aspect was the adaption of the method to aerial photography. The GIS and remote-sensing software package ILWIS 3.4 was used to create anaglyphs which were successfully integrated into the interpretation process.

Having interpreted the aerial photographs, all relevant traces of both traditional and conflict archaeology were digitised on screen as detailed polygons and dated as accurately as possible.

3.3 *Results*

The detailed study and interpretation of aerial photographs in the research area of 443 km² resulted in an inventory of 26,987 features of traditional and conflict archaeology (cf. Fig. 3). A selection of features has been discussed in order to analyse the structure, organisation and layout of the Great War landscape in the study area. The intention is not to give a detailed analysis of all feature categories, but rather to point to the importance and applications of World War One aerial photography in the field of conflict archaeology.

Trenches, which are perhaps a symbol of positional warfare during World War One, make up a large part of the recorded features. Large numbers of these features were constructed on both sides of the no-man's-land. The length of these defensive fire trenches (both Allied and German) totalled 416.59 km and were connected with no less than 252.3 km of communication trenches. The contemporary field manuals (i. e., Chef des Generalstabes des Feldheeres 1918) give an indication on which types of trenches were built. When comparing the aerial photographs with these manuals, it becomes clear that the aerial photographs show many unknown (sometimes experimental) local variations. Each of the fire trenches has been interpreted and fitted into a newly developed typology of this feature. The frequency of the trench types clearly shows that most of the trenches were constructed with square traverses. The total length of such features amounted to 204.9 km. The second largest group comprised trenches with round traverses, but the length of these was significantly lower (82.04 km). A similar typology has been developed for communication trenches. The majority of these features (75.91 km) has a zigzag trace although communication trenches with a sinuous trace, a straight trace and trenches with a straight traversed trace were also popular features in the area studied, measuring 43.02 km, 39.34 km and 36.83 km, respectively. In particular, the high frequency of straight communication trenches was surprising, because this type was clearly disapproved of in field manuals.

Discussion of the different types of trenches makes it clear that there was a large diversity

of trenches in the area studied. The interesting thing is that some trenches only occurred occasionally (which is important for the cultural management of this heritage) and sometimes even in a specific context such as excercise trench systems. The temporal aspect of the inventory makes it possible to date some trench lines to a certain extent. Soon after the Battle of the IJzer, both parties started to entrench themselves into the area, separated only by no-man's-land. In some areas, this stretch of land was wide (up to almost 2 km), while in other places Allied and German trenches were only 20 m apart. It is interesting to note that defensive positions were constructed with the same type of trenches. Trench lines with square traverses were made throughout the war, while trenches with semicircular traverses were chronologically earlier.

