FORGOTTEN AND LOST? ARCHIVAL RESEARCH OF AERIAL PHOTOGRAPHIC COLLECTIONS OF THE WESTERN FRONT 1914-1918

A Guide to the Archives

Birger Stichelbaut

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Front Cover Image: German aerial photograph of the Ypres Salient 1917, In Flanders Fields Museum

Abstract

Historical aerial photographs are an often overlooked source of information for archaeological, historical and landscape research. This monograph provides an overview and introduction to the collections which found their origin in the First World War and which are amongst the earliest systematic aerial collections. Along the Western Front from the end of 1915 onwards, aerial photo-reconnaissance units were sent out to record the outline of the enemy's defences. The photographs were produced by an almost industrial process, brought together over four years, and survive in large quantities; archival collections are spread out across Europe, the United States and even Australia. The most important and interesting collections are discussed, with a focus on their content, quantity, and geographic distribution.

Key Words

aerial photography, archive, archaeology, World War I, Western Front

Izvleček

Zgodovinske letalske fotografije so pri arheoloških, zgodovinskih in pokrajinskih študijah večkrat prezrt vir informacij. Monografija ponuja pregled nad kolekcijami, ki izhajajo iz prve svetovne vojne in sodijo med najzgodnejše sistematične zbirke fotografij posnetih iz zraka. Od leta 1915 naprej so vzdolž Zahodne fronte zračne opazovalne enote registrirale obrise sovražnikovih obrambnih položajev. Fotografije, ki so jih izdelovali v domala industrijskem obsegu in jih zbirali skozi širi leta, so se v velikem obsegu ohranile. Hranijo jih arhivi, ki so razprostranjeni po vsej Evropi, v Združenih državah Amerike in celo v Avstraliji. Opisane so najpomembnejše in najbolj zanimive zbirke letalskih fotografij Zahodne fronte, s posebnim poudarkom na njihovi vsebini, obsegu in geografski razprostranjenosti.

Ključne besede

letalske fotografije, arhiv, arheologija, Prva svetovna vojna, Zahodna fronta
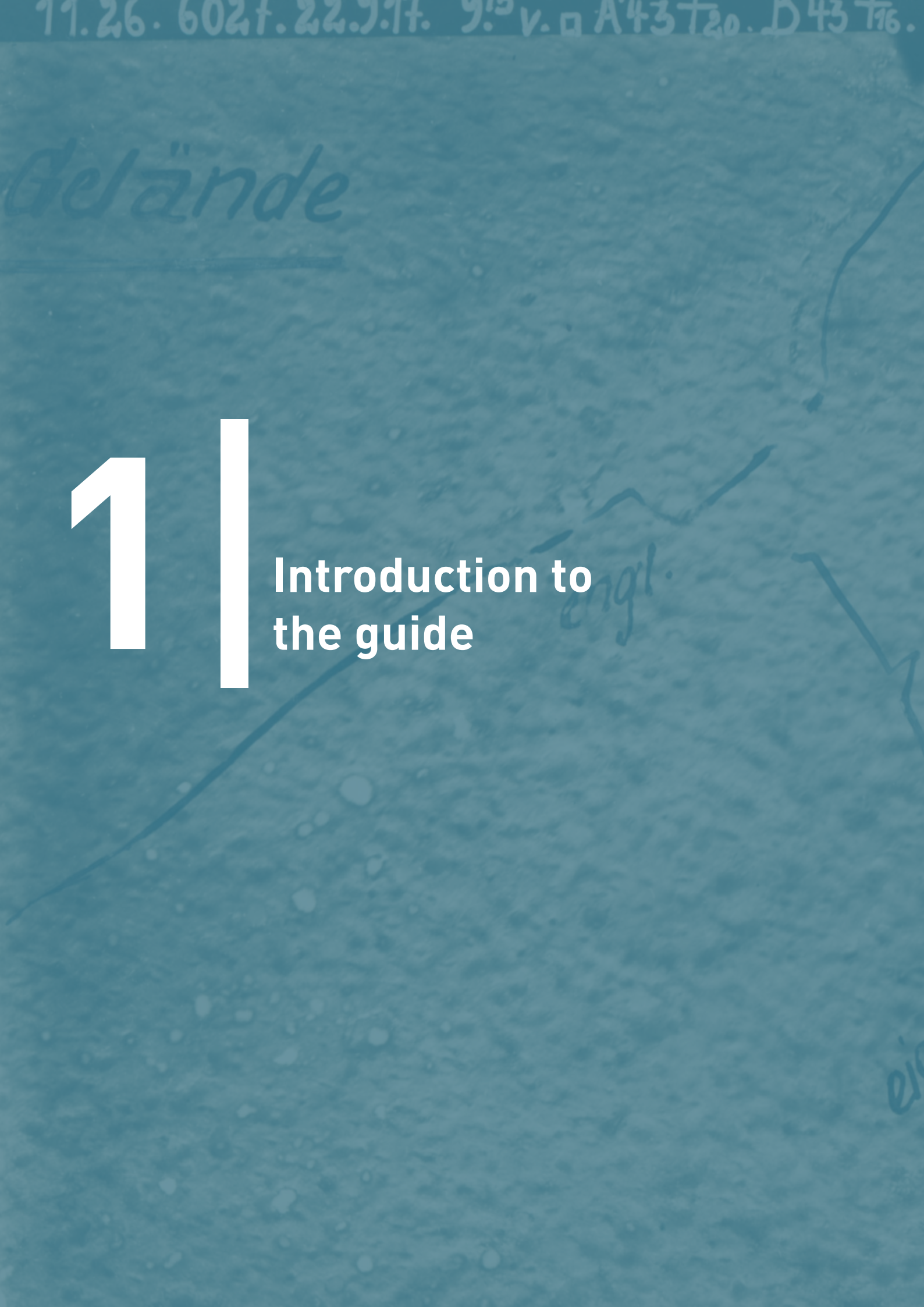
Contents   Pages

1 | Introduction to the guide

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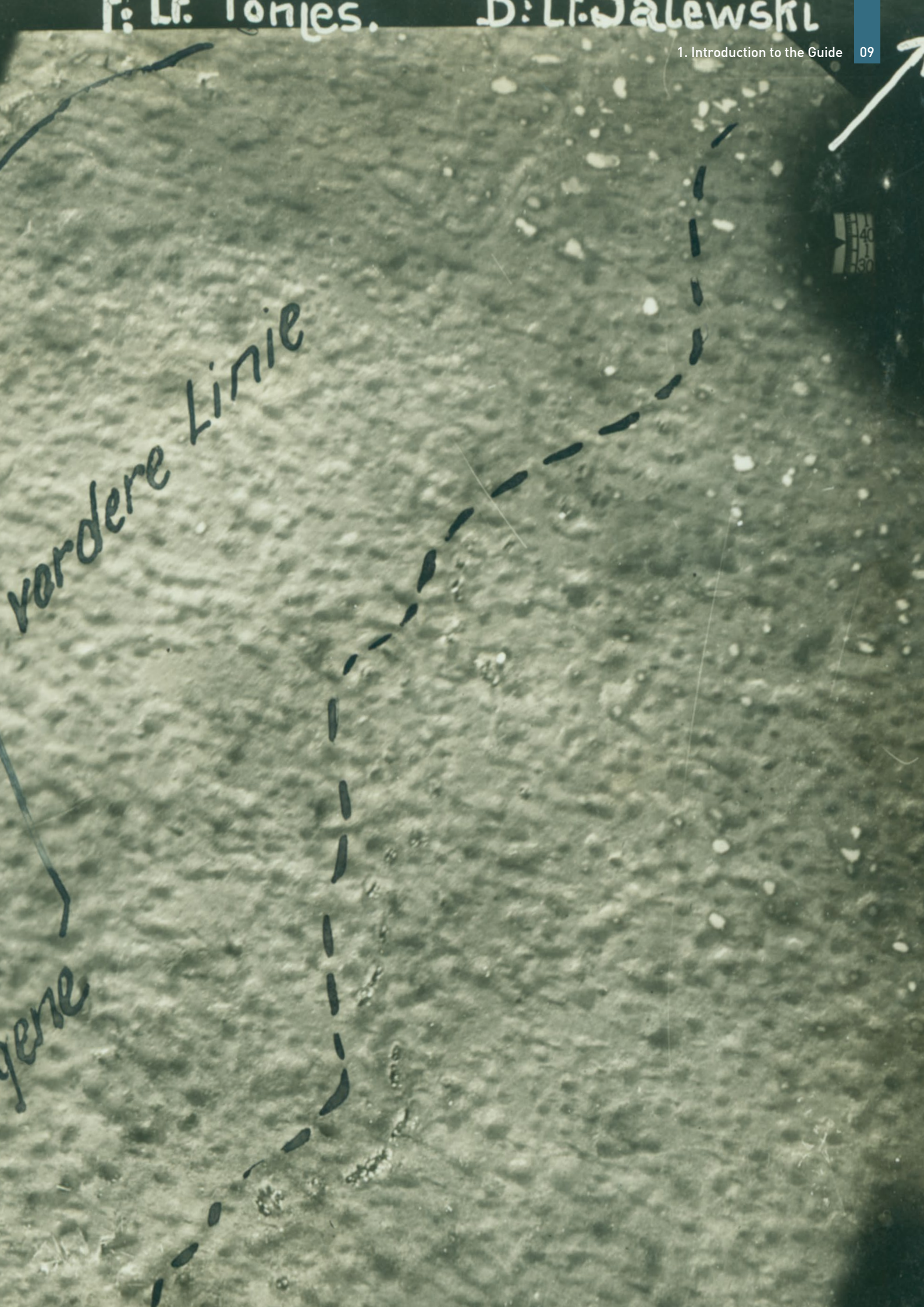gene

Fig. 1: German aerial photograph (22 September 1917) of a the Allied-German frontline totally during the Third Battle of Ypres.

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This guide is prepared within the framework of the Archaeolandscapes Europe project and aims to facilitate the access to historical aerial photographs dating from the First World War.

1|1 Aim and scope of this guide

This guideline to accessing the archives of First World War aerial photographs is framed within the European Commission funded ArchaeoLandscapes Europe project. The main target of the Archaeo-Landscapes project is to address existing imbalances in the use of modern surveying and remote sensing techniques and to create conditions for the regular use of these strikingly successful techniques across the Continent as a whole. It aims to create a self-sustaining network to support the use throughout Europe of aerial survey and remote sensing to promote understanding, conservation and public enjoyment of the shared landscape and archaeological heritage of the countries of the European Union.

The project's long-term legacy will be better appreciation of the landscape and archaeological heritage of Europe, closer contact between heritage professionals and the general public, more effective conservation of the shared cultural heritage, the international sharing of skills and employment opportunities, better public and professional education, the wider use of archive resources and modern survey techniques, and higher professional standards in landscape exploration and conservation.

The project stresses that Europe has a rich but seriously under-exploited inheritance of aerial photographs from the last one hundred years, documenting the dramatic landscape transformations of recent decades and containing a wealth of information about as yet unknown (and therefore unprotected) landscape features and archaeological sites from the more distant past. The very existence of these archives, which are scattered throughout large and small institutions across Europe, is often hardly known in the broader heritage field and their potential for landscape and archaeological studies remains largely un-assessed. The aerial photographs of the First World War are for large parts of Europe the very first aerial photographs available, making them an important resource, not just for the study of the First World War and its archaeology (de Meyer 2005, de Meyer 2009, Stichelbaut 2011) but also for more conventional archaeology (Stichelbaut, De Clercq et al. 2013), landscape research (Gheyle, Dossche et al. 2013), museum displays (Chielens 2009) and many other fields of research.

This main corpus of this text is based on a doctoral dissertation focusing on the archaeological application of WW1 aerial photographs (Stichelbaut 2009) supplemented with new data. A number of articles have been published on this theme to make these collections more accessible (Stichelbaut 2006, Stichelbaut and Bourgeois 2008, Stichelbaut and Bourgeois 2008, Stichelbaut 2009, Stichelbaut and Bourgeois 2009, Cowley and Stichelbaut 2012).

1|2 How to use the guide

The purpose of this guide is to provide an overview of historical aerial photographs dating from the First World War with a focus on the Western Front in Belgium and France. The major aerial photographic collections are discussed in detail, providing insight in the content and geographic coverage of different archives. This guide is best used by looking at the overall view of all aerial photographic archives (see 10, First World War aerial photographic coverage in Europe). The distribution maps allow identifying specific areas of interest relating to particular archives. Once the relevant archives are identified, the user should then direct its attention to the more detailed description of the archives. This guide will help in locating specific aerial coverage for a given location at the Western Front in Belgium and France.

In addition to this document, many of the maps and developed GIS indexes are online accessible on the ArchaeoLandscapes Europe website[1]. The digital maps provide additional information to this document specifying for instance unique box file numbers and a quantification of the aerial coverage of the five main archives.

1|3 WWI aerial photography

Along the Western Front from the end of 1915 onwards, photo-reconnaissance units

were sent out systematically for different purposes but mostly to record the outline of the enemy's defences. The majority of the aerial photography was intended to show the first lines of defence, although many strategic missions were carried out to capture information far behind enemy lines. Aerial reconnaissance work was conducted by a variety of nationalities. The photographs were produced by an almost industrial process, brought together over four years, and survive in large quantities; archival collections are spread out across Europe, the United States and even Australia. In the study of World War One landscapes, the importance of the archival aspect should be emphasised because this forms the starting point of any further research. Scholars willing to study an area should be well informed of both the geographic and physical dissemination of these collections in a variety of archives and museums. An understanding of the principal goal of aerial photography – gaining intelligence on the enemy – shows us the necessity of a multi-archival approach. Moreover, this is especially true if we want to understand extensive regions on the fronts rather than particular sites.

Consequently, it should be clear that for an aerial study of German occupied territory, we should mostly rely on the war records in allied archives. These scattered sources and the need for combining collections is well illustrated along the Flemish coastline. On Belgian, British and French aerial photographs of the occupied

territory along the North Sea we have an oblique "seaside" view of the entrenchments, thus protecting the safety of the pilot and observer. On German photographs of the same area we have exactly the opposite view, looking towards the sea.

A GIS plotting of many the collections has been carried out, but not only to have an idea of the dispersion of these sources through Europe. Where possible the intention was also to have an idea of blind spots and hot zones, enabling a realistic assessment of future research areas. It is believed that this goal has been realised for the largest archives. The production of this kind of overview maps required huge work efforts in archival research.

To facilitate any future co-operation between different archives, institutes or even individual scholars it would be a good idea to set up an international research network for the study of historical aerial photographs. A start has already been made on this by the Aerial Archaeology Research Group (AARG), which has created a working group on the study of historical aerial photographs. Within the European ArchaeoLandscapes Project this has resulted in a working party focussing on the accessibility of the archives. An online survey has revealed the existence of many national aerial photographic collection and brings this data together in a map portal:

http://www.d1319503-42371.cp.blacknight. com/arcland.eu/index.php/archives
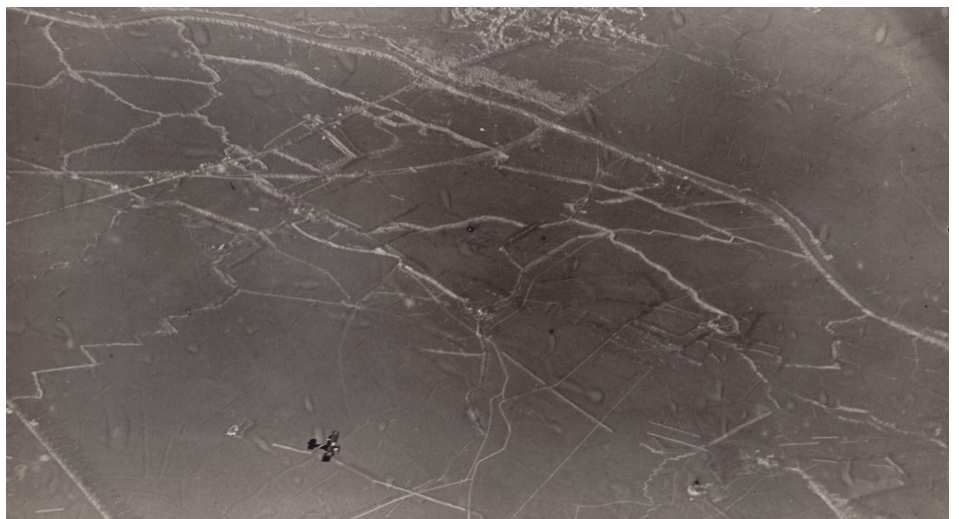
Fig. 2: Allied reconnaissance aircraft flying over the destroyed city of Ypres (source: IFFM).

1. http://www.d1319503-42371.cp.blacknight.com/arcland.eu/index.php/archives

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Overview of aerial photographic collections

2

World War One aerial photographs can be found in a variety of different archives, private collections and museums. The amount of photographs, their quality, and above all their accessibility vary enormously. The following institutes have significant sources available:

National/military archives:

Bayerisches Haupstaatsarchiv (Germany)

Belgian military archives (Belgium)

National Archives and Record Administration (United States)

Russian State Military History archive (Russia)

Service Historique de l'Armée (France)

Kriegsarchiv Vienna (Austria)

Österreichische Nationalbibliothek – Bildarchiv und Grafiksammlung (Austria)

Ufficio Storico dell'Aeronautica Militare, (Italy)

Army museums and memorials:

Australian War Memorial (Australia)

L'Historial de la Grande Guerre (France)

Imperial War Museum (United Kingdom)

In Flanders Fields Museum (Belgium)

Royal Museum of the Armed Forces and Military History (Belgium)

The above overview is neither exhaustive nor detailed. It only gives us an idea of the dispersion of the more important collections. At most of the national archives of the warring countries and their army museums, enquiries have been made to discover where major collections could be expected to be found. Most of the institutes answered that collections were available for study, but at different levels of quantity, quality and accessibility. It was not possible to research every single archive or collection but, based on the information sent by the archives and museums, selections have been made for a detailed study of the most promising and largest collections. Private collections are also numerous and many individual aerial photographs can be purchased through online auctions sites such as Ebay (Haupt 2001).

In the following chapters, the most important and interesting collections will be discussed and dealt with by their country of origin.The focus will be on their content, quantity and geographic distribution of the aerial coverage where possible. In most cases it was not possible to acquire data on the history of the collections since no documents or historical sources were available. We have created GIS-based index layer that comprises the geographic coverage of all major aerial photographic collections and, where possible, combined it with a quantification of these records. This tool allows determination of which archives are of interest for particular areas in Europe.
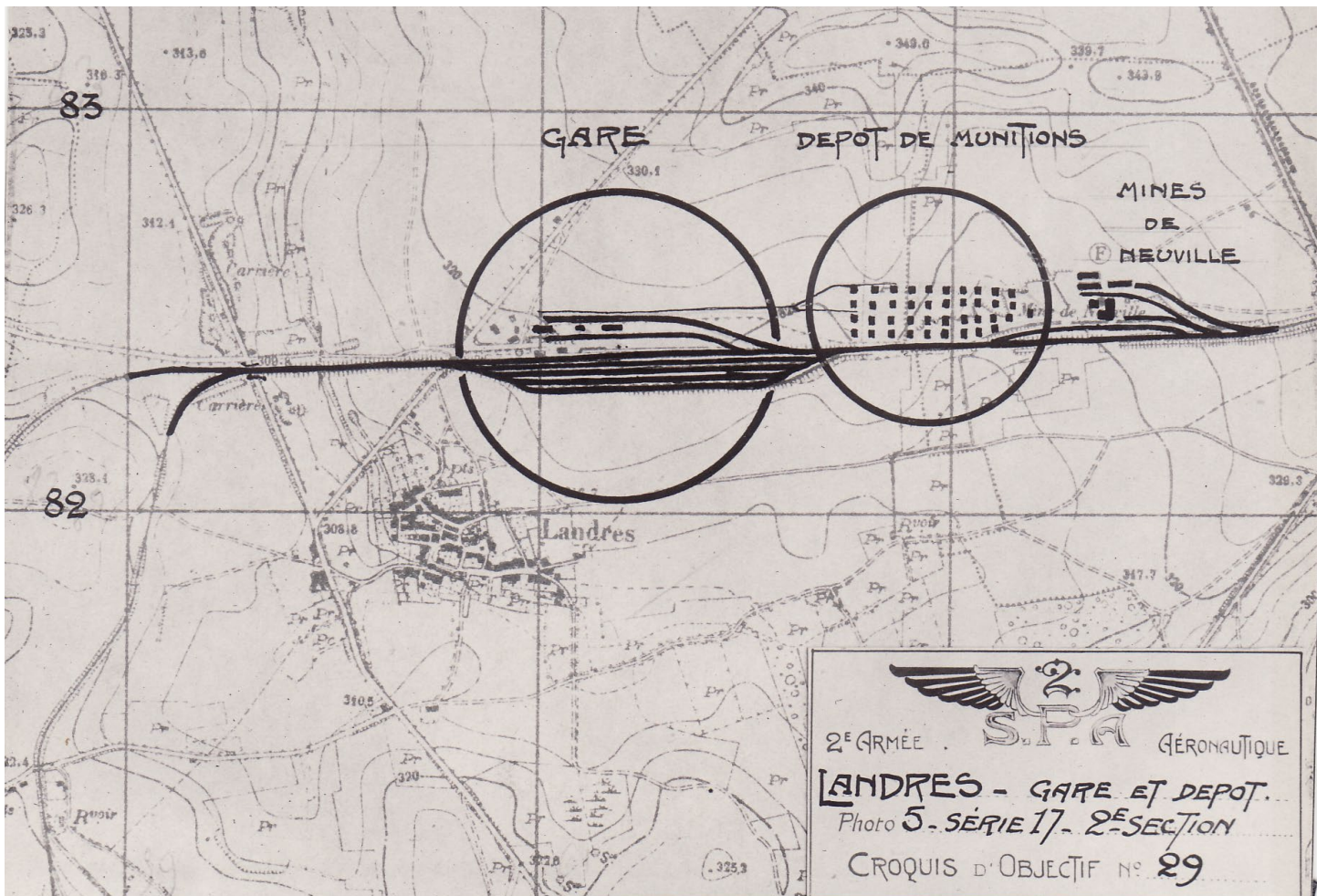
Fig. 4: French aerial photographs of a German ammunition dump near Landres and the corresponding interpretation map (source: NARA RG 120).

3 | Royal Museum of the Armed Forces and Military History

The Collection Photos Aériennes '14-'18 at the KLM-MRA is the largest collection of historical aerial photos in Belgium. Approximately 48,500 aerial photographs are arranged in 1,931 record numbers linked with place names. At first sight, the arrangement of the card index is difficult to fathom and does not encourage accessibility. But the GIS approach of the archival information enables better understanding about the density and distribution of most of the aerial photographs (88%). In some municipalities, there is a density of up to 117 aerial photographs per square kilometre, illustrating the quantity and importance of the collection. Besides the main collection, aerial photographs can be found in the Moscow-archive and the *Fardes Journalières (Collection '14-'18 Aviation-Aérostation)*. Although confined in volume, they can be considered to be valuable supplements.

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Fig. 5: Oblique aerial photograph of the Belgian frontline in 1917 (In Flanders Fields Museum).

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The Royal Museum of the Armed Forces and Military History in Brussels (KLM-MRA) houses the largest collection of aerial photography in Belgium[3]. Additional aerial photographs can be found in the Belgian military archive in Evere (part of the Intelligence and Security Staff Department of the Belgian army or SGRS-S/A) and at the In Flanders Fields Museum in Ieper.

The collection of World War One aerial photographs, the *Collection Photos Aériennes '14-'18[4]*, at the KLM-MRA is the largest in Belgium. The majority of the aerial photographs were taken by the *Aviation Militaire Belge (AvMB)* (the Belgian military aviation) during World War One. The history of how these photographs found their way to the museum is unclear, but the large quantity of aerial photographs and the structure of the organisation make us believe it was bequeathed to the Topographic Service of the Belgian army during the inter-war period. Later the Topographic Service was replaced by the National Geographic Institute but it is assumed that the photographs were donated (Moerenhout 2007) to the KLM-MRA shortly after its official foundation in 1923 (Koninklijk Legermuseum Brussel 2007). However, no written records exist at the museum to support this assumption.

The structure, quantity and geographic distribution of this important collection are discussed in the following pages, emphasising its importance and unique character.

3|1 Collection Photos Aériennes '14-'18

The KLM-MRA collection consists of 365 boxes of aerial photographs, containing 48,511 individual photographic prints. Despite being the largest collection of World War One historical aerial

photographs in Belgium, its existence and research potential is not widely known. The aerial photographs are retrieved from the filing cabinets by referring to a sizeable geographic card index, which contains numerous places covering the Belgian front. In some cases this corresponds with an actual archival record which can be retrieved from the stack. On the cards the sum total of archived photographs for a place name has been noted down, accompanied by the nearest toponyms in the quarters of the compass. For the most part however these are only cross-references to other cards but this complicated system has a bearing on the systematic research of the whole collection. Thanks to the co-operation of the archival staff, there was the possibility to examine the filing cabinets, thus enabling a clear understanding of the collection's structure.

The 365 box files of photographs are classified under the alphabetical heading of 1,935 place-names, which are reproduced from the captions of the aerial photographs (for example *Dixmude, Ferme de la Nouvelle Batterie, Carrefour Wagner*, etc.). However this classification is ambiguous since the place names are divided into two separate classes.

A first group, "the place names only in use during 1914-1918", contains names of cabarets, trenches, trench map references (for instance IJzer B 16,500, 47 N., Point 49 J., etc.) and general war toponyms (mostly names of farms, crossroads and woods). These names were only in use during

the conflict and do not exist anymore on modern maps. The second set is called "modern names", meaning they are not connected to World War One and are mostly still in use. This group contains the names of villages, roads, canals, railways and local place names, such as those of brooks, hamlets, mills, bridges and hills.

Most of the images are (near) vertical aerial photographs. Panoramic and oblique photographs are also found but in a smaller quantity. Unfortunately, these have not been stored separately and are found in the same boxes.

3|2 Other collections at KLM-MRA

In addition to the *Collection Photos Aériennes '14-'18*, aerial photographs can be found in other departments of the KLM-MRA. Without going into too much detail the following assemblages should be briefly mentioned: the *Moscow-archive and the Collection '14-'18 Aviation-Aérostation*.

During the Second World War, historical documents at the Belgian Department of Defence were captured by German occupying forces and transferred to Germany. In 1945, they were transferred to Russia and were subsequently assumed to have been lost. In Moscow, Belgian researchers rediscovered these documents (1.8 km of documents) in secret Russian archives and they became known as the Moscow-archive.

This collection mainly contains material related to the World War One and in May 2002 the archives were finally returned to Belgium where a provisional inventory was completed (Lefèvre 2002: 2).

A brief study of this catalogue revealed some interesting aerial photographs, which can be thematically divided into three parts. The first group consists of artillery filing cards. These were used to index enemy artillery positions and include both a trench map extract and an aerial photograph of the position. The second section comprises aerial photographs taken mainly during the Final Advance in Flanders (28 September 1918 – Armistice) and are in fact photographs of large parts of East Flanders (Belgium)(for example Afsnee, De Pinte, Deinze, Deurle, Ghent, Grammene, Landegem, Ledeberg and Lovendegem). These are of importance because the area covered is a supplement to the *Collection Photos Aériennes '14-'18*. Forty-six German aerial photographs near Antwerp make up the last third group of aerial photographs in the Moscow-archive; these were taken in 1918 by order of a German Pioneer Corps officer. They provide an unparalleled view of the German incorporation of the old Brialmont stronghold in the Antwerp-Turnhoutstellung (Eyndhoven 2008) and are studied as a separate case-study (Stichelbaut 2008). (Stichelbaut 2008).

Aerial photographs in the *Collection '14-'18 Aviation-Aérostation* complete the *Collection Photos Aériennes '14-'18* in certain fields. This collection consists mainly of the *Ordres Journaliers*. Numerous orders and reports of the day were accompanied by supporting aerial photographs. This was mainly the case in 1915 and remained so until 1916. This is therefore an important source for the early stage of Belgian aerial photography.

Fig. 6: Belgian aerial photograph of the Trench of the Death near Dixmude (Belgium)(source: IFFM).

3|3 KLM aerial photographs in Belgium

The collection of the KLM-MRA primarily holds aerial photographs taken by the reconnaissance units of the Belgian Military Aviation during World War One, thus the distribution of the photographs is broadly limited to the area between Nieuwpoort and Steenstraat. This was the front occupied by the Belgian armed forces and was divided into six front sectors (Nieuwpoort, Ramskapelle, Pervijse, Diksmuide, Lo and Steenstraat) (Debaeke 1998: 12). Occasional British, French and some captured German photographs can be found in the collection, but only in small quantities.

The majority of the place names (58%) belong in the group of 1914-1918 place names, which are not found any more on modern topographic maps. Consequently, it is almost impossible to know the coverage of these aerial photographs.

To solve this problem, specific research was made to relocate all the place names on present cartographic records by using contemporary trench maps of different scales, thus tracing many of the historic names. Attention was concentrated on Belgian trench maps or *Plans Directeurs*. We integrated different cartographic sources to create a quantitative and geographic distribution map of the entire aerial photograph collection: not only existing digital topographic maps but also a selection of scanned Belgian trench maps. To combine these informational layers in their proper position with correct scale, the paper maps had to be georeferenced. In order to accomplish this:

"...a number of locations with known coordinates must be identifiable on the map or image, referred to as ground control points." (Conolly and Lake 2006).

In our case study, four to six ground control points (GCPs), such as crossroads and churches, were selected on both the scanned historical trench map and the present-day topographic map, and through a first-order polynomial transformation the trench map was integrated in the GIS. In this process, three operations take place: translation, scaling and rotation (Conolly & Lake 2006: 87), resulting in a georeferenced map in the same coordinate system as the existing scanned topographic maps. The trench maps used were *Plan Directeur Armée Belge* Nieuwpoort 1:20,000 (01/07/1918), *Plan Directeur Armée Belge* Diksmuide 1:20,000 (01/03/1918) and *Plan Directeur Armée Belge* Merckem 1:10,000 (01/10/1916). This data was supplemented by a number of photographed trench maps originating from the voluminous cartographic collection at the KLM-MRA.

The next phase consisted of meticulously exploring the cartographic data in search of the 1,935 place names with photographic coverage. Several difficulties were encountered. First of all, many of both the "modern" and "1914-1918" record names were not found on any of the historical and current topographic maps. Secondly there were multiple possibilities for the location of some individual toponyms (for instance Hoekstraat, Kaphoek, etc.) and, finally, some only refer to common names of mills, brooks and roads (for example Molentje, Kruiststraat, etc.) for which there are multiple options.
We have joined a database with the place names, the sum of aerial photos, the box number and a unique identification number for each record with plotted point locations, providing a distribution map in the GIS of all the toponyms for which aerial photographs are available.

36 French and Dutch villages were located and represented as well.

We located 1,371 (i.e. 71%) of the 1,935 place names. The easiest to find were the villages of which 97% were located. The remaining villages, mostly in France, could not be located in detail because of spelling mistakes on the boxes and multiple alternatives (several villages with the same name), which is also the case for the remaining roads, canals and railways.

The least successful identifications were local place names, war toponyms and trenches. These names are very hard to interpret because they possibly do not occur on the consulted trench maps, lie outside the Belgian front area, or have too many alternative options.

3|4 Geographic distribution of the KLM-MRA aerial photographs

As expected, the majority of the KLM-MRA aerial photographs are located in Belgium with only 311 photographs are located in France (0.73%) and 18 in the Netherlands (0.04%). Most of the aerial images are of the front area between Nieuwpoort and Ieper **(Fig. 8).** The municipalities with most aerial photos within their boundaries are Diksmuide (9,271), Houthulst (6,600), Middelkerke (5,178), Langemark-Poelkapelle (4,285), Nieuwpoort (2,460), Ieper (1,510), Staden (1,233) and Kortemark (1,218). These figures might however give a simplified view because the surface area has not been taken into account.

Strategic reconnaissance missions were often carried out, mostly by special squadrons and escadrilles (Finnegan 2006). It is however interesting to see the range of this specific type of photo-reconnaissance missions.

There is almost an abundance of sources on hand, even for areas up to 40 kilometres away from the static front zone in West Flanders. **Fig. 8** represents both the density of aerial photos in the front-zone communities as well as the distribution well behind German lines. Also remarkable is the relatively dense coverage of the borderland between the Netherlands and Belgium, most likely to monitor the German *Hollandstellung*.

This area was an almost continuous line of field defences and concealed bunkers which had been constructed in case the Netherlands broke its neutrality (Eyndhoven 2008).

3|5 Unique aerial photographs?

Our counts indicate with certainty that there is a collection of approximately 48,500 aerial photographic prints in the KLM-MRA (*Collection Photos Aériennes '14-'18*). By applying GIS techniques it becomes possible to come to conclusions about the distribution and density of the aerial photographic coverage.
There is, however, a major limitation we have to bear in mind: the presence of multiple photographic prints of the same negative. Glass negatives were printed in large numbers and the demand for aerial photographs in different army units was high (Vrancken 1999).

Type of place name	Located	%	Unlocated	%	Sum
Village	358	97	11	3	369
Canal	7	88	1	12	8
Road	30	86	5	14	35
Cabaret	40	83	8	17	48
Railway	4	80	1	20	5
Trench map reference	56	79	15	64	71
Local place name	291	73	110	27	401
War toponym	568	61	367	39	935
Trench	17	27	46	73	63
Total	1,371	71	564	29	1,935

Table 1: KLM-MRA place names.

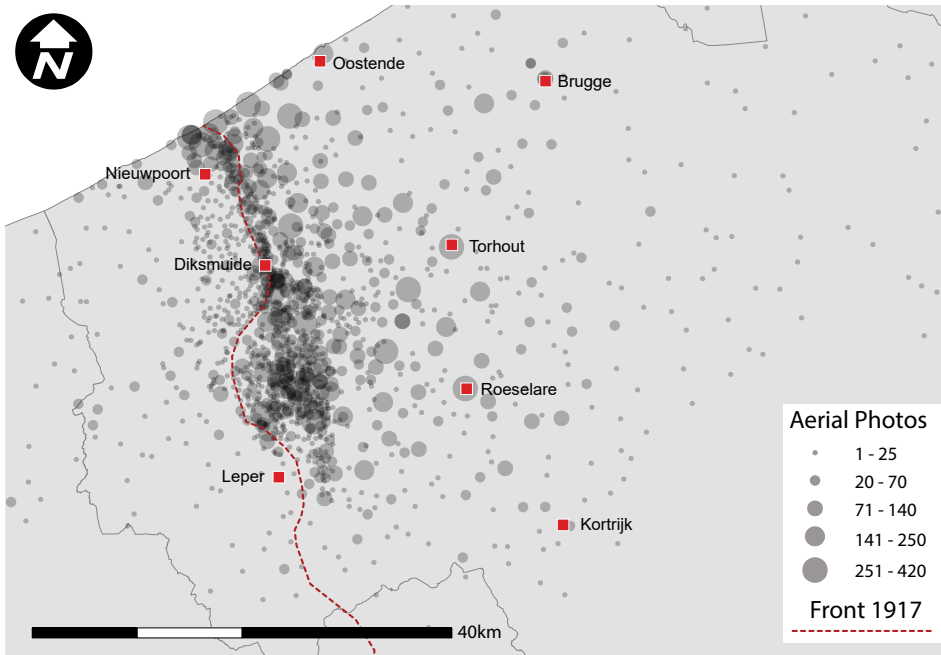|	Place names	Aerial photographs	%
Located	1,371	42,853	88
Unlocated	564	5,658	12
Total	1,935	48,511	100

Table 2: Percentage of located place names at KLM-MRA.
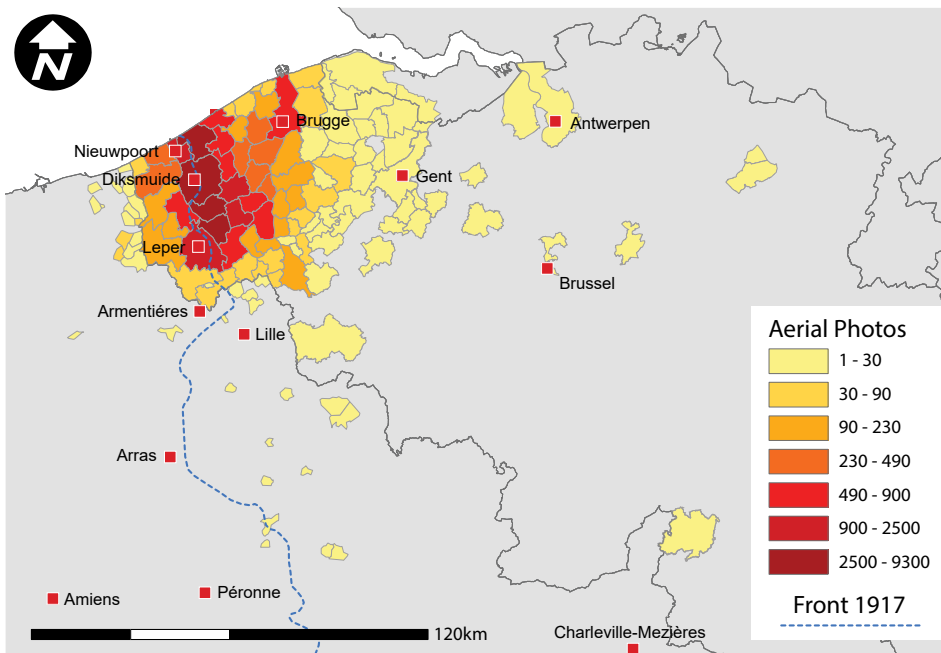
Fig. 7: KLM-MRA located place names (point density).

Fig. 8: KLM-MRA density of aerial photographs per community.

operative, under the direction of Commander d'Hendecourt (d'Hendecourt 1935), for which absolute numbers are not available. However, it can be assumed that thousands of additional negatives were developed because his photographic service was active for the entire airfield of Houtem. By combining the output of both photographic services, we come to a sum of circa 20,000-25,000 different negatives.

These numbers are substantiated by looking at the research on the Belgian *Fardes Journalières* at the KLM-MRA carried out by Walter Pieters. He has evidence of at least 1,467 unique photographic reconnaissance flights, carried out between 6 August 1914 and 11 November 1918 by the AvMB (Pieters 2007). For 36% of these photo-reconnaissance flights the minimum amount of photographs taken was mentioned. This leads towards an average of 12.7 aerial photographs per mission so it seems reasonable to extrapolate this number to a minimum of 19,000 different negatives. Presumably the total is even higher because for the majority of the flights (64%) there is no data available but this number corresponds more or less to the data provided by Captain Jaumotte.

A large quantity of prints of these negatives have survived and is known as the *Collection Photos Aériennes '14-'18*. Consequently, some prints are duplicates and will be found in several boxes with different place names. Without collecting information on every printed aerial photograph it is impossible to know with certainty the number of unique prints.

On the other hand, a reasonable assumption can be made about the quantity of Belgian World War One aerial photographs using different sources: autobiographical documents of individuals involved in aerial photography and the *Fardes Journalières (Collection '14-'18 Aviation-Aérostation)*.

The commander of the Belgian aerial photographic service at the Moeren aerodrome, Captain Jaumotte, expressly stated that more than 15,000 perfectly exposed negatives were taken of his airfield, which were printed several times (Jaumotte 1919). At a later stage there was a second photo department

3. For practical information see: http://www.klm-mra.be/klm-new/engels/main01.php?id=menu_links/startpagina
4. Aerial photographs collection ('14-'18).

Fig. 9: German artillery fire on the British lines near Nieuwpoort at the North Sea (In Flanders Fields Museum).

4| Belgian Military Archive (SGRS-S/A)

The collection of aerial photographs at the Belgian military archive is rather confined and heterogeneous. Nevertheless, its study is interesting from a methodological point of view. While it is perfectly possible to locate every single aerial photograph, this type of locating is time-consuming and it adds little to the knowledge of the distribution of Belgian aerial photographs because the collection itself is already a restricted set of photographs for which the selection criteria are unknown. However, this type of GIS research for small collections can be interesting to locate specific aerial photographs in areas with otherwise low densities in other collections such as, for instance, behind the Belgian lines.

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Fig. 10: German fortifcation at the Yser River (In Flanders Fields Museum).

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The Belgian military archive at Evere[5] (Brussel) has a limited collection of aerial photographs, the basis of which is made up of ten folders containing 754 aerial photographs[6]. The collection seems to be a selection of loose images without any structure. Sometimes a series of photographs can be found with successive serial numbers[7], but we are unacquainted with the final selection criteria of the entire collection.

The collection consists of aerial photographs differing in quality, height, date, location and even nationality. The majority of the photographs (676 aerial photographs or 90%) is of Belgian origin, while the remainder were taken by German observers (10%). The largest group or 55% of the photographs date from 1917, 16% from 1916, 27% from 1918 and 2% remain unknown. Oblique (nine photographs) and panoramic (13 photographs) photographs turn up occasionally but the bulk of the photographs are vertical.

The location of 611 photographs was retrieved and represented as individual point locations on a distribution map **(Table 3).** By analogy with the geographic distribution of the KLM-MRA collection,

the sum of aerial photographs and the density per km² is represented on **Fig. 11.** Both the density and total number are the highest in Langemark-Poelkapelle, followed by Houthulst and Diksmuide.

4|1 Geographic content and distribution of the aerial photographs

The majority of the individual aerial photographs have been located individually as a case study on handling heterogeneous collections.

Unlike with the KLM-MRA collection, there is no coherence in the distribution of the photographs. Successive photographs in the folder are located some distance from each other so consequently the exact localisation of photographs in such an archive becomes a sustained and time-consuming process. The results largely depend on the aerial photographic inter-preter's experience and solid knowledge of the landscape and toponyms.

Community	Sum of aerial photographs	Aerial photographs/km²
Langemark-Poelkapelle	199	3.75
Houthulst	141	2.52
Diksmuide	150	1.00
Nieuwpoort	24	0.77
Middelkerke	34	0.45
Staden	15	0.32
Kortemark	8	0.14
Ieper	16	0.12
Alveringem	7	0.09
Lo-Reninge	4	0.06
Hooglede	2	0.05
Koksijde	2	0.04
Ichtegem	2	0.04
Veurne	4	0.04
Zonnebeke	2	0.03
Oostende	1	0.03

Table 3: Belgian military archive (SGRS-S/A) - aerial photographs per community.

Fig. 11: Belgian military archives (SGRS-S/A) - point distribution.
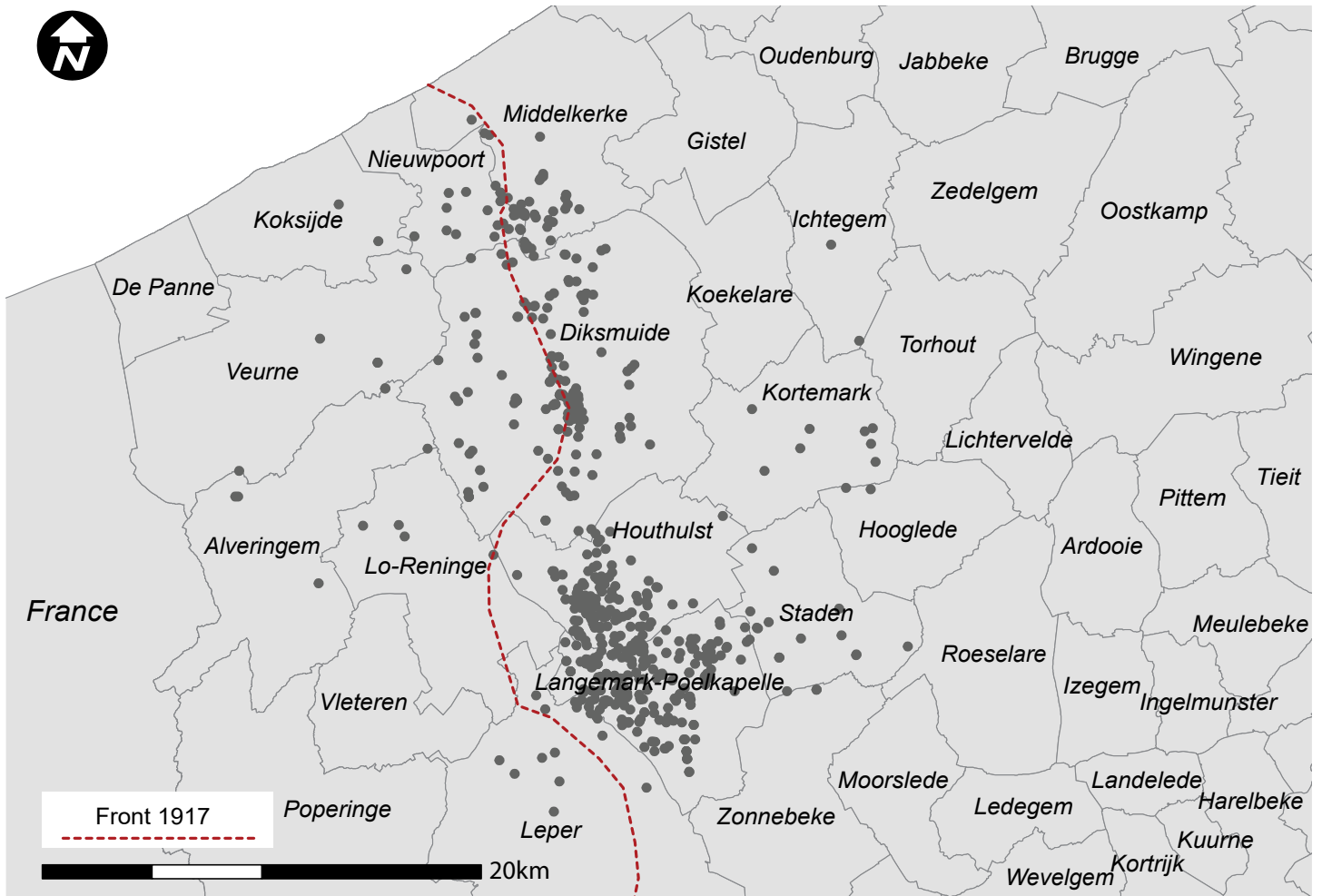
5. Archival section of the Intelligence and Security Staff Department of the Belgian army (SGRS-S/A).

6. File numbers: SGRS-S/A: Folder 251-254, 257-258, 261 and 264-265.

7. Original Great War serial number, for instance: A 41, AvmB 1001, Z 478, etc.

Fig. 12: French aerial photograph of Fort de Douaumont at the Verdun front (source: In Flanders Fields Museum).