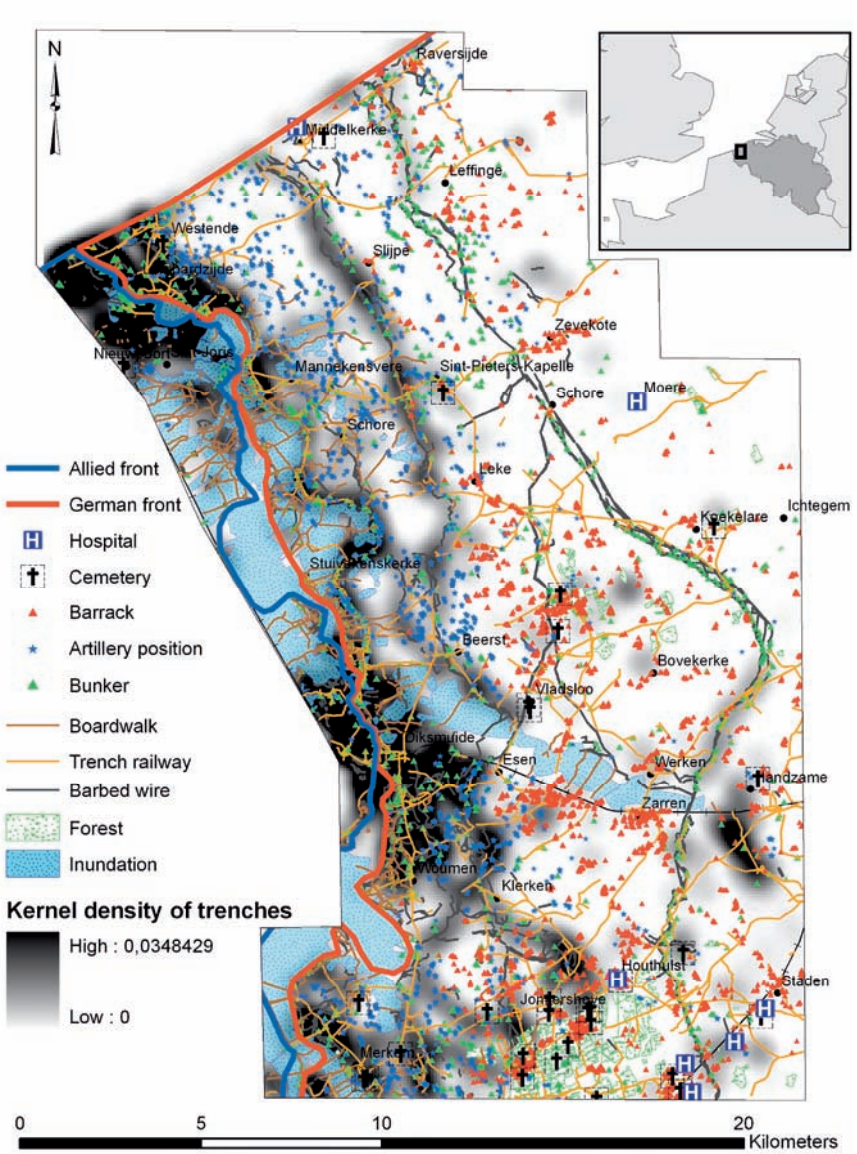

Fig. 3: Density and point distribution map of a selection of the recorded features.

Bunkers and barbed-wire entanglements were distributed in the front and rear areas. In both cases, they were arranged to form defensive positions. The entire defensive system consisted of lines of more than 1,700 bunkers with 510 km of barbed-wire entanglements in front of them. The early defensive positions consisted of a combination of trenches and bunkers. Later positions no longer included large numbers of trenches, reflecting the changing military doctrine.

Marshy landscapes covered with mud are an archetypal representation of the front lines. This generalisation is valid for a large part of the study area. Because of the inundation of the area between the IJzer River and the Diksmuide-Nieuwpoort railway, a large part of the landscape became practically inaccessible. To reach the outposts and advanced listening posts, situated on the higher ground in the flooded area, both sides constructed long wooden boardwalks (216.7 km) to connect them with the drier parts of the landscape. A network of narrow-gauge railways was constructed to facilitate the transportation of building materials (wood and concrete) and ammunition from the rear areas towards the front. Careful photographic interpretation reveals the complex nature of this network, which comprised 480.4 km of narrow-gauge railways in total. In many cases, these railways lead to the 2,680 artillery positions which were recorded. They also have a very diverse typology and are mainly situated between one and five kilometres from the front. Just behind this artillery area, 3,300 barracks have been identified. Their location was related to the presence of railways and woods, occurring mainly between four and nine kilometres from the Allied first line. In addition to barracks, there were seven hospital sites, also closely related to a railway, and clustered in the southern part of the front, closer to the more active front near Ypres where both armies suffered from higher casualties. Forty-two German war cemeteries were also observed, which is important because they have not been visible on the landscape since the 1930s, and in the 1950s were relocated into larger cemeteries in Langemark and Vladsloo.

The detailed analysis of the feature categories illustrates the individual character of smaller regions within the study area and the strong relationship between the network of military features and the landscape. For instance, the absence of a large trench density near the inundations, the location of defensive positions west of the villages, the construction of trenches with breast-works in the polders and wet area, the importance of strategic height for the location of trench lines, and the position of a large number of canvas screens on the flat polders to conceal troop movements from terrestrial observation can be quoted in this respect. It is also important to mention that the location of trench lines and the defensive positioning of bunkers was not always as might be expected when studying German war regulations. The aerial photographic interpretation shows that the real situation on the battlefield was often different to the "ideal battlefield" as described in the war manuals.

The overview and analysis of war features gives an idea of the distribution and density of features which were recorded on aerial photographs. Such an approach reveals how the Great War battlefield really was organised and where certain types of features were situated. Therefore, this kind of information and the maps provide a very useful tool for the cultural management of this type of heritage and the war landscape in Flanders.