5 | Imperial War Museum

The Box Collection at the Imperial War Museum is an incomparable archive of World War One aerial photographs. Due to the organisation of the collection with index card drawers, it is possible to look up individual aerial photographs in specific locations but a major disadvantage, however, is being unable to look at the actual images. The aerial photographic distribution varied enormously from 1915 to 1918. There was an expansion of the photographed area in all directions for each war year. Creating a digital grid, similar to the system used during the war, which was used as an index map, allows us to visualise and analyse the distributions and coverage of the Box Collection. For the first time it becomes clear which areas have aerial coverage and in what quantity.

Despite the extensiveness of the Box Collection, the aerial photographs cannot be considered as the exhaustive inheritance of the Royal Flying Corps (later Royal Air Force). Not every negative which was taken during the war has been preserved at the IWM and moreover the origin of the collection lies in the training material of the RAF School of Photography at Farnborough (NAPLIB 1999). In the past, several unknown criteria for selection were applied. Some negatives were deliberately destroyed at Farnborough around 1927 and are supposedly buried beneath the airstrip (Going 2009).
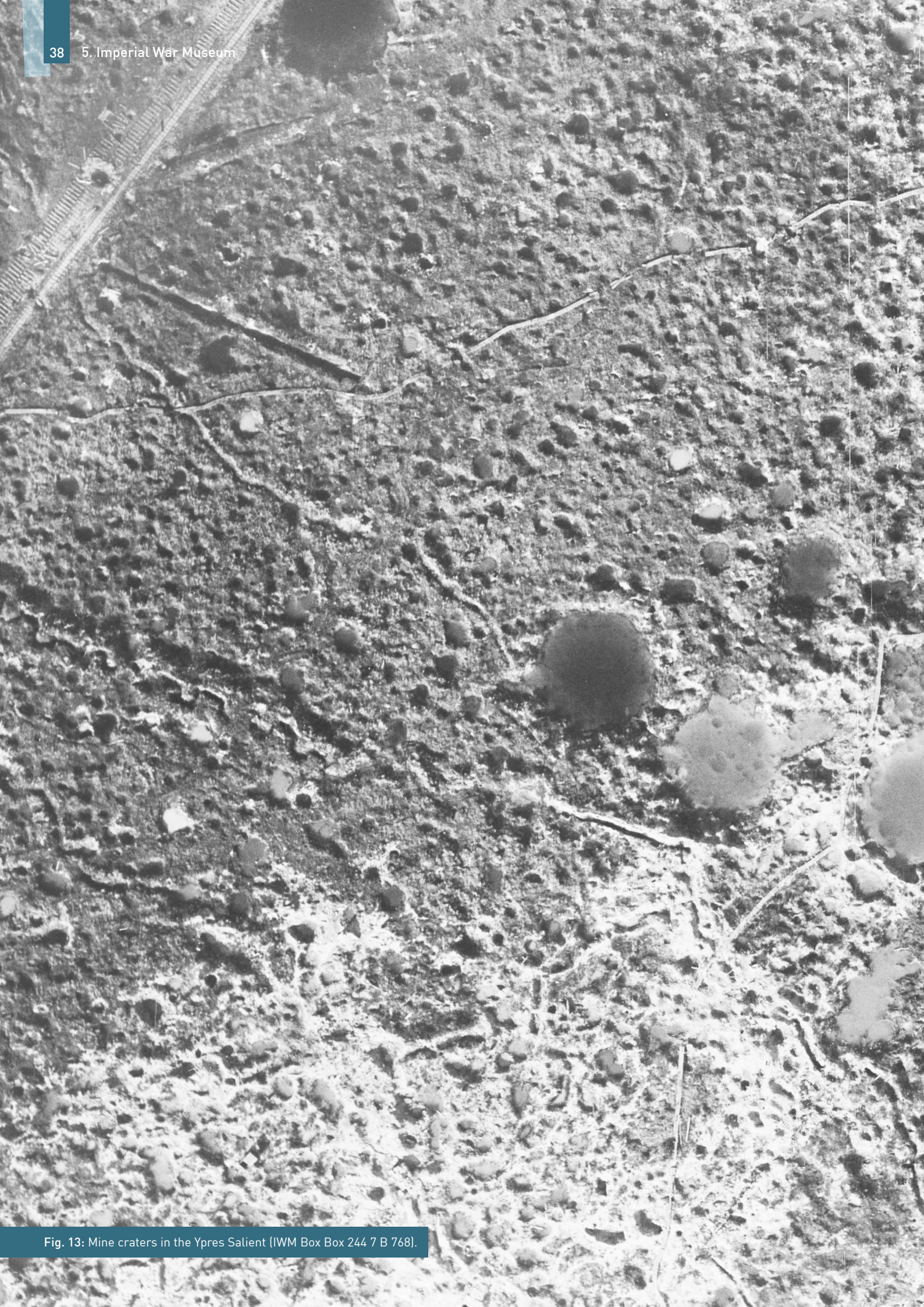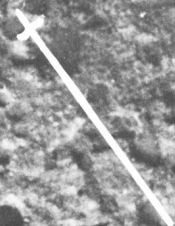
Fig. 13: Mine craters in the Ypres Salient (IWM Box Box 244 7 B 768).

7. B. 7 6 B
28 I. 11b. 12a
23·9·18·4
F·8¼"

5

The collection of aerial photographs at the Imperial War Museum (IWM) in London is probably the most famous in the world and is mostly referred to as the "Box Collection" (Imperial War Museum 2007). The collection was reported to hold more than 80,000 aerial photographs dating from World War One (Watkis 1999), but proved to be significantly larger. Its origin lay in the reconnaissance work done by the British Royal Flying Corps (RFC, later RAF). This collection is unique and somewhat different from other assemblages of aerial photographs from many perspectives. The organisation and structure will be discussed before going into further detail about the areas and dates covered. For a summary of this collection see Stichelbaut et al. (2010). The collection can be accessed at the All Saints Annexe at the London branch of the museum[8].

5|1 Organisation and structure

The Box Collection consists of original glass-plate negatives and not of paper prints. The IWM is the only known museum in the world where such a considerable number of valuable negatives has survived. Most other major archives possess only paper prints. According to Watkis, the collection comprises between 80,000 and 90,000 original glass negatives (Ibid.) that are mostly related to the Western Front. The collection is believed to have been transferred between 1932 and 1935 from the Royal Air Force (RAF) School of Photography at Farnborough to the IWM (NAPLIB 1999, Watkis 2006). Disregarding the importance and size of the Box Collection, remarkably little research has been done to open up the collection. Only a very limited reference guide is available at the IWM but one swiftly learns that the Box Collection is in two locations: the Imperial War Museum departments at London and Duxford.

The London branch of the museum keeps a card index of the negatives stored at the IWM's Duxford location. This separation has far-reaching consequences; the principal disadvantage being that we cannot see and study the images. At the IWM in London, a map card index is available to go through the collection keyed to the GSGS (Geographical Section of the War Office General Staff) map numbers. These index cards are arranged by year and location. The classification by location is unique and is based on the 1:40,000 maps that were used during World War One, but to understand this classification it is necessary to give a brief introduction to trench map referencing (see 5.1.1).

Fig. 14: Example of an IWM index card in the 1915 drawer of vertical aerial photographs.

The Box Collection's index consists of several drawers with reference cards. Most cards refer to five aerial photographs and at the top of the cards there is an indication of the Series (the Unit or Wing that took the aerial photographs). For each negative the box and negative number, size, date, map and plotting on the trench map is indicated. **Fig. 14** is an illustration of such an index card and refers to three aerial photographs taken by the 1st Wing. The photographs are stored as negatives 1494-1496 in Box 60 at the Duxford branch of the museum. These particular aerial photographs measure 5x4 inches, were taken on 24 September 1915 and cover an area on map sheet 36 C (1:40,000 series) within 6,000 yard square G. For some trench map sheets, a small selection of contact prints from the glass negatives are available and stored in boxes at the London branch, also filed according to the map sheet number. The selected trench map sheets cover mostly the Ieper and the Somme regions, scenes of fierce British actions during the war. Contact prints and enlargements of the glass negatives can be ordered, but the selection has to be based on the index cards (without see-ing the actual aerial photographs) or by means of the few available contact prints.

The Box Collection can be subdivided into certain smaller and conveniently arranged units. First, the distinction is made between vertical and oblique aerial photographs. The card index starts in 1915 and is continued through the following years of the war. Each year is consequently subdivided into map sheets and lettered squares. Within the classification of the vertical photographs, there is a further breaking down into a "wide" and "normal" index card per year. Some lettered squares

Fig. 15: Organisation chart of the IWM Box Collection.

cover each of these categories during the same year. The raison d'être for this is obscure. At first, it was assumed that these were aerial photographs of different Units or Wings, but comparative research contradicted this theory. The origin of this distinction is probably to be found when the two different indexing systems were combined in the early history of the Box Collection. The structure of the collection and the card index is schematically summarised on an organisation chart **(Fig. 15).**
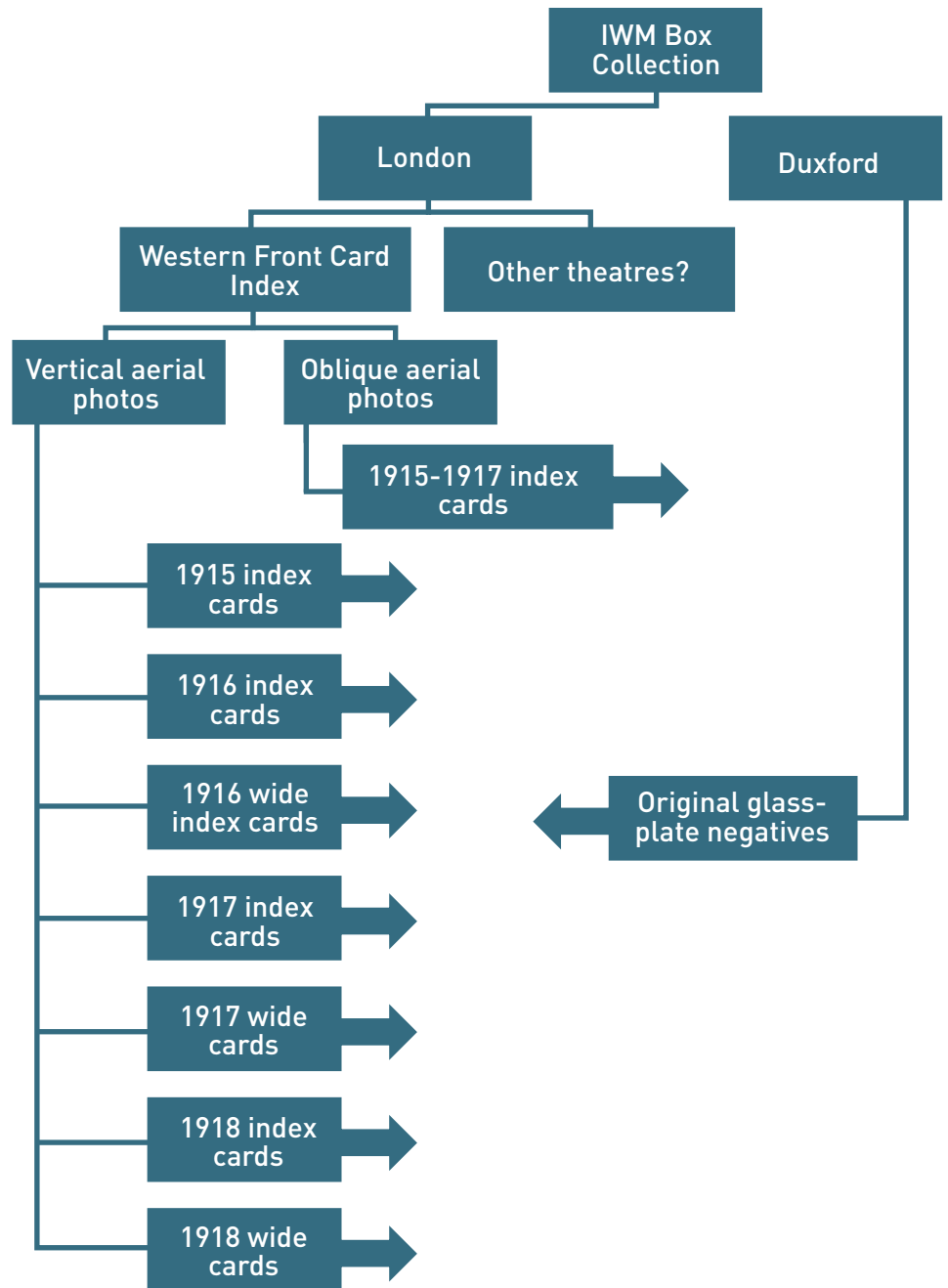
5|1 .1 Trench map referencing

Trench maps are historical maps on which enemy and sometimes friendly trenches are indicated. The British trench maps were produced under the auspices of the Geographical Section of the War Office General Staff (GSGS) (Piggott 1983) and by Field Survey Units at the front. Normally these are large scale maps (1:10,000 and 1:20,000) but smaller scales also exist (i.e. 1:40,000) (Chasseaud 1991). In particular, this latter group is of special interest for the IWM's Box Collection.

Because of their tactical and strategic use, the maps were provided with a reference squaring system allowing the accurate positioning of installations, trenches and military organisations. The main grid system of the trench maps is based on the 1:40,000 series of maps (GSGS 2743 series of maps). These map sheets are approximately 36,000 yards wide. Each 1:40,000 map is further divided into four 1:20,000 maps and sixteen 1:10,000 map sheets (Fig. 16).

NW1	NW2	NE1	NE1
NW3	NW4	NE3	NE4
SW1	SW1	SE1	SE2
SW3	SW4	SE3	SE4
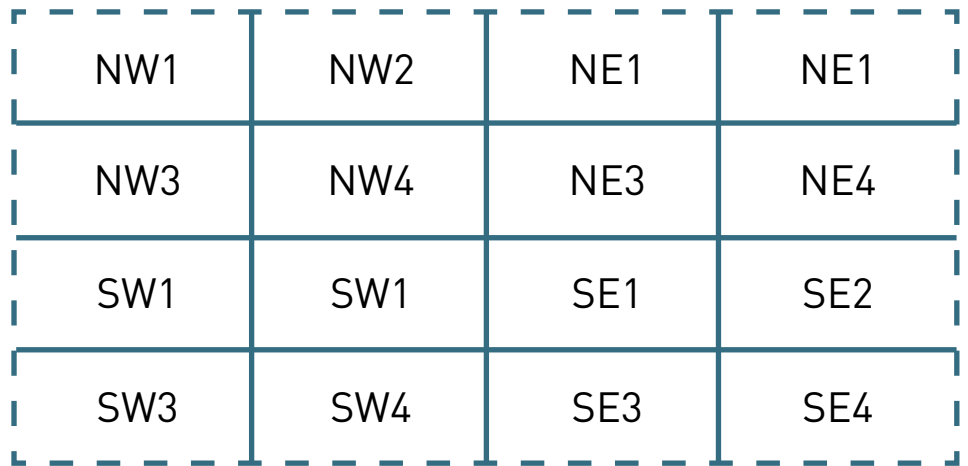
Fig. 16: Schematic overview of a 1:40,000 sheet subdivided into four 1:20,000 (NW, NE, SE and SW) and sixteen 1:10,000 sheets (NW1, NW2, etc.).

Most important for locating aerial photographs is the referencing system of the 1:40,000 map sheets. The key index to the sheets is based upon the pre-war Belgian national survey (Chasseaud 1991). The names of the Belgian map sheets were adapted from the existing system and further extended into France (Chasseaud 2008). The map sheet names currently in use in Belgium are still the same.

To be able to give a detailed map reference on these 1:40,000 sheets, each sheet is subdivided in 24 rectangles, marked in upper case from A to X. The coverage of the main British trench map sheets in Belgium and France is shown in **Fig. 17** together with the lettered 6,000 yard squares in the inset. This index map is a research tool for locating particular trench map sheets.
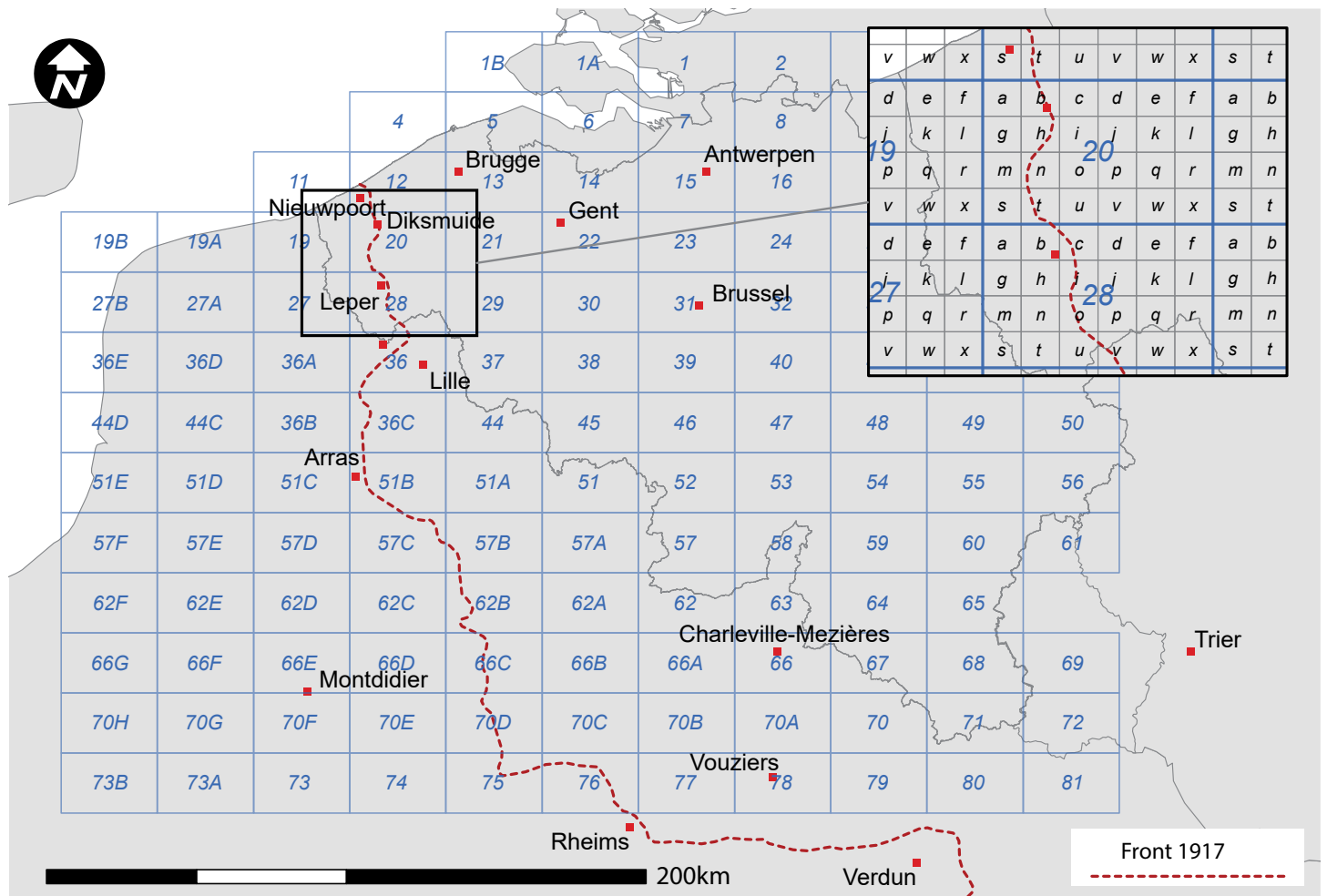
Fig. 17: Key index to locating 1:40.000 trench map sheets and further subdivision in lettered squares.

For an even more exact reference to a trench map, the upper case lettered squares are subdivided into 30 or 36 numbered squares of 1,000 yards (1-30 or 1-36) and each of these again into four quadrants (a-d), each 500 yards square and within them further sub-square coordinates were used in tenths or hundreds. Thus it is possible to pinpoint features with up to a five-yard accuracy on a trench map (NAPLIB 1999, Anderson 2008, Chasseaud 2008).

5|2 Geographic content of the IWM Box Collection

Because the collection is so important, it is essential to understand not only the distribution of the aerial photographs but also some quantitative and temporal aspects. Although Watkis clearly states that the Box Collection also covers other theatres of war (Watkis 1999), the card index is restricted to the Western Front, therefore limiting the accessibility of the collection.

Possibly most of the coverage related to the other theatres of war may have been deliberately destroyed due to a lack of room (Kedar 1999). However, some separate boxes with World War One aerial photographs still exist and contain photographs of India, Iraq, Palestine, Africa and even Afghanistan. The organisation of the Box Collection according to the 1:40,000 map sheets and lettered squares enables the compilation of a precise quantitative distribution map.

Based on the outlines of the scanned and georeferenced topographical maps of Belgium (1:10,000) (Nationaal Geografisch Instituut 1993), an identical grid was drawn in GIS for the outlines of the British 1:40,000 trench map sheets in Belgium and France. The appropriate map sheets were subsequently numbered in accordance with a diagram showing the total area surveyed or partially surveyed during the war (Chasseaud 1991) and an index to the 1:40,000 maps of Belgium and parts of France (Anderson 2008). The result was a digital grid, equal to the British map sheets and their corresponding designation.

The next step was to divide these map rectangles into smaller units corresponding with the upper case lettered squares on the 1:40,000 map sheets. The size of the lettered squares was determined by georeferencing an example of a trench map to the digital grid. Squares of the new grid were lettered in upper case from A to X. The data from the two layers were combined (map sheet designations and lettered squares) resulting in 3,072 numbered and lettered squares going from 1B A to 81 X **(Fig. 17)**.

Box Collection vertical coverage

The most significant parameter for an analysis of the aerial coverage of the archive is that the number of negatives in the Box Collection remains unknown. The negatives in Duxford cannot be counted due the inaccessibility of the stack area. Therefore an investigation was made into the number of cards in the Box Collection's card index. This dataset may not disclose the absolute number of aerial photographs but it will indicate the ratio of aerial photographs per lettered square and give an approximation of the total number of negatives.

The basis of this calculation was the counting of the cards in the vertical and oblique aerial card index drawers. For each map and lettered square the number of filing cards was meticulously counted. In total, 28,200 cards were recorded for the 1,516 subdivisions in the vertical index drawers. A first subdivision was based on the date; further breakdowns depended

on the map sheet number and lettered squares. As mentioned before, multiple index card drawers exist for the same trench map sheet in the same year.

It is more interesting to calculate the approximate number of aerial photographs instead of the number of index cards. One way of doing this is multiplying the amount of cards by five since on most cards the details of five aerial photographs are recorded. Unfortunately, this leads to an overestimation and only indicates the maximum possible number of photographs. The last card of each subdivision can contain information on just one or up to five aerial photos.

To calculate the minimum number of aerial photos in the collection, the number of times a lettered square was found in the different subdivisions (1915, 1916, 1917, 1918 and the respective "wide" index card drawers) was counted; in other words, we counted the number of subdivisions. This figure indicates how many last cards were counted. For each lettered square, the minimum amount of photographs was calculated first by subtracting the amount of last cards from the sum of the cards. This number is then multiplied by five (five aerial photographs on each card) and the number of last cards added to the answer. This basic calculation, gives the minimum number of aerial photographs in each of the lettered squares. The maximum number of aerial photography is simply the number of index cards multiplied by five. **Table 4** gives approximation of the minimum and maximum numbers of aerial photographs of the different war years, together with the difference.
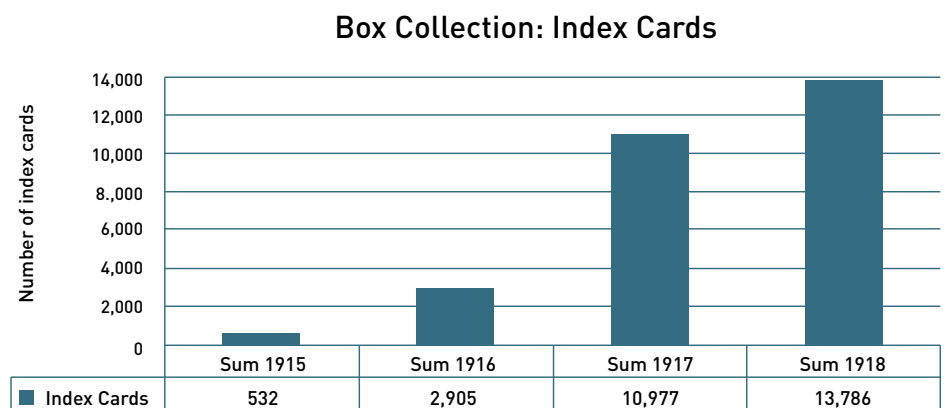
Box Collection: Index Cards

	Sum 1915	Sum 1916	Sum 1917	Sum 1918
Index Cards	532	2,905	10,977	13,786

Fig. 18: Distribution of index cards (vertical aerial photographs) per year.

The minima and maxima are the highest in 1918, and the same is true for the difference. This indicates the more mobile character of the war towards the end: more squares were photographed but with less density. The minimum value of the vertical aerial photographs can be taken as a good guiding number. The calculations suggest the IWM collection of aerial photographs consists of approximately 133,000 glass-plate negatives, a figure significantly higher than the numbers put forward by Watkis (Watkis 1999). This disagreement can be explained by the previous lack of detailed research on the volume of the Box Collection.

Box collection vertical coverage	Min	Max	Remainder
1915	2.472	2.660	188
1916	14.001	14.525	524
1917	52.737	54.885	2.148
1918	64.078	68.930	4.852
Sum	133.288	141.000	7.712

Table 4: Minimum and maximum amount of vertical aerial photographs.

Box collection vertical coverage	Min	Max	Remainder
1915	1	5	4
1916	117	245	128
1917	992	1,280	288
1918	96	240	144
1919	8	40	32
S.d.	3	15	12
Sum	1,217	1,825	608

Table 5: Box collection oblique coverage.

Oblique coverage of the Box Collection

The same methodology was used for the oblique coverage **(Table 5)**. These photographs are listed in a separate drawer. There is remarkably less coverage: for 1915 there is an absolute minimum of just 1 photograph and only 117 are dated for 1916. The peak of the coverage was in 1917 with a minimum of 992 oblique aerial photographs. An additional observation concerns the occurrence of photographs dated for 1919; approximately eight oblique aerial photographs were taken after the war. These photographs were possibly taken to help with damage assessment or as an aid for writing the official war histories. Carlier describes that one of the goals of the immediate post-war aerial photography was to document the ruins which were caused by the enemy (Carlier 1921).

This collection is probably incomplete because of the small numbers recorded. This is confirmed by the fact that the KLM-LRA collection contains a number of British oblique aerial photographs that cannot be retrieved from the IWM Box Collection. The selection criteria for the composition of this part of the Box Collection unfortunately remain unknown.

By using contemporary sources, an equivalent reference grid to the one used in the war was created in the GIS. This was based on the 1:40,000 map sheets and further breakdown into upper-case lettered squares. In addition, a thorough count of the Box Collection's card index was made. From this, an approximation of the minimum and maximum number of aerial photographs in the collection was calculated. In order to obtain an idea of the geographic coverage of the aerial photographs, it was necessary to combine these separate research tools. To meet this requirement, the GIS files were linked to the spreadsheet with the counts per upper-case lettered square. This system allowed reflecting the quantitative and temporal distribution of the glass-plate negatives in GIS. In order to combine and compare data from different archives all data was stored in the same coordinate system (Belge Lambert 1972).

5|2 .1 Box Collection Coverage in Belgium and France

The geographic distribution of the Box Collection will be specified in the next pages. It is based on our research of the card index drawers. Only the calculated minimum number of photographs will be used in the geographic representation of the aerial photographic coverage by year.

Vertical aerial photographs

Vertical photographic coverage is available for vast areas of the British sectors of the Western Front. The available aerial photographs dating from 1915 are related to the following major British actions and battles of that year. Photographs are available in trench map squares almost along the entire front line between Ieper in the north and Lens in the south, just north of Arras (Fig. 19). The greatest density of the coverage lies near La Bassée, Armentières and Ieper. An interesting observation is the occurrence of some aerial photographic coverage up to 30 kilometres behind the British lines and 15 kilometres into the German back area.

In 1916, the most important extension of the area covered was southerly towards Arras and Péronne. This limit was defined by the junction between the British and the French armies, just north of the River Somme. It is not surprising that the Somme Offensive (July to November 1916) was well covered by thousands of negatives since it was among the fiercest battles of World War One. The shifting towards the east after the start of the offensive on the Somme Front is easily recognised on the density map. Northwards there is coverage up to the northern part of the Ypres Salient, with some peaks in map sheet 28: the area near Langemark, Sint-Juliaan, Ieper and Wijtschate.

In the next year of the war, a dramatic increase in the quantity of still existing negatives was observed. Compared to 1916, the Box Collection for 1917 holds almost four times the number of negatives: 54,885 aerial photographs. The dissimilarity on the distribution map is equally distinctive: more photographs were taken in a larger area.

The photographed area expanded in all directions. In the northern part of the front, in Flanders, aerial photographs covered both the Belgian and British front sectors. A major part of the province of West-Flanders, including most of the Flemish coastline, was photographed during 1917. The largest density in Flanders can be recorded at the Ypres salient, which was certainly due to the start of the Third Battle of Ypres. To the south, between the Belgian-French border and north of Arras, an area with fewer aerial photographs was observed. A gap in the photographed German hinterland north-east of Douai was also recorded. Then from Arras southwards, the density rose again to its peak and the extent of the covered area expanded again. This had everything to do with the German withdrawal to a newly constructed position, the Hindenburg line (Payne 2008).

IWM Vertical coverage	Aerial photographs	Area covered (km²)
1915	2,472	1,253
1916	14,001	3,173
1917	52,737	10,933
1918	64,078	27,467

Table 6: Aerial photographs vs. covered area
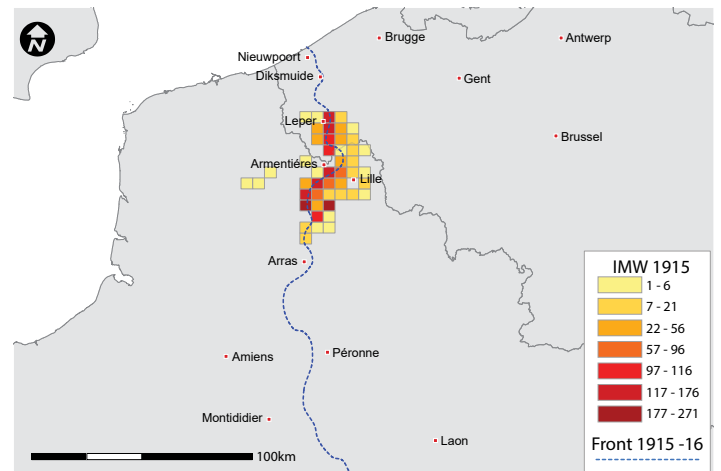

Fig. 19: IWM 1915 coverage.
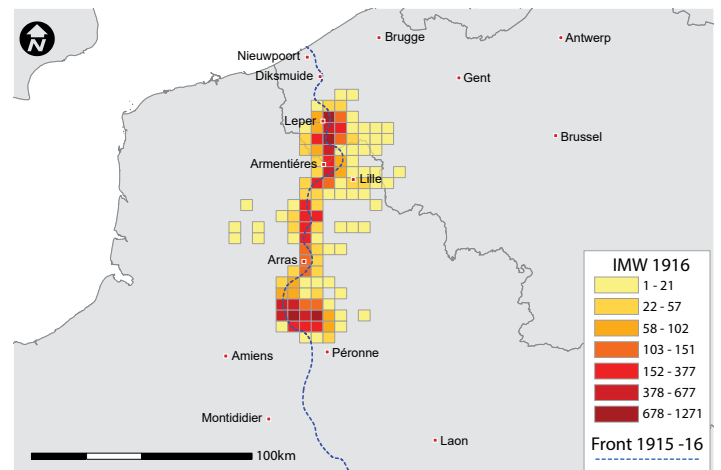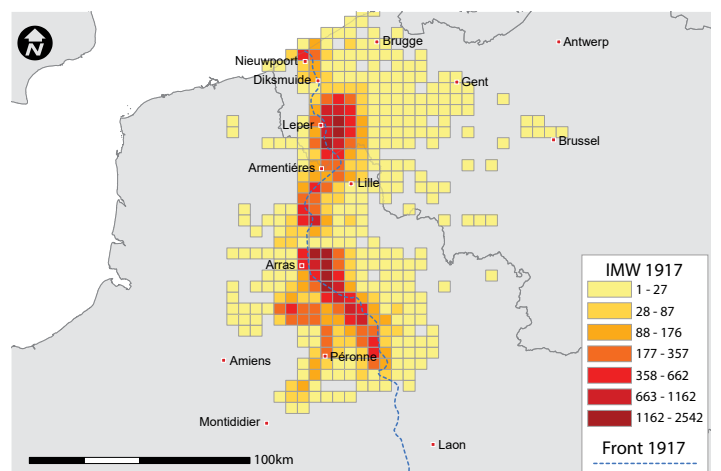

Fig. 20: IWM 1916 coverage.

Fig. 21: IWM 1917 coverage.

This defensive position line ran from Arras to Soissons but aerial photographic coverage is only available for the part up to Saint-Quentin. The area between the old front line of November 1916 (after the Somme Offensive) and the Hindenburg line was also photographed before the withdrawal at the beginning of March 1917. The German back area behind this famous fortified position was also photographed but to a lesser degree than in Flanders. The distribution of the 1918 aerial photographs shows the same tendency as in 1917: a larger photographed area. For the entire year of 1918, the IWM has 64,078 photographs which are located in 1,030 unique lettered map squares. The coverage is once more extended in all directions.

The coverage of 1918 is much more difficult to interpret due to the wide dispersion of the photographs. The distances between the extremes of coverage are impressive: 220 kilometres from north to south and 255 kilometres from east to west. When we look however at the quick succession of different offensives during this last year of the war, the spread of these negatives becomes clear. The first part of 1918 was dominated by German offensives along the Western Front: the Spring or *Kaiserschlacht* series of offensives. The Allied lines were pushed backwards in many places, sometimes by as much as 60 kilometres during the German Somme Offensive[10].Finally, the Allies blocked the German advance and started to push the Germans back during the Second Battle of the Marne. By August 1918 the Allies returned again to the offensive and the Hundred Day Offensive against the Central Powers was started, which would ultimately lead to the Armistice signed at Compiègne on 11 November 1918. Due to these shifting lines and the return to a more mobile warfare it is impossible to attribute certain air coverage to specific actions or campaigns without looking at the date of the photographs themselves. Fig. 16 shows an overall IWM coverage. This figure illustrates the whole of the distribution of the World War One aerial photographs. Not only is the large accumulation of aerial photographs near the front lines noticed, but also the wide area far behind the German lines for which the Box Collection has aerial coverage available.

The number of aerial photographs which are stored at the IWM strongly differs year by year. There are only 2,472 aerial photographs that can be dated in 1915. This number is multiplied by a factor of 25 in 1918. If we look at the area covered in square kilometres, a similar tendency between the values in 1915 and 1918 can be noticed. If on the other hand the data for 1917 and 1918 are compared, a discrepancy can be observed. The area covered in 1918 is almost three times the 1917 surface area. There are however only 11,000 more 1918 aerial photographs preserved. These numbers clearly indicate there are in general fewer photographs per lettered map square due to the larger surface area covered.
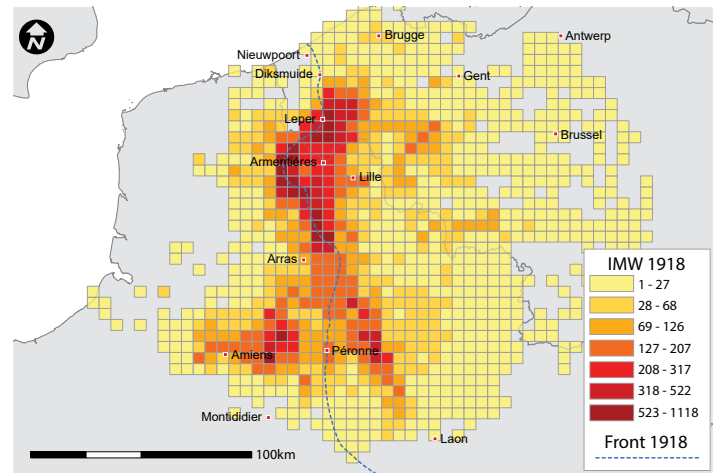

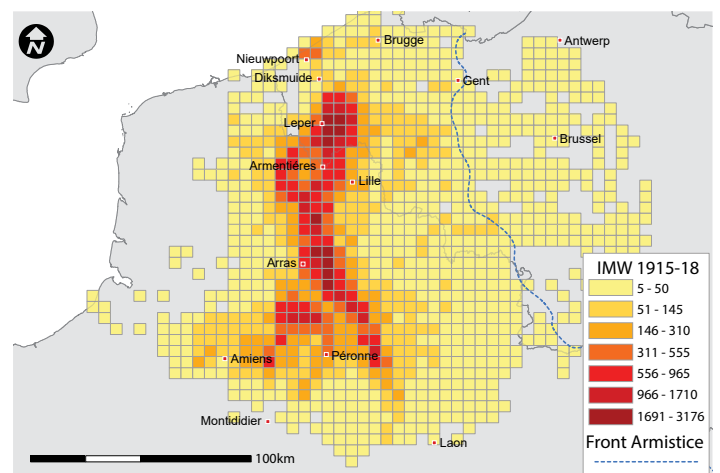Fig. 22: IWM 1918 coverage.

Fig. 23: IWM coverage 1915-1918.

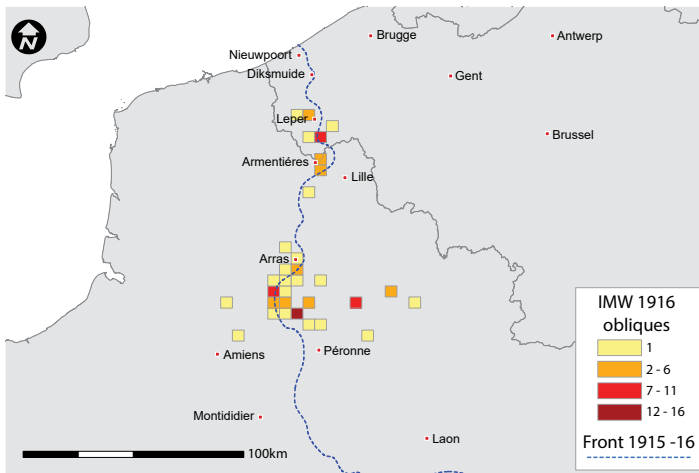Fig. 24: IWM 1915 oblique photographs.
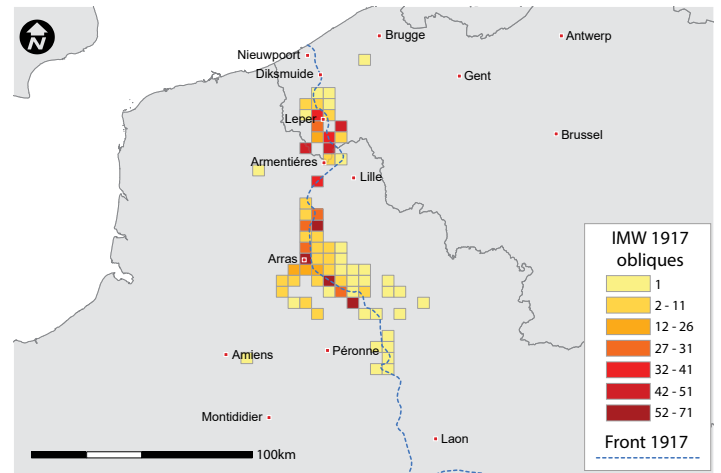
Fig. 25: IWM 1916 oblique photographs.

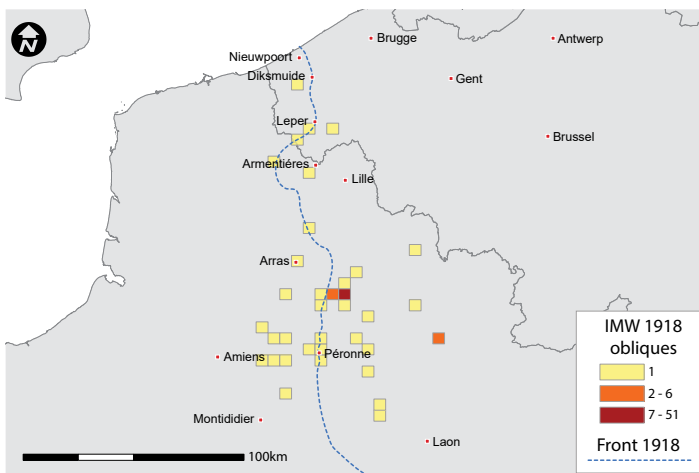Fig. 26: IWM 1917 oblique photographs.

Fig. 27: IWM 1918 oblique photographs.
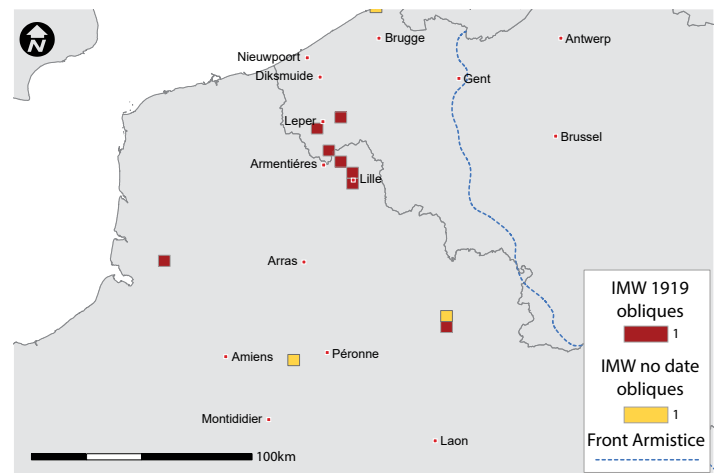
Fig. 28: IWM 1919 oblique photographs and photographs without date.

James Streckfuss kindly shared information that may shed light upon the British total sum of 1918 aerial photographs. At the Royal Air Force Museum, a small journal was researched indicating the number of negatives exposed and the number of prints made from those negatives per RFC/RAF squadron. This journal indicates that at least 218,657 individual glass plates were exposed in 1918 of which 5,165,091 prints were made. This means only approximately 30% of the negatives survived.

Oblique coverage in Belgium and France

The coverage of oblique aerial photographs is spread over 117 lettered squares. For 1915 there is only one photograph in trench map square 28 I: the town of Ieper. For 1916, more coverage is available but the numbers remain rather limited. The photographs are mostly concentrated at the 1916 front line between Arras, the Beaumont-Hamel and Thiepval sector and to a lesser degree the Ypres Salient. The occurrence of additional coverage behind the main 1916 front line can in certain locations be related to static sectors such as Armentières and the construction of new trench lines (for instance the Hindenburg line near Marcoing and Ribecourt). For other areas, the reason for the availability is unknown and cannot be linked to any operational demands. Most of the preserved oblique photographs were taken in 1917.

They show especially the Hindenburg line between Arras and St-Quentin and parts of the Ypres salient. The coverage in 1918 is again more limited and very dispersed **(Fig. 27)**. This is due to the changing character of the war in 1918, evolving towards a more mobile warfare. The main concentrations seem once more related to the main trench lines along the British front. Remarkably some coverage from 1919 also survives. In addition, these images are very hard to interpret. They are possibly related to damage assessment, the writing of official war histories or even the leisure activities of aerial photographers who remained in Belgium and France until 1919.

8. http://www.iwm.org.uk/collections-research/about/photographs

9. Squares 28 C (766 photographs), 28 I (631 photographs) and 28 O (866 photographs).

10. Also known as the First German Drive from 31 March to 4 April.

Fig. 29: Highly detailed vertical aerial photographs of the lunar like landscapes at the frontline(source: In Flanders Fields Museum).

6|

Australian War Memorial

The AWM houses a diverse collection related to different theatres of war. The Western Front Aerial Photographs Collection is well organised and we succeeded in plotting all the aerial photographs per year in the GIS. This overview clearly demonstrates the uniqueness of the archive. In some map squares additional coverage can be found which is not available at the Imperial War Museum. The coverage is divided into two clusters: a first cluster near Ieper and secondly the area within the triangle formed by Arras, Montdidier and St-Quentin.

Of equal interest is the Western Front Mosaics collection. Most of the 333 mosaics were compiled after the war because the importance of aerial photographs for the comprehension of the battlefield was acknowledged by Australia's chief historian, C. E. W. Bean. The photomosaics are a rewarding source which enables us to have an overview of complete front sectors. However, the cartographic applications are rather limited because of large distortions towards the edges. The general aerial collection of the AWM was little known. The intensive analysis of the content elucidates the geographic and temporal distribution of the aerial photograph coverage.

J.21 a.4.6.

J.20a.1.5.

P4Æ.4.
2.7.17 _ 11.
Sh.28.

J 24b90

I 18455

FRONT — — — — LINE — — — — — —

J.21 a.4.6.

J.20a.1.5.

P4Æ.4.
2.7.17 _ 11.
Sh.28.

SORS
WOD

J.152.55.75.

J136.02.

I187.00.55.

BRITISH

Fig. 30: Oblique photograph of the Allied frontline at Hooge and Sanctuary Wood, just east of Ypres (In Flanders Fields Museum).

J.21 a.4.6.

J.20a.1.5.

P4Æ. 4.
2.7.17 — 11.
Sh.28.

I 24698

I.184.55

FRONT — — — — — LINE — — — — — — —

6

Few people are aware of the existence of a major collection of historical aerial photographs in Australia. The Australian War Memorial (AWM) comprises a memorial, a museum and the largest military archive in Australia. This archive is a major source for the study of Australian theatres of war. The memorial was developed out of the Australian War Records Section and as early as 1917, this organisation started collecting paper records, maps, photographs and war relics, forming the foundation of the AWM (Bean 1917). This creates a unique situation where an archive has been formed as part of the process of creating official war history.

The archival department contains an important collection of aerial photographs of different theatres of war. The most extensive is the Western Front collection of aerial photographs. Other coverage is related to Gallipoli and the Palestine Front. Each of the components will be discussed separately. Contrary to the Imperial War Museum, the collection mostly consists of contact prints since not many glass-plate negatives have survived.

The Western Front and Palestine aerial photograph collections are registered in he same way: both are catalogued according to their location on British maps. The Western Front collection is classified upon the location based on the lettered squares on the British 1:40,000 map series **(see chapter 5.1),** which is the same system used at the Imperial War Museum in the UK. The aerial photographs of the Palestine Front are recorded in a similar way, but based on maps with different scales. The principal part of this collection consists of aerial photographic prints, although some negatives are kept at the photographic department. The Gallipoli collection is very confined and comprises only some 60 photographs.