4 Conclusions

A survey of accessible aerial photography collections in different countries has revealed the existence of sizeable collections from the Great War. Their existence is not widely distributed thus only a few specialised researchers have made use of these resources. We believe it is of the utmost importance to gain insight into these archival assets so that we can use these images in our methodologies. Rather than studying and discussing one collection, a brief overview of all the major collections is presented along with the distribution of their aerial coverage throughout Europe. By using GIS, it is possible to combine data from different sources into one layer of information. This layer indicates where, to what extent and in

which archives we can expect to find Great War aerial photos. We believe this provides research tools to locate specific aerial photographs from collections of several hundreds of thousands. These historical photos can be used for a variety of scientific applications, including the potential to detect 'new' but already destroyed archaeological sites, both as crop- and soil-marks. The pictures can reveal interesting information for historical geographers, such as, for example, land use, forestation, field systems, etc. The study of the Great War landscape and archaeological remains using GIS offers unique insights which cannot be achieved by means of other research methods. In some cases (such as isolated military features in the hinterland), aerial photos are the only resource available, while in other cases complementary information can be gathered using trench maps. But throughout all these examples we have the advantage of a bird's-eye view which provides a unique landscape-oriented research scale rather than a site-by-site approach.

References

Bewley, R., 2005: Aerial Archaeology. The First Century. – Aerial Photography & Archaeology 2003. A century of information, Academia Press, Ghent: 15–30.

Bewley, R. & Raczkowski, W., 2002: Future Development of Aerial archaeology. – Aerial archaeology. Developing Future Practice. NATO Science Series **337**, IOS Press, Amsterdam: 1–8.

Beylot, A., 2009: Military Aerial Photographs, from 1914 to the present. A survey of the French sources. – Images of Conflict: Military aerial photography and archaeology, Cambridge Scholars Publishing, Cambridge: 135–150.

Carlier, A., 1921 : La Photographie Aérienne pendant la Guerre. – Librairie Delagrave, Paris.

Chef des Generalstabes des Feldheeres, 1918: Allgemeines über Stellungsbau. – Druckerei des Chef des Generalstabes des Feldheeres, S.L.

Crawford, O.G.S., 1955: Said and Done: the autobiography of an archaeologist. – Wiedenfeld, London.

Finnegan, T.J., 2006: Shooting the front. – National Defence Intelligence College Press, Washington.

Fuchs, A., 2000: The Bavarian War Archive in Munich. – Over the Front **15** (2).

Haupt, P., 2009: Great War Aerial Photographs in German Archives: a Guide to the Sources. – Images of Conflict: Military aerial photography and archaeology. – Cambridge Scholars Publishing, Cambridge: 151–164.

Hauser, K., 2008: Bloody Old Britain: O.G.S. Crawford and the archaeology of modern life. – Granta Books, London.

IWM, 2007: Box Collection vertical photographic coverage (unpublished document). – Imperial War Museum, London.

Matchette, R., 1995: Guide to Federal Records in the National Archives of the United States. – National Archives and Records Administration, Washington DC.

NARA, 2008: Web version based on Guide to Federal Records in the National Archives of the United States. Compiled by Robert B. Matchette et al. Washington, DC: National Archives and Records Administration – www.archives.gov/research/guide-fed-records/groups/120.html (6/02/2008).

Saunders, N., 2002: Excavating Memories: Archaeology and the Great War, 1914–2001 – Antiquity **76:** 101–108.

Stichelbaut, B., Devriendt, D., Goossens, R. & Bourgeois, J., 2005: Reconstructing the past: the use of digital photogrammetry and GPS measurements for the study of the 1914–1918 wartime landscapes. – AARG Annual Conference, Leuven: 89.

Watkis, N., 1999: The Western Front from the Air. – Redwood Books, Wiltshire.

Address of the Authors:

Dr. Birger Stichelbaut and Prof. Dr. Jean Bourgeois, Ghent University, Department of Archaeology and Ancient History of Europe, B-9000 Ghent. Tel.: +32-9-264-41-06, Fax +32-9-264-41-73, e-mail: birger.stichelbaut@ugent.be, jean.bourgeois@ugent.be

Manuskript eingereicht: Dezember 2008
Angenommen: Februar 2009