6|1 Western Front Aerial Photograph Collection

The most significant collection at the AWM for this research is the Western Front Aerial Photographs Collection. Glass-plate negatives are not available and the collection can be accessed by browsing through printed aerial photographs rather than a card index[12]. This collection was compiled during the war and in the 1920's by the Australian War Records Section to document the Australian battlefields at the Western Front.

The collection consists of 16,030 possibly unique aerial photographs that are easily accessible and have a huge research potential. Although not comparable with the huge Box Collection of the IWM as regards quantity, it is a very important source for the battlegrounds on which Australian soldiers fought. The collection mainly consists of British photographs taken by the RFC and RAF even though it contains Australian, French and even some captured German aerial photographs. It is a valuable collection of aerial photographs in itself and not just a supplementation to the Box Collection.

The organisation of the Western Front aerial photographs resembles the Box Collection. It allows the retrieval of aerial photographs based on the 1:40,000 GSGS sheet numbers and twenty-four 6,000 yard lettered squares. While organising the aerial photographs, the Australian War Records Section or the AWM staff went a step further. The further subdividing of the lettered squares into the numbered 1,000 yard squares was taken into account as well. However, the date of the photographs was not reckoned. To summarise, there is a split up in 1:40,000 sheet numbers and 6,000 yard lettered squares. The aerial photographs are subsequently ranked by 1,000-yard subdivision instead of the date. The collection comprises 60 well-organised boxes of printed aerial photographs and no distinction is made between vertical and oblique photographs.

The aerial photographs were compiled into a collection to document the Australian battlefields in Belgium and France. Consequently they only start in 1916 when Australian troops were sent over from Gallipoli and Egypt (Bean 1929). The Australian Flying Corps (AFC), a component of the British Royal Flying Corps, only consisted of four complete squadrons.

From these, only three (AFC Nos. 2, 3 and 4) served at the Western Front from the end of 1917 until Armistice (Cutlack 1940). Consequently, the Australians relied almost completely on the British air weapon to provide intelligences and aerial photographs. Because of this, the greater part of the AWM aerial photographs were actually taken by the RFC and RAF. Besides these British photographs, occasionally Australian, some French and even a couple of German photographs can be found.

Since the main organisation of the collection is similar to the Box Collection, the same methodology was applied. The developed GIS file that corresponds to the 1:40,000 map sheets is also applicable for this collection. All aerial photographs were glanced through and counts were made per year for each of the lettered 6,000-yard squares. These counts are based on the quantity of aerial photographs instead of on index cards, which provide the absolute number of aerial photographs. The structure of the collection allows us to explore the distribution of the aerial photographs along the Western Front through time. **Table 7** illustrates the increasing number of aerial photographs. The first year of Australian Imperial Force's (AIF) actions on the Western Front is scarcely represented **(Fig. 32)**. No more than 2,338 photographs for 1916 were put into the archives. Two clusters of photographs can be recorded **(Fig. 32)**. The first gives information on the front between Ieper and Neuve-Chapelle. The emphasis is on Fromelles, the scene of major Australian losses (Bean 1929) and the salient just south of Ieper. The second cluster matches an area on which the battle of the Somme had been fought between June and November 1916. In the north the coverage commences at Neuville St-Vaast and runs south to Thiepval.

Fig. 31: Allied aerial photograph of a destroyed landscape and trench fortification in the Ypres Salient (source: AWM).

The main density is between this village and the ground up to 15km east of the village, corresponding with the area in which fierce fighting took place and the new front line was stabilised at the end of the battle. Against our expectations, no coverage was found of Pozières at all, which was the other famous 1916 Australian battleground. There is no obvious reason why coverage of this area is absent but it is all the more astonishing because the official Australian historian C. E. W. Bean spent more than 250 pages on the episode (Bean 1929). Twice as many photographs are listed for 1917 at the AWM **(Fig. 33)**. The 1916 dichotomy in locations of 1916 aerial coverage however continues. The area covered in Flanders increased towards the north-east of Ieper because of the Third Battle of Ypres. The southern cluster covers the ground gained by the German withdrawal behind the Hindenburg line

and the German back area between 10 and 15 kilometres deep. Remarkably, many aerial photographs were taken of areas held by the Allies. This supports the idea that many photo-reconnaissance missions documented their own lines to check the effectiveness of camouflage and to monitor the construction of field works.

Almost 10,000 aerial photographs can be consulted for the last year of the war **(Fig. 34)**. The northern cluster around Ieper decreased because of the German offensives in Flanders. The highest density was recorded in Hollebeke and Comines-Warneton, and some additional coverage exists for the Merris sector. The second group of photographs was more difficult to analyse: 1918 was a tumultuous year and major parts of the front line shifted their location.

The area covered was enormous: 3,900 km². It extended from the Siegfried line, which the Germans used as a jumping-off point for the Spring Offensive or *Kaiserschlacht*, to the former 1916 battlefield of the Somme over which the Allies were pushed back (Payne 2008). The front stabilised east of Amiens until the start of the final offensive against the Central Powers in Europe on 8 August 1918. This complex situation makes it almost impossible to attribute specific aerial coverage to particular actions or battles in-between the static front lines. The heart of the coverage is located on trench map sheet 62D, near Villers-Bretonneux and Le Hamel (Bean 1937), two locations where major numbers of Australian troops were employed. The coverage near the Siegfried line remains impressive, although no distinction can be made from which phase the photographs date. **Fig. 35** represents the locations of all the photographs taken from 1916 to 1918.

The question presents itself as to whether this collection is unique or consists of files which are also held in the Box Collection. An acceptable answer is difficult to formulate without a detailed comparison of individual aerial photographs of all lettered squares. The GIS plotting of the coverage can however provide some indications. When comparing the total coverage of the IWM collection to the AWM collection in GIS, it immediately becomes clear that most of the AWM coverage is located on the same trench maps as the Box Collection. Yet this was not unexpected because most of the AWM coverage is of British origin.

If the data is examined in detail (when comparing the aerial photograph coverage per year), some unique coverage can be identified at AWM. The AWM collection has unique coverage in 7 lettered squares[14] for 1916 with a total of 23 aerial photographs; for 1917 there are only 5 photographs in 2 unique[15] squares and up to 26 photographs in 8 squares[16] for 1918.

This comparison of GIS data identifies at least 54 unique aerial photographs in 17 squares for which no coverage exists at the Imperial War Museum's Box Collection. Most of the unique coverage is a southwards extension of the IWM coverage. This simple calculation makes it clear that the AWM aerial photographs have to be considered as more than just duplicate files of the Box Collection. Although the minimum number of unique photographs seems rather confined, we have to bear in mind that this is only valid for the squares for which no coverage is available at the IWM. It is almost impossible to compare the content of squares for which both archives have coverage.

AWM	Aerial photographs
1915	0
1916	2,338
1917	4,021
1918	9,671
Sum	16,030

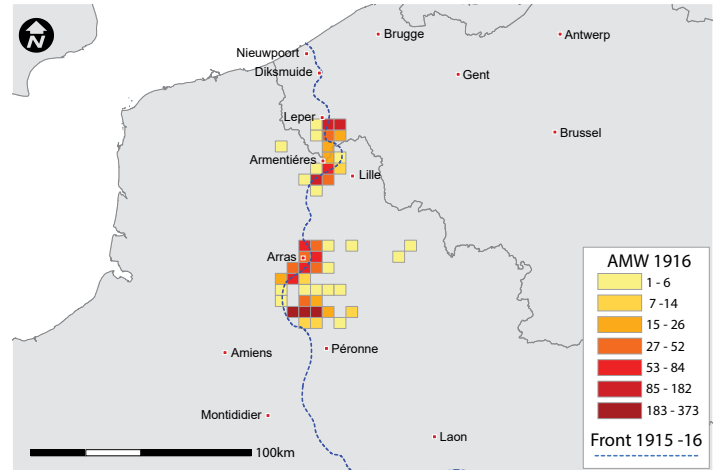Table 7: IWM 1915 oblique photographs.

Fig. 32: AWM 1916 coverage.
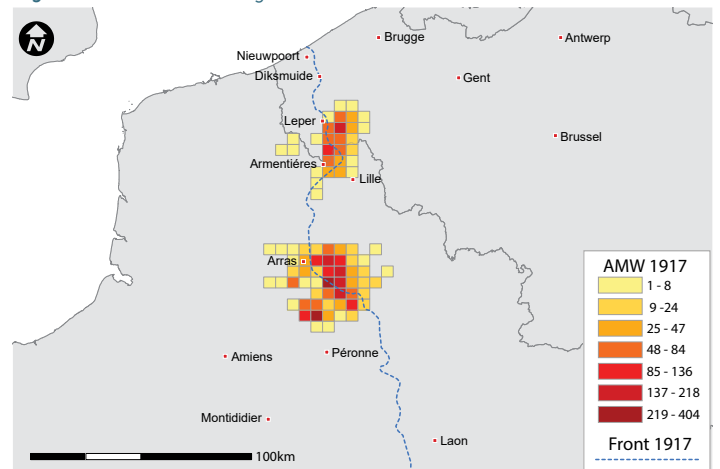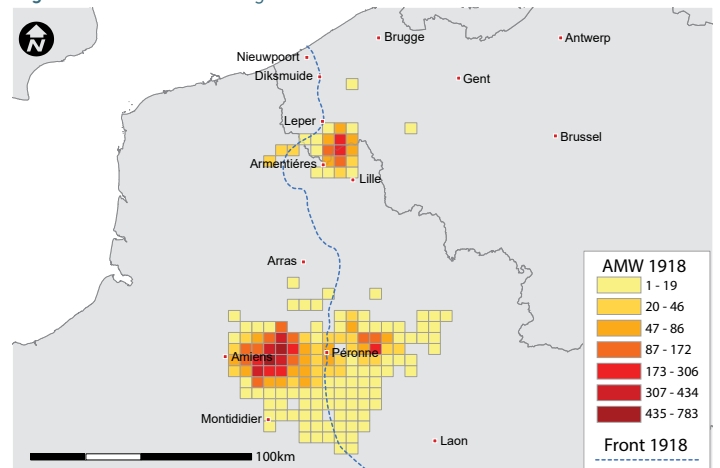

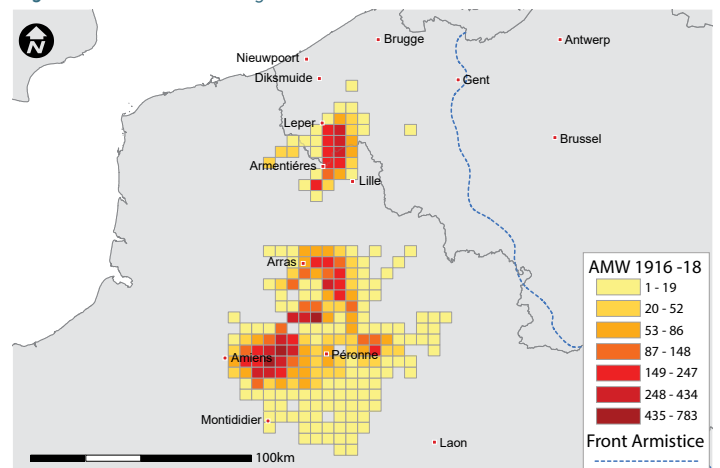Fig. 33: AWM 1917 coverage.

Fig. 34: AWM 1918 coverage.

Fig. 35: AWM 1916-1918 coverage.

6|2 Western Front Mosaic Collection

Separately from the Western Front Aerial Photographs Collection, the archive holds hundreds of large-format photomosaics as part of the map collection of the AWM. Some date from during the war; however the greater part were compiled at the end of the 1920s under the direction of A. E Scammell and P. O. Spicer[17] of the Australian War Records Section. Given the period, the mosaics will have been ordered for the writing of the *Official History of Australia in the War of 1914-1918* edited by C. E. W. Bean (Bean 1929). Bean clearly took an interest in accumulating World War One aerial photographs and the compilation of photomosaics, and acknowledged their value for the interpretation of the battlefields, presumably using the mosaics as an aid while writing parts of the official history of Australia during the war (Woods 2007). The four volumes covering the Australian Imperial Force (AIF) at the Western Front were published between 1929 and 1942 (Bean 1929, 1937, 1938, 1942).

The mosaics are, in general, compiled from photographs taken by the British Royal Flying Corps. Occasionally some aerial photographs taken by one of the squadrons of the Australian Flying Corps or French Escadrilles can be spotted. Most of the mosaics consist of the original collaged photos; others are high quality reproductions. The map collection is arranged in 16 Periods of artificial time spans, referring to specific actions during the 1914-1918 war.

There are no mosaics available for the first four periods, and it is not even clear what areas the first four periods cover – presumably they are Gallipoli and the campaigns in the Near East. The different periods cover and illustrate the following actions [18]:

5 - Armentières:
April-July 1916

6 - Fromelles & Armentières:
July - October 1916

7 - Pozières & Mouquet Farm:
July - September 1916

8 - Armentières:
November 1916 - April 1917

9 - Ypres:
September - October 1916

10 - Somme:
October 1916 - February 1917

11 - Retirement from the Somme:
February-April 1917

12 - Hindenburg line:
May 1917

13 - Messines:
May-August 1917

14 - Ypres:
September-November 1917

15 - Messines:
November 1917 - March 1918

16 - Merris:
April-July 1918

The collection of mosaics contains 333 photomosaics and photomaps in total. Because of the diverse scale and the area covered by the mosaics, we did not represent the distribution of these mosaics in GIS. Since the AIF only arrived in France in the spring of 1916 (Bean 1929) and the collection is concentrated on the Australian involvement in the war, no mosaics are available for 1915. There are many mosaics available for 1916, focusing on the Ypres salient, the Somme, Armentières, Fromelles, Pozières and Mouquet Farm. It is remarkable that coverage for Pozières is available, as this forms a gap in the Western Front Aerial Photographs Collection.

Even more photomosaics are listed for 1917. They are mostly for Armentières, the last phases and the retirement from the Battle of the Somme and the Third Battle of Ypres.

The 1918 mosaics are more confined, both in number and in spatial distribution. They only document the aftermath of the battle for Messines Ridge and the Merris front sector near Bailleul.

The photomosaics at the AWM are a useful tool to explore the organisation and structure of the front sectors were Australian activity took place. At a single glance it is possible to gain an overview of both the front line and the back areas. As they were nothing more than collages, their cartographic value is limited. Due to the movements of the aircraft that served as photographic platforms, it was almost impossible to obtain perfect vertical photographs and these distortions were not corrected on the photomosaics. Due to this, flaws can be detected where roads and trenches do not match up accurately and, as a result, the precision of the mosaic work is far from ideal.

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11. More practical info and an extensive online search engine on: http://www.awm.gov.au/

12. A card index is available, but for the Western Front the correlation between the card index and the boxes with aerial photography is unclear. Therefore we chose to base our analysis on the actual photographs rather than this card index.

13. The Royal Flying Corps was created on 13 May 1912. On 1 April 1918, the Royal Flying Corps and the Royal Naval Air Service were joined to form the Royal Air Force (RAF).

14. 27 W, 51B E, 51A D, 51A I, 51B O, 57C C and 57C Q.

15. 27 W and 27 X.

16. 66D T, 70E H, 70E G, 70E A, 66E P, 66E Q, 66E V and 70F D.

17. On many mosaics the compilation date is mentioned together with the person responsible for the plotting of the aerial photographs.

18. The same spelling of place names is used as indicated on the mosaics. The numbering starts from five, this is because for the first four periods there are no aerial photographs available.

BATTLE WOOD

CHATEAU

WHITE CHATEAU GROUNDS
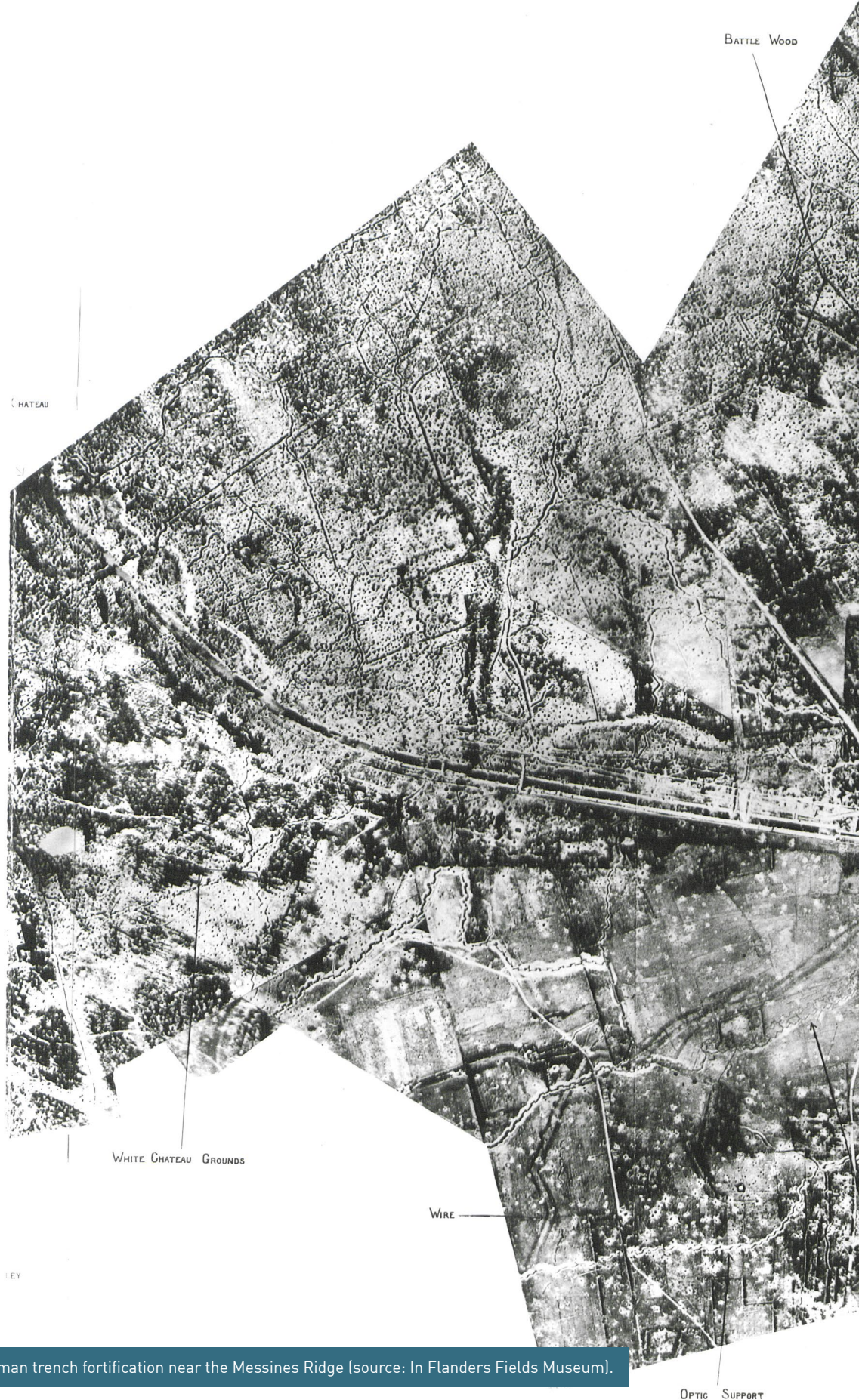
WIRE

LEY

OPTIC SUPPORT

Fig. 36: British mosaic showing the German trench fortification near the Messines Ridge (source: In Flanders Fields Museum).

IMP AVENUE

MOUNT SORREL

IMAGE CRESCENT

KLEIN ZILLEBEKE

OAF KEEP

DUMP

OBLIQUE TRENCH

YPRES–COMINES RLY.

CEMETERY

P.S. 6 Sqdn. R.F.C.

7| Bavarian War Archive

The Bavarian War archive in Munich houses what is assumed to be the largest known archive of World War One aerial photographs, of which the collection of reconnaissance photographs *(BS-Aufklärung)* is the most sizeable and important. As for the quantity of aerial photographs, the collection is beyond comparison but unfortunately this pictorial collection has not been thoroughly researched and many questions remain unanswered: for example, the actual number of collected aerial photographs.

By means of the GIS-approach and reprocessing of the finding aid it is possible to cast light upon the distribution and content of this archive; not only coverage of the Western Front in Belgium and France is available but parts of other war theatres are also represented. The plotting of the place names clearly indicates a clustering of the aerial photographs in two distinct areas at the Western Front, which probably corresponds with the Bavarian army corps area of operations.

Unfortunately the content is not as well known as for instance the IWM, AWM and KLM-MRA. Instead of a geographical classification of the photographs, the organisation of the Bavarian War Archives holds on to the principle of originality; the collection is organised as the images were received. This means the *BS-Aufklärung* is filed according to the units who took the aerial photographs, which affects the accessibility of the aerial photographs. To get round this difficulty, the finding aid was adapted and converted into an alphabetical index list. Moreover, most of the place names have been plotted in the GIS, elucidating the geographic coverage and density of this unique collection. This approach makes the collection easier to survey. Unfortunately the coverage seems less coherent and more scattered than, for example, the IWM's photographs.

The Palestine aerial photographs of the archive are also important. Compared to the *BS-Aufklärung* this collection already has been used by a variety of applications. A detailed catalogue of the images is available in the archive.

Several collections covering parts of Germany during World War One came into being as training material for Bavarian pilots and observers. The actual size of these collections is not really understood since their description by Fuchs (2000) and Braun (1994) is inconsistent. However it is indisputable that these pictorial collections (*BS-Flieger-Beobachter-Schule Schleissheim* and *BS-Luftaufnahmen Lager Lechfeld*) contain more than 10,000 images of Bavaria and are a unique source for fields of study such as historical geography, geology and archaeology.

327.

328.

Wilhelm-Stellung

Fig. 37: Detailed photograph of the destoryed landscapes in the Ypres Salient (In Flanders Fields Museum).

7

In our search for large collections of Great War aerial photographs, we were soon confronted with problems relating to collections. After Germany's retreat and the armistice in 1918, the records and files of the different German armies[19] were taken with them (Fuchs 2000).

During the Third Reich almost all aviation records of the independent armies were collected in a separate archive. Unfortunately most of this collection was destroyed during the Second World War (Fuchs 2000) therefore secondary sources have to be used (Potempa 2000).

Fortunately not all of the historical records were sent to Berlin. For instance, some major photographic collections remained at the *Bayerische Kriegsarchiv,* the Bavarian War Archive in Munich , with important aerial photograph collections among them. Achim Fuchs, the former director of the archives, states that: *"one can hardly estimate the number of aerial reconnaissance photographs"* (Fuchs 2000).

Aerial photos can be found in different photographic collections of the Bavarian War Archive *(Bildsammlungen or BS).* The most extensive collection is the *BS-Aufklärung* (Photo-reconnaissance collection) and it covers different theatres of war but mainly the Western Front. German aviation units were also active in Egypt and Palestine. In total, 2,663 aerial photographs of *Feldfliegerbateilung* 304 are stored in the glass-plate negative collection of the Palestine collection *(Negativ Sammlung: Palästina-Flieger-Aufnahmen).*

The collection of aerial photographs taken by training units in Germany is also important *(BS. Flieger-Beobachter-Schule Schleissheim).* It contains more than 10,000 aerial photographs of places and military installations in Bavaria.

Additional aerial photographs can be found in a variety of other pictorial collections, although their composition is less coherent; for example *Bestand Luftaufnahmen Lager Lechfeld, Bestand Bildsammlung Vermessungstruppen* and finally the *Bildsammlumg-Nachlasse.*

The most important collections will be described in detail. However, it is important to bear in mind that these collections are accompanied by little information on their origin and composition. The primary focus of our approach is to make the collections more accessible by elucidating the content of the main collections through a GIS approach.

7|1 BS-Aufklärung – Western Front aerial photographs

The Bavarian War Archive supposedly houses the largest collection of World War One aerial photographs in the world. However there is little knowledge of its content. Occasionally the collection is briefly mentioned in publications, mostly emphasising its volume (Fuchs 2000). Fuchs summarises the collection for instance as:

"...aerial photographs taken during military missions... the number of photos is in the six figures, but many exist in duplicate and triplicate. They are mostly from the Western Front. Most are paper prints but from the Bavarian units there exist about 10,000 glass negatives." Fuchs 2000)

The quantity of the collection is mostly described as "a six number digits of photographs". Real numbers on the content are not yet available. This collection is known at the Bavarian War Archive as the Bildsammlung-Aufklärung, the pictorial collection of reconnaissance photos. The Bavarian War Archive and also the BS-Aufklärung are organized by origin of material. For the aerial photographs this means that they are arranged according to the units which took them. The majority of the units are of Bavarian origin, although Prussian and occasionally even Württemberg units also show up.

This collection was put together using photographs which had been sent to higher levels such as army groups, armies and divisions or specific users such as cartographic units and artillery commanders. Additionally some series of photographs were ordered by army detachments for a specific tactical use or documentation.

7|1 .1 Organisation and structure of the Western Front aerial photographs collection

The collection is only described to a certain degree in the reference guide. The *BS-Aufklärung* consists of 127 box files containing large numbers of aerial photographs per box , archived in far from ideal circumstances. Some of the photographs are in bad condition and in some cases hundreds of photographs are curled up to fit in the box folders. The collection seems to be made out of two parts. The first part consists of box files numbered from 1 to 86. These are photographs from different units. The following 41 box files are named by the unit which took the photographs (i.e. Box File Prussian *Fliegerabteilung* 23). The reason for this division is unclear and it does not relate to a difference in geographic coverage or a distinction between Prussian and Bavarian photographs.

The finding aid to the collection describes the contents per box file. It mentions the unit responsible for taking the photographs, a general location of the aerial photographs based on several headwords, a selection of place names for which coverage is available and sometimes even gives a map reference to a 1:25,000 map. The use of a geographic headword only applies for the numbered box files (1-86).

Ordinarily sized series of photographs from the same photo-reconnaissance flight are kept together. Consequently, large areas are covered with photographs of the same date, allowing an overview of complete front sectors rather than individual sites. Additionally this facilitates the selection of overlapping photo-graphs that can be used for stereoscopic research.

7|1 .2 Spatial distribution of the BS-Aufklärung

The geographic coverage of the *BS-Aufklärung* is divided over different front lines at distinct theatres of war. The finding aid comprises a classification of these fronts in headwords, thus simplifying the immediate recognition of the photographed area. To gain a more profound insight in the collection, this subdividing is represented:

1. Western Front

   a. Flanders: Belgian coast to Armentières

   b. French Flanders: Armentières-Lens and the French hinterland up to the Straits of Dover

   c. Artois: Lens-Bapaume and the French hinter land up to the coast

   d. Somme: Bapaume-Noyon-La Frère

   e. Champagne: front north and northeast of Rheims

   f. Côtes Lorraines: Verdun-St-Michiel-Toul

   g. Lorraines: Nacy-Lunéville up to the western part of the Vosges

2. Eastern Front

   a. East: Volhynia-Kovel-Strochod (Ukraine)

   b. Baltic States and Finland: northern front near Riga, Reval and Saint Petersburg

   c. Galicia (Central-Europe): Beskids, Przemysl-Lemberg-Cernowitz

3. South-eastern Front

   a. Transylvania and the rest of Romania
   b. Macedonia: Albania-Saloniki up to the Bulgarian border

4. Southern Front

   a. Isonzo Front

   b. Venice: Italian hinterland in the Udine area up to the Piave.

Not all fronts are equally represented; most of the coverage is related to the Western Front. This list therefore only gives a representative view of the collection.

While browsing through a large number of boxes, mostly related to the Flanders front lines, it is possible to state that the collection is much bigger in selected areas than suggested. For instance, the represented place names in the finding aid are only a brief selection. For other box files, a dispersed geographic distribution is suggested while most of the coverage concerns a single village.

7|1.3 Assessing the coverage of the BS-Aufklärung

The primary idea behind assessing the distribution and density of the collection was to create an alphabetical index that could be visualised in the GIS and used as a research tool. However, this would not give a quantitative appreciation of the distribution because the number of photographs remains unknown. In order to have at least a basic idea of the density of the *BS-Aufklärung*, the incidence of the place names in the newly created index list was counted.

The first step in this process was to convert the finding aid (containing a list of box files and a selection of place names) to an alphabetical list of place names. This list contains a reference to the box files in which they can be found in and a number of the listings in the finding aid. For instance Kemmel was counted a total of six times in box files: 12, 13, 14, 23, 51 and 92. The box files were renumbered since only boxes 1-86 had a number in the Bavarian War Archive so the remaining 41 boxes were consequently numbered from 87 to 127.

	Place names	Times mentioned	
Located in Google Earth	439	1.224	
French village	598	2.410	
Unlocated	278	363	
Sum	133.288	141.000	7.712

Table 8: Overview of located place names related to the BS-Aufklärung

Place name	Times mentioned
Armentières	67
Bethune	66
Merville	65
Arras	62
Bailleul	60
Hazebrouck	55
Estaires	49
Lillers	48
Lens	45
Dikkebus	43
Poperinge	42
St Omer	40
Ypres	39
Doullens	38
La Bassée	37
St Venant	31
Lille	30
Aire	29
Douai	27
Givenchy-En-Gohelle	26
Wijtschate	25
Saint-Pol-Sur-Ternoise	24
Bapaume	24
Ablain-Saint-Nazaire	23
Bruay-La-Buissiere	23
St Quentin	22
Warneton	20
Toul	20
Air-Sur-La-Lys	20

Table 9: The 30 most frequently mentioned place names in the BS-Aufklärung.

Fig. 38: Point density map of the BS-Aufklärung (Robinson map projection).

Aerial Photos
- 1 - 5
- 6 - 15
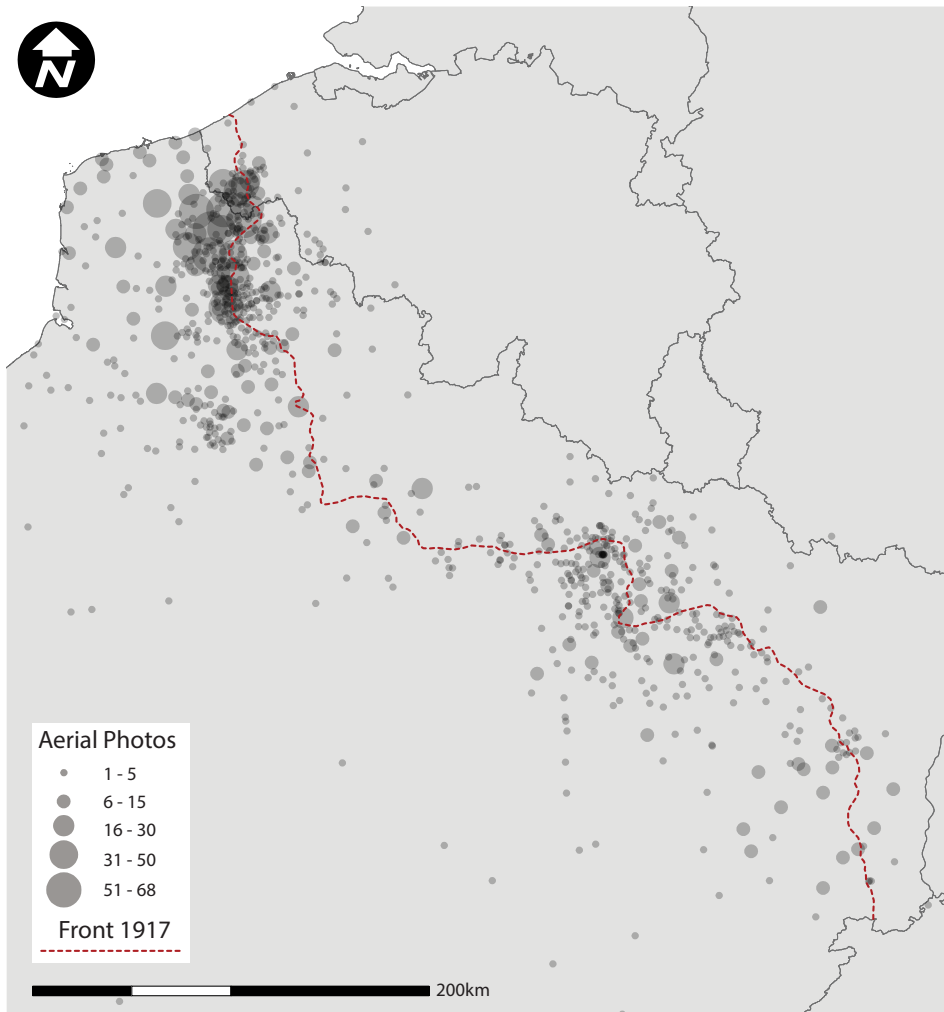- 16 - 30
- 31 - 50
- 51 - 68

Front 1917
- - - - -

200km

Fig. 39: Frequency of located toponyms in Belgium and France related to the BS-Aufklärung.

It was discovered that only 1,315 place names were mentioned in the finding aid and compared to the bulkiness of the archives, this number was rather on the low side. These names were mentioned 3,997 times in the finding aid.

The next step consisted of searching the location of the place names. Several problems were encountered concerning the spelling of these in the finding aid. Firstly there were German transcriptions of foreign place names, secondly the lists contained many spelling mistakes and finally many of the place names do not exist anymore or were only in use during the war. As a result, not all of the place names mentioned in the finding aid could be easily retrieved on modern maps and because of the huge area covered it was not feasible to make use of contemporary trench maps for the location of the toponyms, as was done successfully for the KLM-MRA collection.

Two different techniques were applied for retrieving the location of the place names. First of all it soon became clear that most of the place names were located in France. Instead of manually locating each place name as a point location on a map, a semi-automated procedure was followed. A first attempt was made to link the newly generated Excel file to a GIS file with the locations of all of the villages in France . This new layer represented the location of French villages which show up in the reference guide. Unfortunately many French municipalities have the same name so this resulted in making a choice as to which community was referred to in the refer-ence guide. As a rule, we first looked at the communities in the same box file and in most cases this already gave a conclusive indication about the correct location of the place names. But if there were still several options open, the place name closest to the front was selected. In total 598 of the to-ponyms were located during this operation **(Table 8).** These communities are men-tioned 2,410 times in the finding aid. For locating the remainder of the toponyms, Google Earth was used.

Country	Unique place names	Listed place names
France	835	3.164
Belgium	68	295
Romania	32	36
Ukraine	18	42
Greece	13	20
Slovenia	11	12
Italy	10	10
Macedonia	6	10
Finland	3	3
Poland	3	3
Turkey	2	3
Albania	2	2
Bulgaria	2	2
Germany	2	6
Czech Republic	1	1
Denmark	1	1
Estonia	1	1
Lithuania	1	1
Serbia & Montenegro	1	2
Switzerland	1	2
United Kingdom	1	1
Russia	1	3
Sum	1.015	3.620

Table 10: Mentioned place names per country.

In the searching interface, the remaining place names (and variations in the spelling) were looked up [23]. Using this method, an additional 439 toponyms were located, corresponding with 1,224 listings.

Only 278 toponyms were not located which corresponded to just 363 listings in the finding aid. Most of these names are related to the Eastern Front and are probably the result of incorrect German transcriptions or place names that are not in use anymore.

Some of the place names are mentioned several times, some even up to more than 60 times. **Table 9** represents an overview of the 30 most frequently mentioned place names. These names are mentioned in total 1,100 times in the original document and represent 28% of the total sum of place names. All other toponyms are less than 19 times mentioned in the finding aid. The communities with most coverage are all located on the Western Front. The given place names represent the most densely covered areas and these all lie roughly between Ieper and Arras. The 1,013 place names which are only mentioned once or twice (i.e. 78% of the different place names) will have in general a smaller amount of aerial photographs.

The methodology employed enabled most of the mentioned place names to be located in their geographical context. This mapping allowed an increased comprehension of the geographic extent of this huge collection. Although no absolute numbers are available, an appreciation of the zones with the greatest aerial coverage can be observed through the dot density. **Fig. 38** shows all located place names. There is aerial coverage in at least 22 different countries (see also Table 10)[24].

Most coverage is available for the Western Front in Belgium and France, followed by Romania, Ukraine, Greece, Slovenia, Italy and Macedonia. For the remaining countries, significantly less place names are mentioned in the search tool, thus it is important to keep in mind that the place names we were unable to locate are mostly situated at the Eastern theatres of war.

Two clusters can be determined in Belgium and France. The first group corresponds with the area between the Ypres salient and Péronne. The second cluster is located between Rheims and Saint-Die, with the main point near Verdun. As expected, a large part of the coverage is located behind Allied lines so the Bavarian War Archive is consequently the most important source for studying the allied hinterland.

Since there is no time aspect connected to our GIS analysis, it is not possible to discover the relationship between specific coverage and particular events. However, because of the Bavarian origin of the *BS-Aufklärung*, we can assume much of the coverage is related to the operations of the Bavarian Army.

7|2 Other collections at the Bavarian War Archive

In order to give an exhaustive overview of the aerial photographic collections of the Bavarian War Archive the *BS-Palästinabilder* collection should also briefly be mentioned. It is the counterpart of the Palestine Collection at the AWM. However, the organisation in Munich is somewhat more structured and a selection of photographs is described in a catalogue.

The potential for archaeology and landscape studies was already acknowledged during World War One by Theodor Wiegand. Also immediately after the conflict, Dalman described a large array of possible applications of this source: geology, meteorology, settlement studies, cartography and even archaeology (Dalman 1925, Braun 1987). The Palestine pictorial collection is perhaps the best known of all aerial photograph collections at the Bavarian War Archive and in more recent times they have been used and mentioned in a variety of publications (Kedar 1999, Kennedy 2002).

Some supplementary pictorial collections are also mentioned below. However these form no coherent entity and are merely a mixed group of photographs.

First it concerns the *Bestand Luftaufnahmen Lager Lechfeld,* which contains 697 aerial photographs of Germany, most dating from 1918. According to Braun (1994), these images are part of the Schleissheim pictorial collection, but in 2007 it was obvious they clearly formed a separate collection at the war archive.

Some aerial photographs can be found in the *Bildsammlung Vermessungstruppen*, the pictorial collection of the cartographic units. In box file 64 and 65 some interesting records concerning the restitution of aerial photographs to maps can be found. In addition, some photo albums of the Eastern Front can be consulted.

Finally, a couple of hundred aerial photographs are located in the *Bildsammlumg-Nachlass*, a collection of photographs obtained by legacies. The legacy of Johann Czernmak, Paul Schiffer, Lorenz Köhler and Reinhard Kestern in particular contain a variety of aerial photographs[25].

The pictorial collection of the Bavarian Aviation Observer School at Schleissheim (*BS-Flieger-Beobachter-Schule Schleissheim*) contains aerial photographs of Bavaria taken between 1891 and 1921 (Braun 1987). Currently the collection *BS-Flieger-Beobachter-Schule Schleissheim* contains more than 10,000 aerial photographs of Bavaria taken during the war. An exact number is not available. The finding aid indicates it is the remainder of a much larger collection which was shipped to Berlin during 1938-1939. The finding aid also contains the date and place, and the name of the pilot and the photographer are mentioned. Furthermore some technical information is reproduced concerning flying height, shutter speed, focal length, use of yellow filters, time and weather conditions.

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19. The German armed force during the First World War was mainly composed of Prussian, Saxon and Bavarian armies, along with contingents from the other states.

20. http://www.gda.bayern.de/home/

21. During our research it became unclear as to whether the BS-Aufklärung contains the circa 300,000 mentioned aerial photographs or if only a portion of the photographs is organised into 127 boxes.

22. French GEOFLA® Communes dataset. Each community is represented as a point location.

23. Furthermore these locations were saved in Google Earth as place marks (*.klm files) and imported in GIS using the klm2shape.avx extension.

24. This data was obtained by plotting the place names in GIS. The digital contours of the different countries however represent the European situation up to 2006, before the splitting up between Serbia and Montenegro.

Fig. 40: Early aerial photograph of the burning city of Ieper (Belgium) during the Second Battle of Ypres (source: In Flanders Fields Museum).
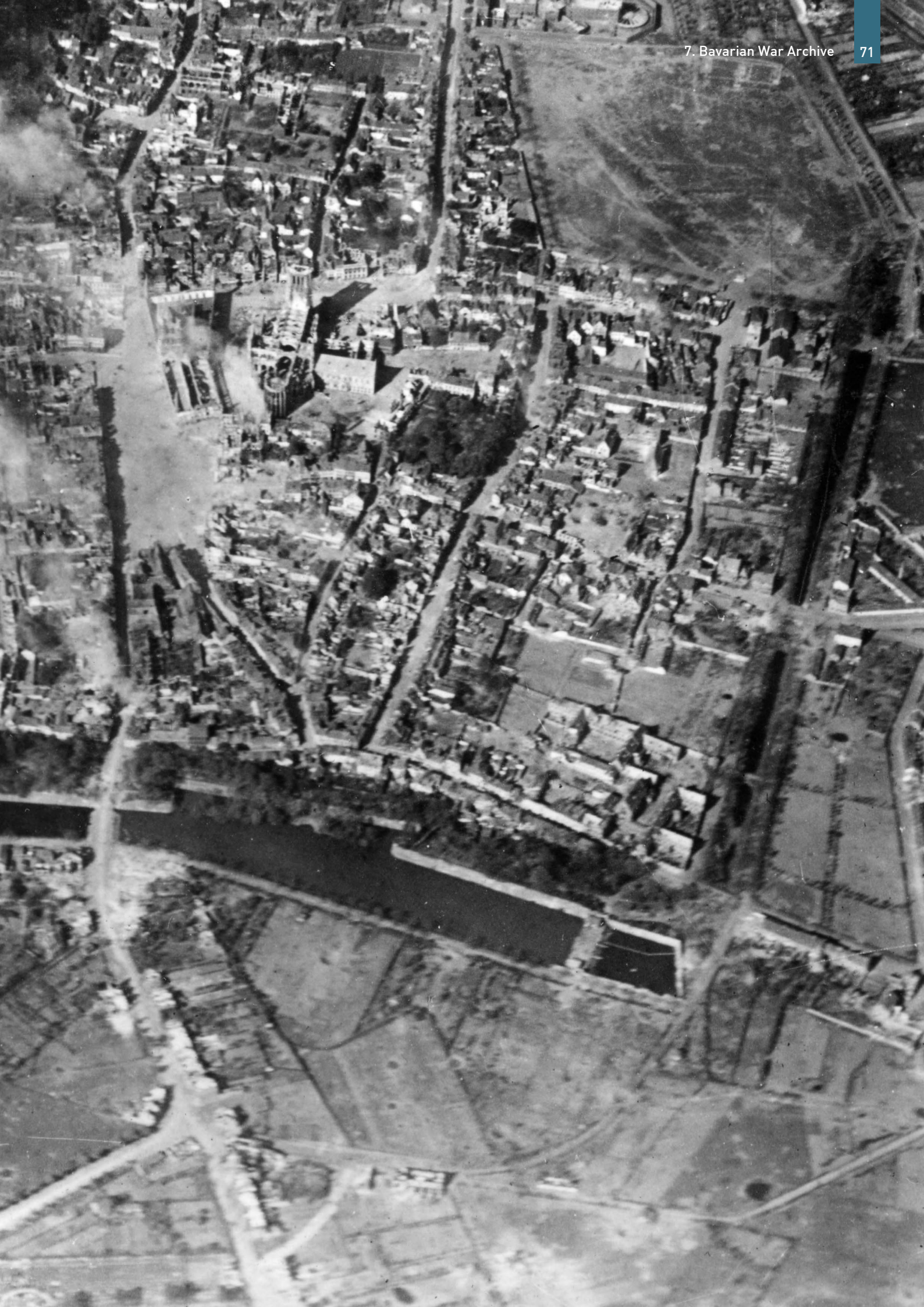
8 | National Archives and Records Administration (NARA) – Washington

Although RG 120 is not the most sizeable collection, the aerial photographs still have special value. Firstly, it is the only know systematic collection of American military aerial photographs of the period. Secondly the structure of the collection allows the retrieval of individual aerial photographs by means of the attached reconnaissance maps and because the photographs are stored in the order they appear on the reconnaissance maps, this archive has a huge potential for stereoscopic research of overlapping images. This is the easiest archive in which to find these kind of photographs. An additional benefit is that photographs on the same reconnaissance map are of the same date and the coverage joins well, making it possible to study an entire landscape at a specific moment.

Because of the lack of an inventory or classification of the boxes with the French aerial photographs it was not possible to include them in the detailed overview. However, most of the boxes were inspected and many of the aerial photographs were examined. This revealed that some of the French photographs are also located in the Meuse-Argonne area. Additional boxes cover Lorraine, Alsace, Luxemburg and Rhineland. The French photographs are filed according to their original serial number.
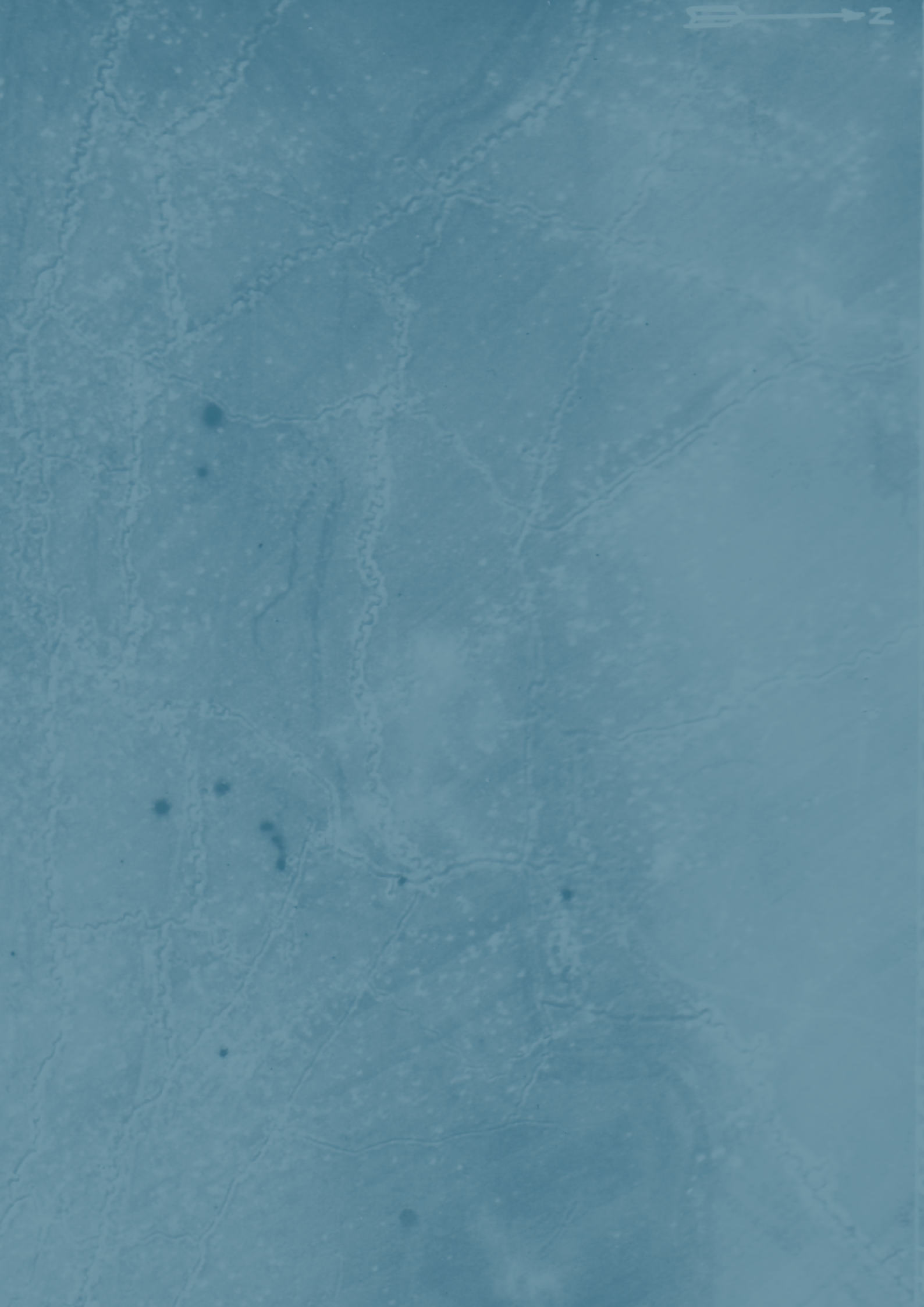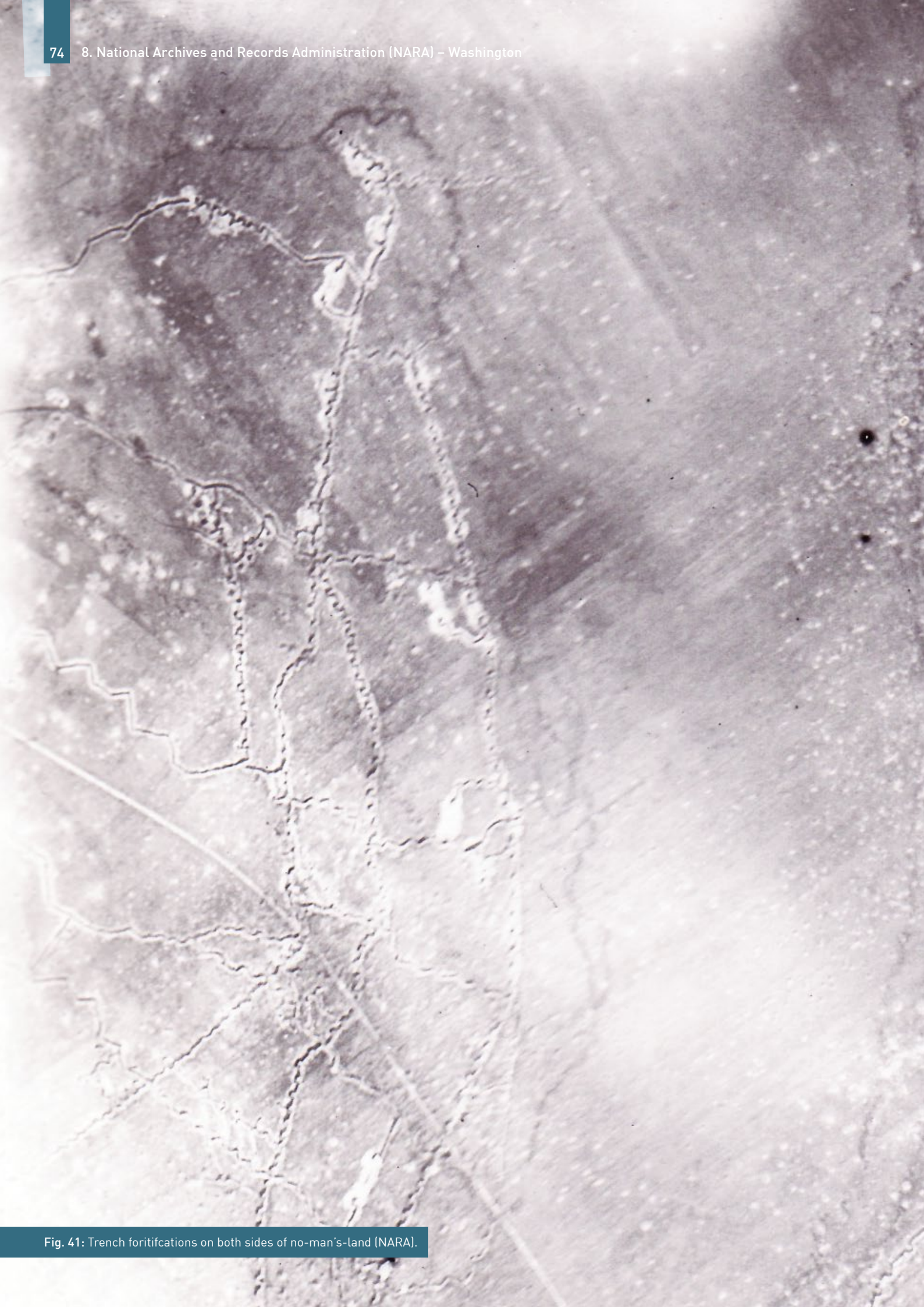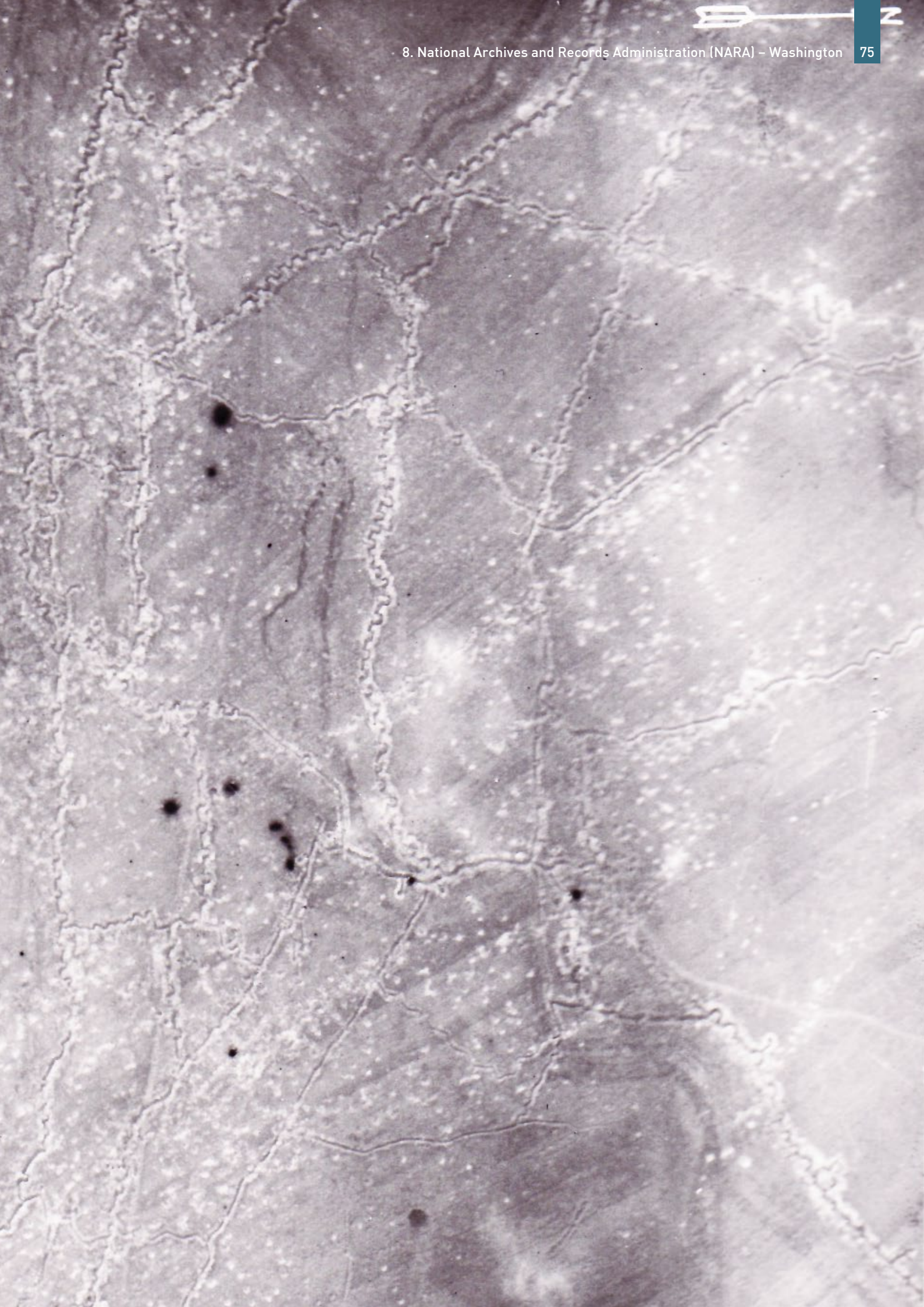
Fig. 41: Trench foritifcations on both sides of no-man's-land (NARA).

8

When Woodrow Wilson declared war upon Germany in April 1917, the United States entered the war in Europe on the side of the Allied Powers. Compared to the air services of its Allied Powers, the Aviation Section of the US Signal Corps (the US military aviation) was still in its infancy. In May 1918 it was transformed into the Army Air Service of the American Expeditionary Force (AEF). In total, 45 AEF squadrons saw action on the Western Front, 18 of which were observation units (Anon. 1962).

The Americans also applied aerial photography at the Western Front (Maurer 1978), but only after a learning period based on British and French examples, simply because virtually no experience in aerial photography was gained by the Americans before the declaration of war (Finnegan 2006). The search for unexploited archives containing World War One aerial photographs directed our attention to the National. Archives and Records Administration (NARA) in Washington D.C. This is an independent agency containing the federal records of the United States.

The guide to the archives (Matchette 1995) refers to the records of the American Expeditionary Forces as Record Group 120. Within the records of the 2nd Section of the General Staff (GHQ AEF), the 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).

Although the existence of this pictorial collection is described in Matchette (1995) and NARA (2008), few researchers are aware of its existence. The collection has been barely used for conflict archaeology or applications such as historical geography in large part because no finding aid or detailed description of the aerial photographs is at hand.

Also, because they are listed within the records of the 2nd Section of the General Staff, the department responsible for military intelligences, one has to be familiar with the structure and function of aerial photography (gathering intelligences on the enemy) to be able to make the connection "aerial photography-intelligence – 2nd Section GHQ". Even these sources proved very hard to find at the NARA, since their exact location could not be derived from Matchette (1995) or the online guide to the NARA. They are at the cartographic department at the College Park branch of NARA.

8|1 Record Group 120: Aerial photos American Expeditionary Forces

The aerial photos of the American Expeditionary Forces are divided into 124 box files. A concise index to these box files is available as an addition to the preliminary inventory of the cartographic records of the AEF (Burch 1966). In January 2007, a one-page description of the aerial photographs became available, estimating the size of the collection as approximately 26,000 aerial photographs[26] (NARA 2007). However in NARA (2008) the collection is described to hold 16,291 items.

The collection only contains printed aerial photographs, typically measuring 18 x 24 centimetres. The NARA aerial photographs can be divided into four parts. The first part is all the miscellanea boxes containing various maps, aerial photographs and even ground photographs (Boxes 1-6). A second part contains American aerial photographs taken in 1918 (Boxes 7-25). The next group comprises aerial photos from 1919 of the American occupied territories in Germany (Boxes 26-68), but these boxes contain many duplicates (Boxes 37-68). The final box files only contain French aerial photographs (Boxes 69-124) of escadrilles attached to French army corps.

The American aerial photographs take up less than half of the collection as the vast majority of the images are of French origin (55 boxes). Only 30 boxes are unique aerial photos taken by the American Air Service.

The photos are first arranged by nationality. A further subdividing is based on the American Army Corps or French *Corps d'Armée* for which the photographs were produced. Subsequent arrangements sort the photographs by squadron or escadrille and finally the photographs are set in order by their original serial number.

Fig. 42: American WW1 aerial photograph of the French town of Montfaucon (source: NARA RG 120).

8|1 .1 Geographic content of NARA RG 120

Many of the American photographs are accompanied by a series of so-called "Reconnaissance Maps" which outline the location of individual photographs. Unfortunately these index maps are not complete. Boxes 7-19 and 22-23 are complete but Boxes 21, 24 and 25-35 have only partial coverage.

A difference in the nomenclature of the reconnaissance maps can be observed. Some mention "Reconnaissance Maps of 1st Army", others "Army Corps". This gives a first indication of the area in which the aerial photographs were taken. Aerial photographs taken for an army corps (military organisation consisting of several divisions), will be taken relatively close to the front line because they have a rather limited tactical horizon. Aerial photography in service for an army (several army corps) (Anon. 1962), mostly took place during long-range reconnaissance missions. Most aerial photography found at the NARA is related to Army Corps aerial photography and has a focus on the front line and the immediate hinterland[27].

The reconnaissance maps contain the plotted contours of the aerial photographs which were taken during a single flight **(see for instance Fig. 43)**. Each of these squares is numbered so it corresponds with the World War One serial number of the images and the maps are named after the squadron which undertook the photo-reconnaissance mission. Additionally the photographed region, date, height, time, and name of pilot and observer are reproduced on most of the index maps. On some maps, the centre coordinates of the photographs are represented in the French Lambert projection.

No form of index is available for the French aerial photographs therefore we know very little about this part of the collection. However, the large quantities of French aerial photographs is easy to explain: some French *escadrilles* were assigned to the American Army Corps or Army observation groups (Anon. 1962) and a close co-operation existed between the Allied air services.

All 1918 coverage of the American aerial photographs is restricted to France, and more specific areas involving American troops, such as the Second battle of the Marne, the Battle of Saint-Mihiel and the Meuse-Argonne campaign (Toulmin 1927). Aerial coverage by American squadrons becomes available no earlier than April 1918. For some areas photographs are available up to the last days of the war in November 1918.

Additionally, a number of aerial photographs from 1919 are available, some depicting the aftermath of the war in France. Apparently in 1919 orders were still given to photograph the abandoned principal German positions on the American battlefields , the explanations for which can vary. It is possibly connected to the writing of the official war histories; other hypothesises are war damage assessment or conducting training flights with newly arrived pilots with no war experience.

Most of the post-war coverage was related to the Allied occupation of the German Rhineland, the principal points of interest being watercourses and connecting roads. Some rare photographs shed light on the photographers' cultural interests as numerous chateaus and castle ruins were also documented.

It must be clear that this collection is under no circumstances to be considered as the complete archive of American aerial photographs taken between 1918 and 1919. Only a portion of photographs survived but the selection criteria are once more unknown. According to a leading officer in the American Air Service, 32,345 glass-plate negatives were exposed during the field campaigns (Toulmin 1927).

Processing RG 120

In order to have an understanding of the collection's distribution, similar to the study and analysis of the other archives or museums, a GIS research was initiated. All available 461 reconnaissance maps were reproduced at the National Archives. Although not all the aerial photographs are accompanied by these index maps, it is believed they give a basic idea of the distribution of at least a part of the collection.

The reconnaissance maps were geo-referenced. The positions of churches, spread over the surface of the reconnaissance maps, were used as ground control points but it was only possible to use this approach for the maps in France. Some of these maps were positioned in the American occupied territory in Germany and since we did not succeed in the acquisition of detailed base maps for this region, a different methodology was used.

Once the maps were in position for France, their outline was drawn in the GIS. The attribute table of this shapefile contains,
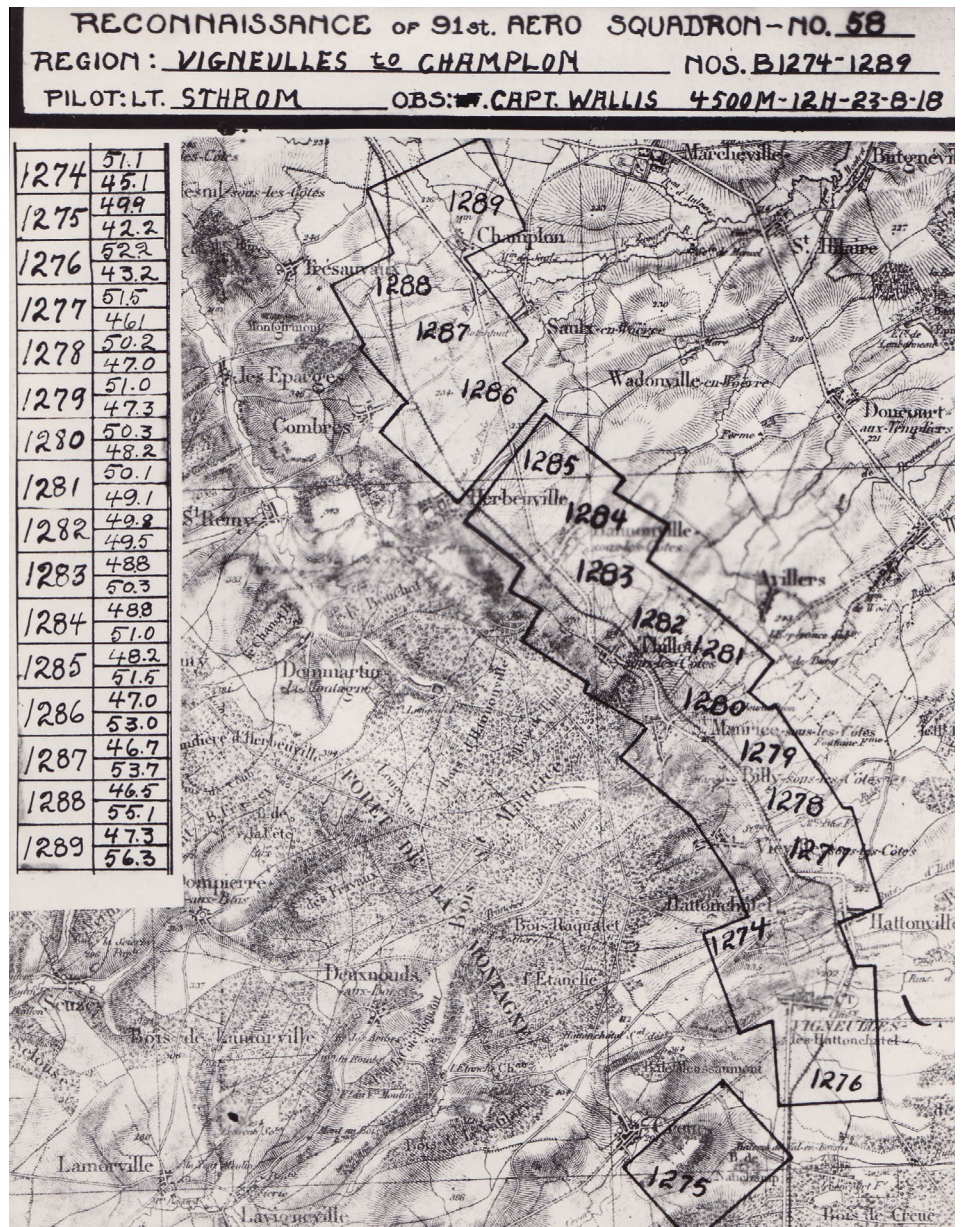

Fig. 43: Extract of Reconnaissance Map (source: NARA RG 120).

where possible, information concerning the flight recorded on the map, such as the date and flying height. The next step consisted of extracting the location of the individual aerial photographs. We decided not to digitise the contours of the photographs because this information was already available on the georeferenced reconnaissance maps. Instead, a point layer was created. For each aerial photograph on the reconnaissance maps, a dot was drawn in the GIS. The result is a point distribution map, representing the individual location of all the photographs that were plotted on the reconnaissance maps found at NARA.

The maps located in Germany were processed using Google Earth. Because of the relatively low density of aerial photographs on the reconnaissance maps, we decided to manually locate the photographs without

georeferencing the reconnaissance maps. Each point was given the name of the reconnaissance map. By doing so, the same amount of information is stored as with the georeferenced maps.

Distribution of RG 120 aerial photographs

The methodology used allows for analysis and visualisation of the aerial photographic collection within the NARA Record Group 120. The distribution of aerial photographs indicates that the coverage is clustered into five distinct areas. Additionally, the flight patterns of the aircrafts can clearly be seen, which is not surprising because the index plot maps (reconnaissance maps) are a reflection of the photographs taken during a continuous flight.

7,267 aerial photographs were located. An initial small cluster of 171 photographs is situated 30 kilometres east of Soissons (Cluster A). Clusters B and C (5,847 aerial photographs) are significantly larger and are situated further to the east, largely between Vouziers and Metz. Cluster D, consisting of 551 aerial photographs, is situated in the Rhineland-Palatinate in Germany, some 100 kilometres to the north-east of clusters B and C. Several flights were conducted to photograph the German-Luxemburg border and the major roads and rivers in the area. The centre of the final group of 698 aerial photographs (Cluster E) is situated at the confluence of the Rhine and the Moselle. From this area, reconnaissance flights photographed both rivers, Koblenz, and also the major roads in the vicinity.

It is interesting to look at the distribution of the aerial photographs per year by analogy with the analyses from other collections. For this we represented these maps in the same way as for the IWM and AWM collection – by using the trench map reference grid which was in use during World War One. The original British trench map referencing system, used to represent the AWM and IWM collections, is limited to the British theatres of operations. To represent the NARA aerial photographs in the same way, the grid was extended east- and southwards. These squares have identical dimensions and link up perfectly, but are not lettered and numbered.

A visualisation of the 5,376 photographs from 1918 meets the expectations because only photographs of the first three clusters are represented. The dates of the photographs range between 25 April and November 1918. Cluster A consists of photographs taken by the 6th photo section of 88th Squadron between 10 August and 31 October 1918. These photographs are related to actions of the American Expeditionary Forces during the Second battle of the Marne. Chronologically, the photographs of Cluster C are the next group, which were taken to support the Battle of Saint-Mihiel (11-19 September). The majority of the photographs date to the months before the battle and were used to map the German defences. Cluster B contains aerial photographs taken during the Meuse-Argonne offensive (26 September-11 November).
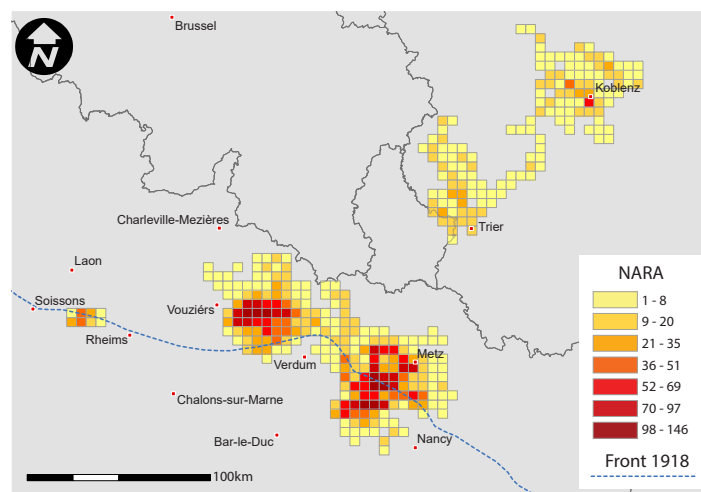

Fig. 44: Density of NARA aerial photographs: 1918-1919.

The analysis of 1,891 of the post-war (1919) aerial photography is more surprising. We expected that each of the post-war photographs would be located in the US-occupied territories in Germany. A group of 642 aerial photographs was however taken between Vouziers and Verdun, photographed by the 24th Squadron, 1st Army. The localisation of the photographs and their dating in 1919 is confirmed by a historic document showing the progress of work on the photographic assignment of the First Army Observation Group. The objectives which needed to be photographed correspond with the battlefield of the Meuse-Argonne offensive. Unfortunately no specific need for this assignment was stated. In our opinion these photographs can be related to the documentation of the destroyed villages at the battlefield. Alternatively, there may have been a necessity for photographs of the battlefield from the viewpoint of the historiography of the AEF. Examples are known where British and French aerial photographs were ordered in the post-war period to document areas where American units had fought but for which no own aerial coverage was available (Maurer 1978).

The remaining 1,249 aerial photographs were taken by photo sections of four different squadrons[29] and are all located in the Rhineland. As part of the 1919 Versailles Treaty, the Rhineland became a demilitarised zone and was occupied by Allied troops. The large ratio of oblique to vertical photographs is unusual and so are many photographs of cultural objects such as castles, fortresses and ruins. These photographs may have been taken for training purposes.

26. Our archival research at NARA took place in December 2006 and this useful tool was not available at the time. Thanks to Matthew Abicht this unpublished document was brought to our attention.

27. ¨divisions are grouped to form army corps, and army corps are grouped to form armies, and the armies are grouped to form an expeditionary force¨ Toulmin, H. (1927). Air Service, American Expeditionary Force 1918. Nashville, The Battery Press.

28. Progress Chart: Progress of Work on photographic assignment. 1 Jan to 10 Jan 1919 – First Army Observation Group.Aerial photos of the AEF. Source: Nara, RG-120,Box 30 of 124.

29. 1st, 12th, 88th and 91st Squadron.

Fig. 45: American aerial photograph of the village of Montfaucon in September 1918 (source: NARA RG 120).

9| Other collections

The AWM houses a diverse collection related to different theatres of war. The Western Front Aerial Photographs Collection is well organised and we succeeded in plotting all the aerial photographs per year in the GIS. This overview clearly demonstrates the uniqueness of the archive. In some map squares additional coverage can be found which is not available at the Imperial War Museum. The coverage is divided into two clusters: a first cluster near Ieper and secondly the area within the triangle formed by Arras, Montdidier and St-Quentin.

Of equal interest is the Western Front Mosaics collection. Most of the 333 mosaics were compiled after the war because the importance of aerial photographs for the comprehension of the battlefield was acknowledged by Australia's chief historian, C. E. W. Bean. The photomosaics are a rewarding source which enables us to have an overview of complete front sectors. However, the cartographic applications are rather limited because of large distortions towards the edges.
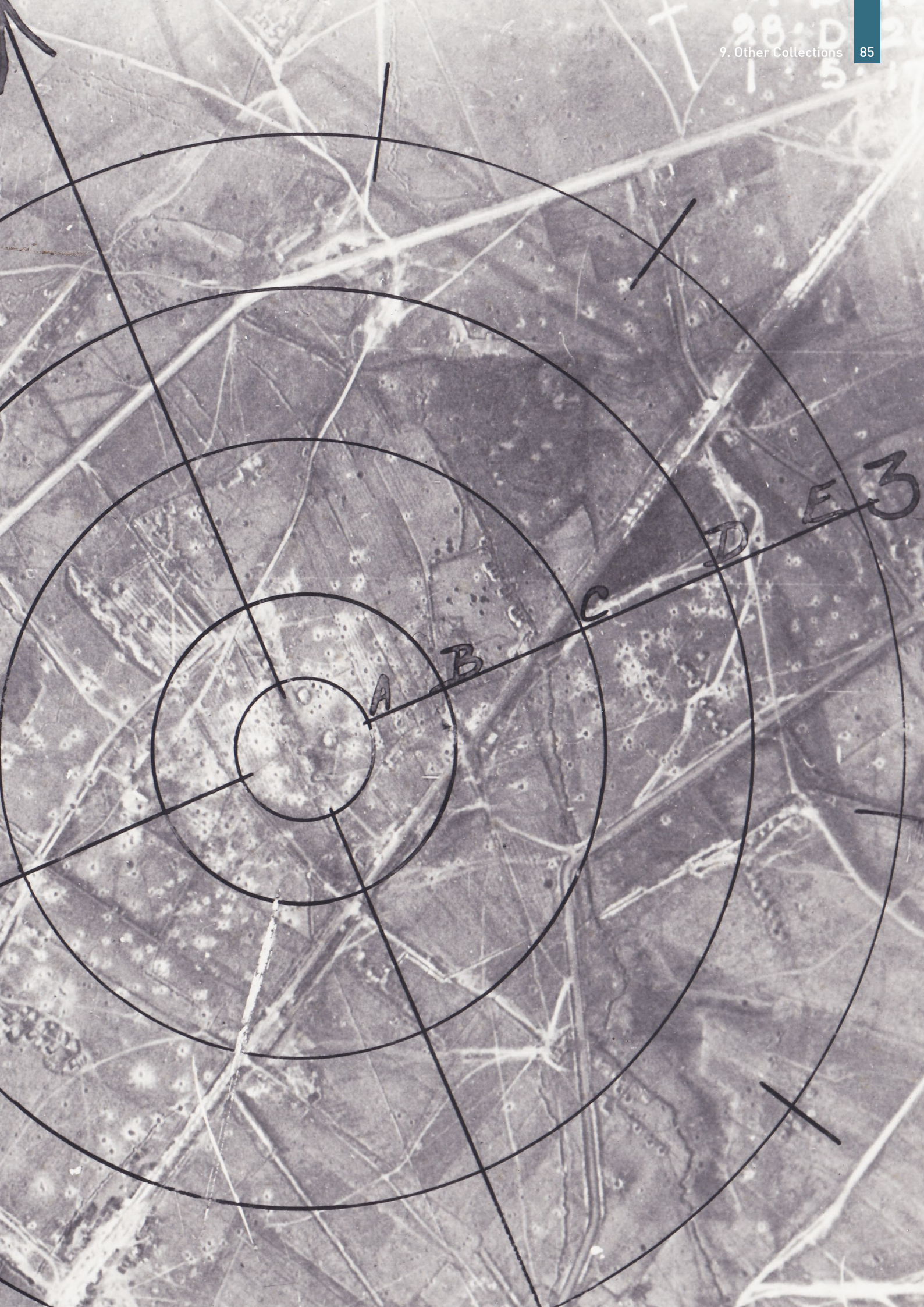
The general aerial collection of the AWM was little known. The intensive analysis of the content elucidates the geographic and temporal distribution of the aerial photograph coverage.

9

Some smaller collections are introduced in this chapter. They were consulted but not included in a GIS overview. The collections are small and/or heterogeneous. however they contain some rare individual aerial photographs which cannot be retrieved from any other archive or museum.

9|1 Service Historique de la Défense - Paris

It is striking that the overview of the main collections does not contain large numbers of French aerial photographs. This does not mean that the French Army did not produce any aerial photographs, but rather that they did not survive in the archives. Recent research has examined what happened with these collections after the end of the war (Beylot 2009). Beylot describes that during the war an archive was created within the Geography Department of the French Army to preserve large numbers of aerial photographs. On 1 July 1918 the archive contained approximately 200,000 aerial photographs of the Western Front, 20,000 of the Italian Front and 1,000 aerial photographs which were taken by the *Armée d'Orient* (Ibid.). In 1923 the archive was split up into different military regions and was unfortunately lost track of (Ibid.).

The *Service Historique de la Défense* at the Château de Vincennes in Paris still contains a collection of 12,000 aerial photographs which were taken during World War One (Ibid.)[30]. This collection is however strongly fragmented and archived without any kind of indexing system. Other French aerial photographs can be found in the US National Archives and Records Administration.

9|2 Musée de l'Armée, Art et Histoire – Paris

The French Museum of the Army, Art and History at Les Invalides houses a collection of aerial photographs. This material was used for the first exhibition dedicated to World War One aerial photography and the exhibition catalogue (Humbert 1988) is still an important reference book on the subject. Unfortunately the map and photograph research room of the museum was closed for renovations during the time span of our research so it was not possible to research the volume, content and distribution of the museum's aerial photographic collection.

According to Beylot (Beylot 2009) the collection comprises 3,000 French aerial photographs and might therefore have a future research potential for some parts of the Western Front.

9|3 Ferko Collection – UTD Texas

A collection of aerial photos is held at the University of Texas at Dallas (UTD). The UTD library contains a huge collection of documents and photographs covering the history of aviation in general (History of Aviation Collection). The topic of World War One aerial photography is covered by the Ferko/Williams World War One Collection. The Ferko collection consists of 528 numbered boxes with all sorts of information related to aviation during World War One. 26 boxes of this collection contain a variety of aerial photographs, covering different dates and theatres of war[31]. Unfortunately, there is no methodical cataloguing system because most folders consist of private photo albums.

Without being complete, the following interesting photographed locations are mentioned: the Ypres salient, the Belgian Coast, German aerodromes in Flanders and France, Saloniki, Jericho, forts and castles in Germany, Dover, Warsaw, Jerusalem and Nazareth. The collection also contains approximately 1,500 aerial photographs in photo albums which were compiled by German aviators. This would explain the large number of photographs taken far behind German lines and especially near and around airfields. Two unnamed boxes contain additional German aerial photographs, catalogued by the German flying unit which took the photographs[32]. Here again it was impossibility to locate specific locations without browsing through the entire collection.

9|4 In Flanders Fields Museum - Ieper

The aerial photographs held at the documentation centre of the In Flanders Fields Museum at Ieper are an amalgamation of Belgian, British and German aerial photographs, some 2,500 in total. An interesting series of photographs was already collected during the war, by an early German aerial photographer, *Leutnant von Kanne* (Chielens 2009, de Meyer 2009).

Although this assemblage is rather small, it is interesting to have an insight into the compilation of such a composed photo album by a contemporary aviator. The remaining part of the collection is mainly concentrated on the Ypres Salient and consists mostly of reproductions of British aerial photographs originating from the Imperial War Museum (de Meyer 2006, de Meyer 2009).

9|5 Other German collections

For a very detailed overview of miscellaneous German collections other than those at the *Bayerisches Hauptstaatsarchiv* in Munich we refer to Haupt (2009). This article outlines the content of a variety of German aerial photographic collections such as, for instance, the *Hauptstaatsarchiv* in Stuttgart, the *Bundesarchiv* in Koblenz and the *Agfa Foto-Historama im Museum Ludwig*.

9|6 Russian State Military History Archive – Moscow

Although not covering the Western Front, the Russian State Military History Archive located in Moscow is mentioned because it contains a research potential for countries in Eastern Europe. No details are available on the content or size of the aerial photographic collection of the Russian army during World War One. But after some difficult correspondence with the archive, it turned out that they have an extensive collection of documents related to the topic covering both aerial photographs of the Eastern Front and material related to the history of Russian military aerial photography. To date, the size of the collection unfortunately remains unknown.

Fig. 47: Oblique American aerial photograph of Trèves aerodrome with an extensive exercise trench system in the foreground (source: NARA RG 120).

10 | First World War aerial photographic coverage of the Western Front

The AWM houses a diverse collection related to different theatres of war. The Western Front Aerial Photographs Collection is well organised and we succeeded in plotting all the aerial photographs per year in the GIS. This overview clearly demonstrates the uniqueness of the archive. In some map squares additional coverage can be found which is not available at the Imperial War Museum. The coverage is divided into two clusters: a first cluster near Ieper and secondly the area within the triangle formed by Arras, Montdidier and St-Quentin.

Of equal interest is the Western Front Mosaics collection. Most of the 333 mosaics were compiled after the war because the importance of aerial photographs for the comprehension of the battlefield was acknowledged by Australia's chief historian, C. E. W. Bean. The photomosaics are a rewarding source which enables us to have an overview of complete front sectors. However, the cartographic applications are rather limited because of large distortions towards the edges.
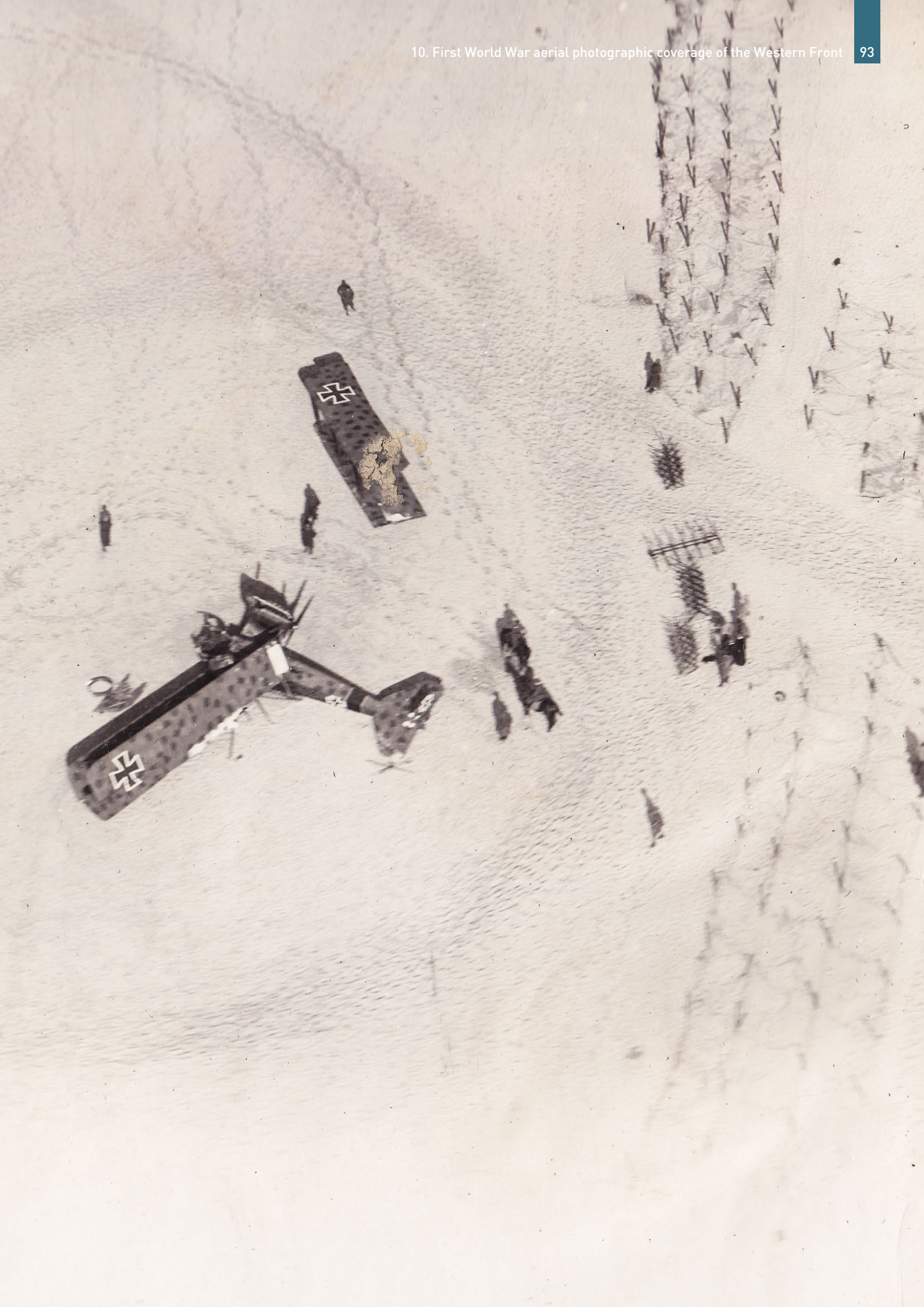
The general aerial collection of the AWM was little known. The intensive analysis of the content elucidates the geographic and temporal distribution of the aerial photograph coverage.

Fig. 48: Crashed German aircraft on the beach at De Panne (In Flanders Fields Museum).

10

The quantities of surviving aerial photographs are enormous: up to several hundreds of thousands of photographs could be tracked. These individual collections form an archival patchwork of aerial coverage, some archives having unique aerial photographs for certain areas, others overlapping to a high degree. These parts however make up a whole landscape of aerial photographs but this overall image has not yet been an object of study.

Most of the limited available publications on archival aspects of historical aerial photographs focus on individual collections (Burch 1966, von Lichem 1985, Braun 1987, Watkis 1999, Fuchs 2000, de Meyer 2006, Stichelbaut 2006) without looking at the overall availability of historical aerial photos.

With the developed GIS approach it becomes possible to combine data from different archives, thus enlarging our research scale to the level of the Western Front landscape. A basic need in this changeover is the possibility to cast the input data in the same mould. The ultimate goal is the construction of a GIS layer capable of showing how much aerial coverage can be expected in the individual archives.

To understand the distribution of all of the accessible Western Front aerial photographic collections we represent all the data in a regular grid that is based on the original map referencing method of the Imperial War Museum (see 5) and the Australian War Memorial (see 6.1.1). Because not all the collections contain information about time at which the photographs were taken, it was only possible to calculate the total number of photographs in each of the trench map squares. The result is a unique layer which represents the sum of all AWM, IWM, NARA, SGRS-S/A and KLM-MRA aerial photographs in a given square.

Unfortunately it is not possible to include the German photographs of the Bavarian state archive in this uniform layer because there is no absolute quantification attached to the located box files (see 7.1.2). Because of the huge importance of the collection, it was decided to represent these aerial photographs by means of graduated symbols (Fig. 49). This legend is weighted by the number of listings of each place name in the finding aid at the Bavarian archive.

The combination and confrontation of this massive amount of information extracted through archival research all over the world gives an interesting and unparalleled view of the availability of aerial photographs (Fig. 49).

Three clusters can immediately be observed. The first and largest group goes from the North Sea in Belgium to Montdidier in France. This cluster consists of photographs taken by both warring parties, although the gravity point of the German photographs lies in the centre between Armentières and Arras. The shifting front lines through the war can be clearly seen on the grid. This cluster covers the Belgian provinces of West and (to a lesser degree) East Flanders and the French regions of Nord-Pas-de-Calais and Picardy. The second cluster is located in Lorraine with some very limited coverage of the neighbouring regions (Champagne-Ardenne, Franche-Compte and Alsace). These areas are only covered by German and American aerial photographs. The eastern limit of the cluster is only covered by German aerial photographs (for instance near Saint-Die). The third group is located in the Rhineland between Trier and Koblenz. These photographs are of American origin and were taken in 1919 as part of the American occupation of the Rhineland.

The areas where aerial coverage is lacking are also important. There is a noticeable gap between the largest clusters, roughly between Compiegne and Vouziers as both the Allied and German collections seem to focus on other areas. This is connected to the absence of Bavarian army operations in the region. From an Allied point of view, the French front line ran from the Somme to the East. Since the French aerial photographic collections are inaccessible and very dispersed (Beylot 2009), these areas can be considered as relatively empty zones. Here, the potential for future aerial photographic research is, according to the present state of research, rather limited. For the easternmost part of the front, from Toul to the French-Swiss border, we are unable to report on the number of aerial photographs. The point locations of the German folders show us that there will be a substantial amount of aerial coverage but unfortunately the organisation of the German collection does not allow us to go into detail.
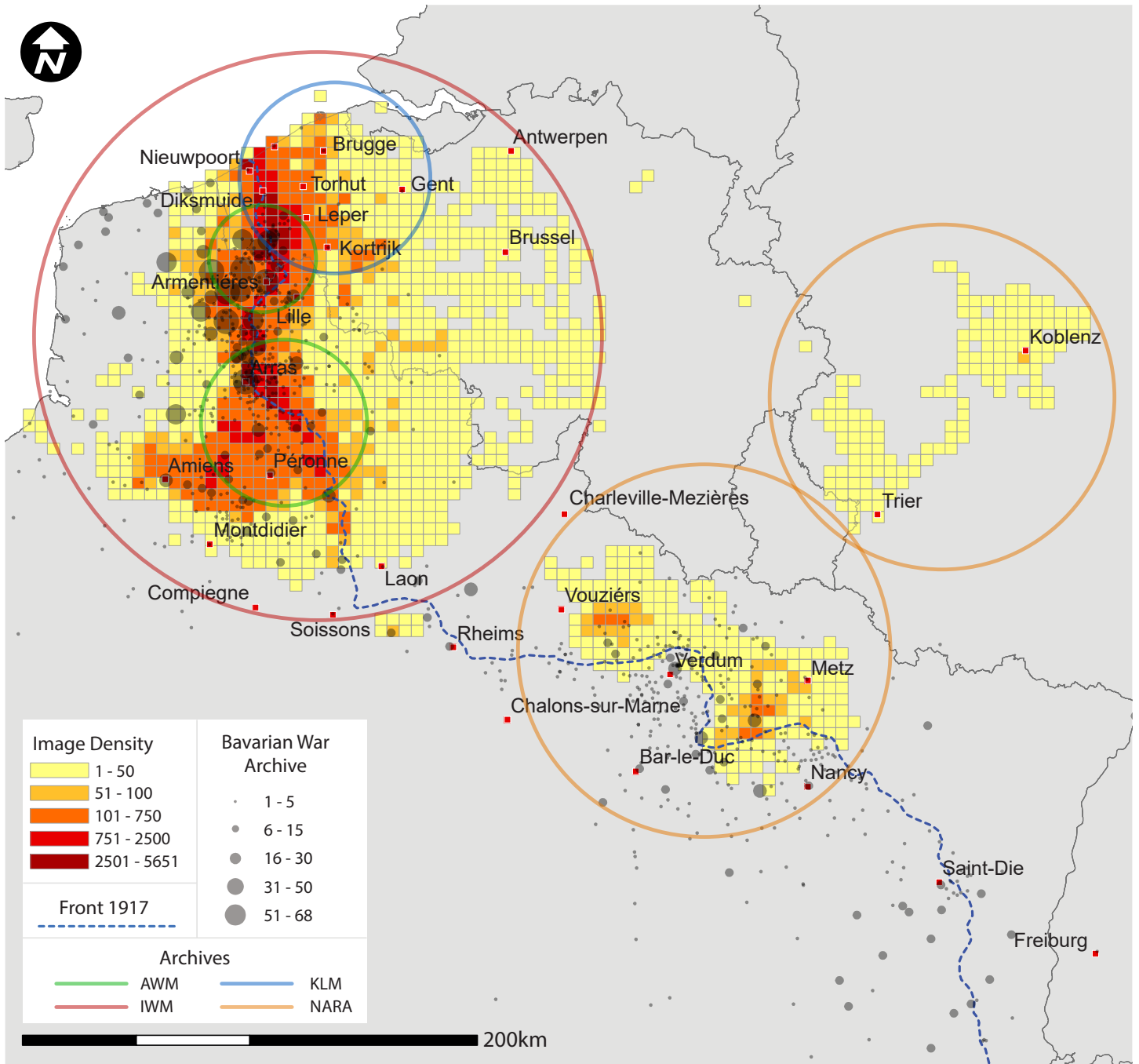
Fig. 49: Distribution of aerial photographic collections along the Western Front.

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FORGOTTEN AND LOST? ARCHIVAL RESEARCH OF AERIAL PHOTOGRAPHIC COLLECTIONS OF THE WESTERN FRONT 1914-1918

A Guide to the Archives

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